ADVANCING ROAD SAFETY IN INDIA
Implementation is the key
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India is undergoing major transformation due to globalization, industrialization, urbanization and technology revolution that has altered health and disease dynamics of Indians. Today, health priorities and efforts are gradually shifting towards control of chronic non-communicable diseases and injuries. More people died due to heart diseases and injuries in India, than communicable diseases in 2015.

Every day, nearly 400 people died in road accidents in India in year 2015; most of them are young in their productive age groups. The number of people who suffered serious injuries is expected to be 30 times more than the number of deaths. These numbers could be much higher considering issues of underreporting. The impact of road accidents on individual, family and society in terms of morbidity, disability, economic and social fall-out is immense. Lack of a powerful and functional road safety authority at national and state level, dedicated funding, inter-sectoral coordination and regular surveillance are a few of the major challenges that needs to be overcome to make significant progress for road safety in India.

Evidence from high income countries clearly indicate that road accidents are predictable and preventable. The UN Decade for road safety (2011-2020) advocates application of 5 pillars (Road safety Management, Safer road infrastructure, Safe vehicles, Safer road use behaviour and Post crash care) as a framework to reduce road accidents and deaths globally. The challenges lie in translating this knowledge to action in India.

NIMHANS provides quality care for persons with brain injuries and at free of cost for poor people. The Dept of Epidemiology / Centre for Public Health at NIMHANS is also the WHO collaborating centre for Injury prevention and safety promotion. The Centre has been actively working in road safety issues since last two decades. The Department has implemented key research cum action projects, developed resource material and trained different categories of professionals, involved in advocacy and provides policy and programmatic inputs for road safety. The Bangalore Road safety and Injury Surveillance Project (2007-12) is one such example that has greatly helped road safety programming in the country.

I am happy that in collaboration with UL India Pvt Ltd., NIMHANS has brought out this much needed comprehensive report on road safety which will serve as a useful resource to advance road safety situation in India. This evidence based report can be used by policy makers, road safety professionals, health managers and researchers, is a wakeup call for all of us to act. I wish them all the best!
India is experiencing increasing road traffic injuries amidst increasing motorization and infrastructure growth in recent years. Every day, nearly 400 road deaths occur on Indian roads and several thousands are hospitalized due to road crashes. WHO estimates the incidence of road deaths to be 16.6 per 100000 population in India. With nearly 3% of all deaths being due to road accidents, and especially with high rates among young people and males, the issue calls for serious and coordinated action from the government and all other stakeholders.

Evidence from high-income countries clearly indicates that road accidents are predictable and preventable. WHO, over time, has facilitated strengthening of road safety programmes at the country level. However, implementation by state and local governments is key to realize sustainable success, and this has been happening at a slow pace and much more needs to be done.

Recognizing the enormity of the problem, the Government of India and governments of its different states have taken several steps in recent years. The Motor Vehicles Amendment Bill 2016 is a landmark step in this direction. Several judicial directives in recent times are aimed at strong actions to be taken by governments. The implementation of these key steps will be an urgent necessity to improve the current scenario. This calls for participation of all key stakeholders in different ministries, industry, academia and civil society to develop coordinated and convergent actions to advance road safety in India. The Regional Office and India Country Office of WHO are major partners in this process in India.

The WHO Collaborating Centre for Injury Prevention and Safety Promotion at NIMHANS has been a major partner in road safety and injury prevention efforts in South-East Asia for several years now and has contributed in a number of ways. The Centre is actively engaged in research, capacity-building, human resource development, advocacy, policy and programme development as well as monitoring and evaluation. The five years of the Bangalore Road Safety Programme is an integrated model with replication. The Centre’s contribution to helmet legislation, reduction of drink driving, pedestrian safety and post-crash care are well known and are built on data-driven programmes.

The United Nations Decade for Road Safety (2011–2020) advocates application of “five pillars” (Road safety management, safer road infrastructure, safe vehicles, safer road use behaviour and post-crash care) as a framework to reduce road accidents and deaths globally. Ensuring road safety is now recognized as a need for sustainable development. The targets set for the same is to halve the global number of deaths and injuries from road traffic crashes by 2020. Information systems to guide further progress need to be improved in this scenario.

This report, by the WHO Collaborating Centre at NIMHANS and Underwriters Laboratories India, has brought available information on road safety in India on one platform that will be useful for many activities among different stakeholders. This public-private collaboration between NIMHANS and Underwriters Laboratories India is also an example of the need for coordinated and convergent actions to strengthen road safety. I strongly hope that this report and the deliberations will move the road safety agenda forward in India.

Dr Poonam Khetrapal Singh
Regional Director
WHO South-East Asia Region
With 400 deaths every day, Indian Roads have become one of the most notorious in the world, and Road Safety is the single biggest Public Safety challenge that we face today. Reports of the NCRB reveal that majority of the victims are below 40 years of age and independent studies and reviews indicate that pedestrians and two-wheelers bear the brunt. And again, the total numbers are growing every year.

Many steps are being discussed to enhance Road Safety covering a wide spectrum of areas— legislation, Infrastructure, Technology, Enforcement, Emergency Response and Education. The recently introduced Motor Vehicle (Amendment Bill) 2016 is a welcome right step. Given the magnitude of the challenge and its multi-dimensional nature, we need a coordinated action that is based on reliable facts and proven safety science.

In 2013, when UL took the decision to join the cause of Road Safety in India, bringing with it, the approach of Safety Science, it was well aware that there will be considerable time before results can be seen. Amongst the many areas that need attention, UL decided to focus on a few— Education and Demonstration Projects being two of them. Also felt was the need for a Status Report that paints a realistic picture of Road Safety in India.

During the year 2016, UL and NIMHANS collaborated to develop the report, Advancing Road Safety in India, building this over the many sets of research reports and statistics available on the subject.

R A Venkitachalam
Vice President— Public Safety Mission
UL India Private Limited
India, one of the biggest democracies in the world, is a topographically, culturally, linguistically and ethnically diverse country. Following market-based economic reforms in 1991, India has witnessed accelerated economic, urban and industrial growth that has transformed Indian society in a significant way. Today, Non-communicable diseases (diabetes, hypertension, cardiovascular diseases, cancers, etc. and Injuries contribute to a greater share of mortality, morbidity and disability in Indian society than communicable diseases.

While many global pundits laud the beneficial effects of globalization, industrialization and urbanization, the reverse side of the coin is also of equal importance in terms of its negative effects. One such negative effect that we see is on Indian roads and road users that has resulted not only in chaos and crisis, but deaths and broken limbs on our roads. With 182.4 million registered vehicles plying for space amidst 5.47 million kilometer road network in 2015, high exposure to traffic environment has grave consequences for health of Indians.

With an estimated million deaths due to injuries (10% of all deaths), one out of five injury deaths occurred on our roads. Official reports state that 148,000 persons died in road accidents in year 2015. Not only have the number of accidents and deaths increased, accident severity (number of persons killed per 100 accidents) has also increased by 35% since 2005. Nearly 30 times the number of deaths sustained injuries that would have resulted in hospitalization. Disabilities due to injury and trauma are significant in this age as the contribution of communicable diseases begins to decline, signifying that lives saved from traditional diseases are only becoming victims of modern day epidemics. If the present slow paced thinking and approaches continue, nearly 240,000 Indians, predominantly young males, are estimated to lose their lives by the year 2030.

Interestingly, unlike other NCDs, most people dying or getting injured in road accidents are males, young and productive section of the population, directly affecting future human resources of the country. State level differentials exist in accidents, deaths and injuries, mainly attributed to socio-economic, cultural and topographical differences as well as reporting practices. Furthermore, it is the poor and middle income sections of Indian society that are affected most. The impact of road accidents on individual, family and society in terms of morbidity, disability, economic and social fall-out, is immense and remains unrecognized.

The scenario was very similar in most High Income Countries of the world till early 1970’s. Many countries turned this scenario and developed – implemented – monitored and – evaluated road safety activities by putting strong systems in place to overcome challenges and barriers in road safety. The results are there in front of us as seen by continuous decline in road deaths and injuries in most countries of the world. Few countries in the world are moving towards Vision Zero with the vision that no one should die on roads.

Now, we know what works, but the challenge is, how to make it work? The beginning of this process lies in good quality and robust data that forms the bedrock for all activities, which is totally deficient in India. The 5 UN pillars of road safety – Road safety management, safe infrastructure, safe vehicles, safe people and post crash care form the guiding principles for implementation. A road map on each of these is the need of the hour.

India has recognized the burden and impact of road crashes, but efforts to address the problem remain far from satisfactory. Our growing graph indicates that – our ongoing efforts are insufficient or our efforts are misprioritised and misdirected. Lack of central and state lead agencies, limited ring fenced funding, poor coordination mechanisms, limited impact of laws, laxity in enforcement, limited safety features on roads and in vehicles, deficient trauma care coupled with absence of public engagement are a few problems plaguing our systems. Far too long, we have relied on informing our people to be safe on roads. Recent judicial engagement and directives is a welcome sign; however implementation of the same to save lives remains to be seen. Adopting public health approaches to control road safety is the need for the hour.

We felt, bringing together all available evidence – information – data – studies on a common platform would lay open the current scenario and provide directions for future activities. The public health perspective places health of people on a high pedestal and is the leading force for all other sectors to convene, converge and coordinate for bringing desired results. This report attempts to provide comprehensive information regarding road safety situation in India from a public health perspective, using information from official reports and research studies. Frequency, distribution and determinants of road accidents and deaths have been delineated, available response systems reviewed and recommendations provided for strengthening the same. The report is intended to cater to policy makers, technical professionals, police, students and general public. The purpose is to examine changes over the last decade in India, identify reasons for the same and provide a framework for subsequent action.

Time is ripe to rethink our strategies to overcome challenges and focus on creating a road safety revolution in the country. There is a need for political commitment like ‘Swacch Bharat’ to ensure this road safety revolution towards a ‘Suraksha Bharat’.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
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<tbody>
<tr>
<td>ADSI</td>
<td>Accidental Deaths and Suicides in India</td>
</tr>
<tr>
<td>BRSP</td>
<td>Bangalore Road Traffic Injury Surveillance Project</td>
</tr>
<tr>
<td>CSR</td>
<td>Corporate Social Responsibility</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GRSSR</td>
<td>Global Road Safety Status Report</td>
</tr>
<tr>
<td>HICs</td>
<td>High Income Countries</td>
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<tr>
<td>LMICs</td>
<td>Low and Middle Income Countries</td>
</tr>
<tr>
<td>MCCD</td>
<td>Medical Certification of Cause of Death</td>
</tr>
<tr>
<td>MoRTH</td>
<td>Ministry of Road Transport and Highways</td>
</tr>
<tr>
<td>MVA</td>
<td>Motor Vehicles Act</td>
</tr>
<tr>
<td>NCRB</td>
<td>National Crime Records Bureau</td>
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<tr>
<td>RTIs</td>
<td>Road Traffic Injuries</td>
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<tr>
<td>RTO</td>
<td>Regional Transport Office</td>
</tr>
<tr>
<td>SRS</td>
<td>Sample Registration System</td>
</tr>
<tr>
<td>TRIPP</td>
<td>Transportation Research And Injury Prevention Programme</td>
</tr>
<tr>
<td>PPP</td>
<td>Public Private Partnership</td>
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<tr>
<td>VRU</td>
<td>Vulnerable Road Users</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>Figure</td>
<td>Description</td>
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<td>-----------------------------------------------------------------------------</td>
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SECTION A
India, one of the biggest democracies in the world is home to a population of 1,336,928,853[1]. The country is a topographically, culturally, linguistically and ethnically diverse federal republic governed under a parliamentary system with 29 states and 7 union territories. Since its independence in 1947, India has nearly doubled in terms of population size, infrastructure as well as overall socioeconomic development, albeit with regional variations. Between 2001 and 2015, the per-capita income of Indians increased more than 5-fold, from ₹17800 to ₹93231/-, while the adult literacy levels increased from 64 % to nearly 75 % (Table 1). Following market-based economic reforms in 1991, India has witnessed an accelerated economic and industrial growth that has changed Indian society in a significant way.

Globalization, urbanization and industrialization have changed people's lives leading to the emergence of newer health issues, referred to as behavior and lifestyle problems. Today, non-communicable diseases (diabetes, hypertension, cardiovascular diseases, cancers etc) and Injuries contribute to a greater share of mortality, morbidity and disability in Indian society than communicable diseases (Table 2). In 2014, non-communicable diseases accounted for 60% of all deaths (5.84 million deaths) [2] and loss of 235 million Disability Adjusted Life Years (DALYs) in India [2].

In recent years, India has witnessed an increase in deaths, hospitalization and disabilities due to injuries. Several factors like globalization, industrialization, migration, access to modern ways of living, increasing income levels, easy availability of vehicles/products, media influence and others have brought human beings in close contact with a variety of new products as well as changing physical environments, resulting in an increased occurrence of injuries and Road Traffic injuries (RTIs).
Table 1: Changing Face of India

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Indicator</th>
<th>2001</th>
<th>2011</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Population</td>
<td>1020000000 $</td>
<td>1210854977 $</td>
<td>1311050527*</td>
</tr>
<tr>
<td>2</td>
<td>Sex ratio (females per 1000 males)</td>
<td>933</td>
<td>940</td>
<td>935</td>
</tr>
<tr>
<td>3</td>
<td>Males (%)</td>
<td>52</td>
<td>51.5</td>
<td>51.9</td>
</tr>
<tr>
<td>4</td>
<td>Females (%)</td>
<td>48</td>
<td>48.5</td>
<td>48.1</td>
</tr>
<tr>
<td>5</td>
<td>&lt;18yrs population (%)</td>
<td>45.6</td>
<td>38.9</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>&gt; 60yrs population (%)</td>
<td>6.4</td>
<td>8.6</td>
<td>8.9*</td>
</tr>
<tr>
<td>7</td>
<td>Overall literacy (%)</td>
<td>64.8</td>
<td>73</td>
<td>71</td>
</tr>
<tr>
<td>7.1</td>
<td>Male literacy (%)</td>
<td>75.3</td>
<td>82.4</td>
<td>83</td>
</tr>
<tr>
<td>7.2</td>
<td>Female literacy (%)</td>
<td>53.7</td>
<td>65.6</td>
<td>67</td>
</tr>
<tr>
<td>8</td>
<td>Urban Population (%)</td>
<td>27.7</td>
<td>31.16</td>
<td>32*</td>
</tr>
<tr>
<td>11</td>
<td>Per capita Income (₹)</td>
<td>23095</td>
<td>64316</td>
<td>87748^</td>
</tr>
<tr>
<td>12</td>
<td>Total no. of Registered Vehicles</td>
<td>54991000</td>
<td>141866000</td>
<td>182445000*</td>
</tr>
<tr>
<td>13</td>
<td>Road length (in Km)</td>
<td>24,69,524</td>
<td>46,90,342</td>
<td>46,89,842#</td>
</tr>
</tbody>
</table>

Source:  
$ Census of India, 2001 and 2011 [7]  
@, Population projection- 71st round of NSSO survey 2014  
^United nation Dept of economic and social affairs/population division.  
# Basic road statistics in India -MoRTH

Table 2: Health Indicators of India (2001-15)

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Indicator</th>
<th>2001</th>
<th>2011</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Crude Birth Rate (per 1000 population)^1</td>
<td>24.28</td>
<td>22.1</td>
<td>20.4*</td>
</tr>
<tr>
<td>2</td>
<td>Crude Death Rate (per 1000 population)^1</td>
<td>8.4</td>
<td>7.2</td>
<td>7*</td>
</tr>
<tr>
<td>3</td>
<td>Life expectancy in years^</td>
<td>62.56</td>
<td>65.96</td>
<td>67**</td>
</tr>
<tr>
<td>4</td>
<td>Infant Mortality rate (per 1000 live births)^2</td>
<td>63</td>
<td>44</td>
<td>37*</td>
</tr>
<tr>
<td>6</td>
<td>Maternal Mortality ratio (per 100,000 live births)^2</td>
<td>301</td>
<td>178</td>
<td>174</td>
</tr>
<tr>
<td>7</td>
<td>Tuberculosis deaths (% of all deaths)^\</td>
<td>5.9</td>
<td>4.1</td>
<td>3.6</td>
</tr>
<tr>
<td>8</td>
<td>HIV deaths (% of all deaths)^</td>
<td>0.46</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>9</td>
<td>Malaria deaths among all deaths (% of all deaths)^</td>
<td>3.07</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>10</td>
<td>Deaths due to Cardiovascular diseases (% of all deaths)^</td>
<td>27.5</td>
<td>28.9</td>
<td>31.6^</td>
</tr>
<tr>
<td>10</td>
<td>Cancer (% of all deaths)^</td>
<td>3.7</td>
<td>5.4</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Source:  
^1 Census of India  
^2 SRS, Registrar General of India  
* WHO Global Health Observatory Data Repository for year 2013  
** World Bank Estimates for year 2014 [9]  
^ World Bank Estimates for year 2015 [10]  
The purpose of the present report is to examine the current scenario of Road Traffic Injuries (RTIs) and road safety in a comprehensive manner from a public health perspective. The report brings together available Indian data, both published and unpublished, and examine the progress made or to be made in the coming years so that suitable remedial measures can be taken by policy makers, professionals and political leaders to save lives.

From a public health perspective, it is essential to bring together all the available (though limited) Indian data to identify gaps in our understanding of road crashes in terms of its burden, determinants and impact to set the stage for further research, policy initiatives and future developments.

Along with developing a national profile and patterns of road crashes, the report also examines road safety in the 29 Indian states and provides key information on vital aspects as state fact sheets (provided in report Advancing Road Safety in India - Implementation is the key: Facts and Figures). National data as available in reports are widely spread out and consolidated information is unavailable. Beginning with information on a few vital aspects, the aim is to gradually develop detailed state reports in the coming days. Road safety being primarily a state responsibility, such data is essential to develop state specific policies, programs and interventions.

Most significantly, The Government of India has recently formulated amendments to India Motor Vehicles Act, 2016 (approved in LokSabha and awaiting approval of Rajya Sabha) with sweeping changes to road safety provisions in many areas. The new format of accident documentation and reporting has also been introduced in March 2017. Simultaneously, many other reforms through court directives are in place. Ministry of Health has introduced many new initiatives for trauma care. With the passage of bill and implementation of these initiatives across states, it would be useful to understand its impact in the coming days. Hence a baseline report at this juncture was felt as an essential requirement to measure progress over time.

In addition, there has been a growing interest by several agencies/professionals/researchers in the area of road safety since the beginning of the decade of road safety. Many of these partners have been requesting the WHO CC for general and specific information on road safety scenario and data on different aspects as a national consolidated report is not available. In view of this it was felt essential to bring together all available data on road safety scenario in India from a public health perspective to aid and strengthen activities in the coming years.

The specific objectives of this India Road Safety Report are to

- Assess the current burden of RTIs in terms of mortality, morbidity and disability(ies)
- Delineate the characteristics and distribution of RTIs
- Understand the various risk factors for road crashes
- Examine the outcomes and impact of RTIs
- Identify the burden and pattern in all Indian states
- Review intervention strategies and approaches
- Understand ongoing mechanisms and polices for RTI prevention
- Trace the major global developments and lessons learnt
- Provide a framework for implementing road safety policies, programmes and interventions
METHODS

The sources of data for this report were drawn from all available national reports (consecutive annual reports of Road accidents in India by the Ministry of Road Transport and Highways (MoRTH), Accidental deaths and suicides in India by NCRB, Basic Road statistics of India – MoRTH, National Family Health Survey 3, reports of the National Highway Authority, individual reports from the Ministry of Transport, Law commission reports, published road safety reports from TRIPP, Medical Certification of Cause of Death, Survey of Cause of Death, Bangalore Road Safety and Injury Surveillance Program etc., as well as from the international data bases of the World Health Organization, Global Burden of Disease, World bank, World Road Statistics, IRTAD reports and others. In addition,

• An extensive literature search for published research articles was undertaken using “select key search words” from different sources like Medline/ PubMed; Google Scholar; Safety Lit; Cochrane Library; Embase, Proquest and Indmed. Individual articles were procured from different journals. In addition, an open search was undertaken on all key words of enquiry. Articles and information published after 2000, in the English language and specific to India are included in this report.

• Unpublished information was obtained through personal contacts, snow ball techniques and other methods. Key newspaper clippings and interesting case studies were also collated from leading Indian newspapers.

• Information was gathered from national and state agencies and from the documents and websites of related ministries.

• Visits were undertaken to police stations and interactions were held with police officials and other subject experts.

• In total, we reviewed more than 30 national reports, around 250 published articles and a large body of unpublished literature for the preparation of this report. (A review matrix with multiple worksheets were created for different variables pertaining to injuries example: Worksheet 1: Incidence of road traffic accidents, Worksheet 2: Road traffic deaths etc).
An ‘Injury’ results from a sudden exposure to physical agents such as mechanical energy, heat, electricity, chemicals and ionizing radiation that interacts with the body in amounts or at rates that exceed the threshold of human tolerance. In some cases (drowning, frostbite) injuries also result from the sudden lack of essential agents such as oxygen or heat (WHO) [14]. This acute exposure and consequent interaction of human – agent and environment results in organ damage when it exceeds the physiological tolerance of the individual [15]. Injuries are commonly referred to as ‘accidents’ which is a term that is considered inappropriate in scientific parlance. By definition, an accident means ‘something which is unexpected and unanticipated and in which nothing can be done towards prevention or reduction of the same’.

Injuries are broadly classified in different ways by different professional groups. Generally, based on intent, they are classified as unintentional and intentional injuries (difficult to demarcate at times). Unintentional injuries include road traffic injuries (RTIs), falls, burns, drowning, mechanical injuries, poisoning, fall of objects, sports injuries and others, while intentional injuries include suicide, homicide and violence of different types (interpersonal, youth, domestic, etc.) and classified under ICD 10 categories. Injuries are also classified based on the place of their occurrence like road traffic injuries, home injuries, work place injuries, recreational injuries, etc. Based on the nature of occupation they are also referred to as transport injuries, home injuries, water sport injuries and occupational injuries. In recent times, this has deepened further by focusing more on products people use like motor vehicle injuries, poisoning injuries, fire injuries, etc[16] Furthermore, injuries are also classified based on the anatomical part of the injured organs like brain injury, limb injury, abdominal injury and other types as per ICD 10 anatomical codes.

Figure 1:
Leading causes of death (2012 and 2030)
Injuries– Global scenario

Globally, nearly 5 million people die each year (73 deaths per 100,000 population) due to injuries which is equivalent to 14,000 people dying every day and one person dying every six seconds. Injuries account for 9% of global deaths, nearly 1.7 times more than the combined number of fatalities from HIV/AIDS, tuberculosis and malaria [17-18]. RTIs (325736) and suicides (242903) are the leading causes of death among young people in the 15-29 year bracket. RTIs are expected to rise to the 7th position in the list of causes of death by the year 2030 (Figure 1) [17].

Nearly 90% of these injury deaths occur in low and middle income countries of the world [17]. According to the Global burden of Disease (GBD) and Injury study (2015), 1.01 billion people sustained injuries that warranted some type of healthcare and 4.7 million people died due to injuries (2015), (ratio of one death per 215 injuries). Of the 2464.8 million DALYs lost due to all diseases, 249 million (10.1%) were due to injuries [19]. Among all causes of injury, RTIs account for a quarter of the deaths, suicides and homicides for another quarter and the remaining half are because of falls, drowning and burns [19].

Injuries – Indian scenario

A scientific and in-depth understanding of the injury scenario in India is limited due to the lack of good quality data even though they are a major cause of deaths, hospitalization and disabilities. At the national level, the information on injury deaths are available from different sources like the Registrar General of India (Medical Certification of Cause of Death (MCCD), the Survey of Cause of Death (SCD), the National Crime Report Bureau (NCRB). World Health Organization (WHO) estimates, the Global Burden of Disease (GBD) study and from limited independent studies. The examination of different national data sources indicates that injuries account for 7.5-12% of all deaths and variations are attributed to the difference in data sources and ascertainment methods. (Table 3)

<table>
<thead>
<tr>
<th>Report/study</th>
<th>Source</th>
<th>Injuries</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey of Cause of Death</td>
<td>Office of Registrar General of India</td>
<td>10.6% of all deaths</td>
<td>Representative sample of rural and urban areas</td>
<td>Misclassification of causes exists.</td>
</tr>
<tr>
<td>Medical Certification of Cause of Death</td>
<td>Office of Registrar General of India.</td>
<td>7.5% of all deaths</td>
<td>Cumulative reports from urban hospitals</td>
<td>Covers only deaths in urban medical institutions and not uniform across the states.</td>
</tr>
<tr>
<td>Accidents and suicides in India</td>
<td>National Crime Record Bureau of Ministry of Home Affairs</td>
<td>45.1 per 100,000 population</td>
<td>Based on police reported data collated from all state crime record</td>
<td>Coverage, completeness and quality of data are unclear.</td>
</tr>
<tr>
<td>World Health Statistics-2015</td>
<td>World Health Organization</td>
<td>9% of all deaths 112 per 100,000 population</td>
<td>Information on indicators in a comparable manner across countries and conditions</td>
<td>Estimates based on data provided by respective countries. Data systems widely differ across countries in validity and reliability</td>
</tr>
<tr>
<td>Global Burden of Disease data estimates</td>
<td>Morbidity estimation was based on multiple data sets, and seven follow-up studies with patient-reported long-term outcome measures.</td>
<td>10.1% of all deaths</td>
<td>Modeling of cause of death based on best available data</td>
<td>Estimates based on data available</td>
</tr>
<tr>
<td>Million Death Study</td>
<td>Nationally representative mortality survey of 1.1 million households</td>
<td>7% of all deaths 58 per 100000 population</td>
<td>Population based study using verbal autopsy methods</td>
<td>Reporting of events by people and based on time to recall</td>
</tr>
</tbody>
</table>
NCRB-2015 reports a total of 547,080 deaths due to injuries with 75% due to accidents (natural and unnatural) [21], while WHO and GBD estimates indicate 1,212,844 [18] and 4,725,100 [19] deaths, respectively. Different national data sources reiterate that injuries in general account for 10.2% of all deaths in India and findings from independent studies vary from 4.9% to 50% depending on the place of data collection and the methodology used.

The Survey of Cause of Death 2010-2013, revealed that injuries accounted for 10.6% of all deaths and a higher percentage of it in the age group of 15-29 years (25%), males (12.4% of all male deaths) and in rural areas (11% of all deaths in rural areas) [20]. A national review of the injury and violence burden in India confirms these findings and considering the issue of underreporting, a million deaths could be estimated to occur each year due to injuries, but the number of injured is not clearly known. As shown in Table 4, studies using verbal autopsy methods or detailed enquiries in general population surveys indicate injury mortality rates to range from 7-18.9 per 100,000 population, while the injury incidence varies from 4.9% to 30% in population based studies.

Deaths that are commonly reported and discussed are only the tip of the iceberg. As per the WHO, for every death, nearly 30 – 50 persons are hospitalized and hundreds seek emergency care [17,36]. In the absence of national surveillance systems and trauma registries, quantifying the number of injured and hospitalized is a difficult task. Data from the Bangalore study revealed this ratio to be 1:35 for deaths and hospitalizations [23] while a population based survey from rural Haryana indicated this ratio to be 1:29:69 for death, hospitalization and minor injuries [24]. Other independent studies confirm this observation as well. The numbers of those not seeking care, referred to as minor injuries can only be a guestimate.

Figure 2: Mortality due to injuries from different sources (% of all deaths)

![Figure 2](image)

Figure 3: Injury Pyramid

![Figure 3](image)
Apart from limited national data sources, a few population based studies indicate that injuries are a much bigger problem showing that national figures are an underestimation of the actual situation. Quantification of the number of persons experiencing injury is complex and difficult because most minor injuries do not get reported in health care facilities/the police nor do the affected seek care for the same. Comparisons are difficult and extrapolations are to be made with caution due to methodological differences in terms of case definition, assessment tools, classification, nature of sample, sample size, statistical analyses and other issues.

A few hospital studies from different parts of India also indicate the high rates of deaths due to injuries which account for 16-20% of all emergency room registrations. (Table 4). Data from 5 years of the Bangalore Road Safety and Injury Prevention program showed that injuries accounted for 20 % of emergency room registrations, 10 % of hospital admissions and nearly a third of hospital deaths, with disproportionately higher rates in the 15 – 44 year age group as well as in the male population.

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Sample (Study period)</th>
<th>Setting</th>
<th>Finding</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Place</th>
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<th>Setting</th>
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</tr>
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</table>

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<th>Author</th>
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<th>Sample (Study period)</th>
<th>Setting</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Jagnoor J et al</td>
<td>2012</td>
<td>Nationally representative sample</td>
<td>1.1 million homes (2005)</td>
<td>P</td>
<td>7*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Sample (Study period)</th>
<th>Setting</th>
<th>Finding</th>
</tr>
</thead>
</table>

Study setting: H= Hospital based study, P= Population based study, PS= Police record study
* Unintentional injuries only

The conclusions are unanimous with regard to the fact that injuries affect younger age groups with a male preponderance. Interestingly, though injuries account for around 10 % of all deaths, it is the leading cause of death in the age groups of 15-24 years and 25-34 years, where it accounts for 24.9 per cent and 22.0 per cent of all deaths, respectively. Injury mortality as per NCRB reports is 45.1 per 100,000 population, in the age group of 15 – 34 years [21]. Data from the Million-Death Study and other studies substantiate
these findings. Similarly rates among men and women are 34.6 and 10.5 per 100,000 population respectively, indicating the disproportionately higher incidence in males as compared to females.

Globally, among all causes of injury deaths, RTIs account for a third, homicides and suicides for another quarter while the remaining are due to falls, drowning and burns [17]. In India, 36% of unnatural accident deaths were due to road crashes (NCRB-2015) making it a leading cause of injury death [21]. The pattern might vary at local or state levels as seen by data from 5 years in Bangalore with road crashes accounting for 20% of urban and 32% of rural deaths[29,34].

Injury outcomes are also measured in terms of Disability Adjusted Life Years (DALYs) reflecting the combination of premature mortality and years lived with disability. Nearly 66,769,700 DALYs were lost due to injuries accounting for 12.4% of total DALYs lost due to all diseases in India as per GBD estimates (GHE, 2012). The consequences and outcomes of injuries are several ranging from instantaneous death (commonly referred to as ‘on the spot’ deaths) to lifelong disabilities. The intermediate outcomes are several, based on the type of injury and are influenced by several factors including awareness, availability, accessibility and affordability of post-injury care. Apart from hospitalization for varying lengths of time based on the severity and nature of injury, disfigurements, disabilities, health conditions and the compromised quality of life of affected individuals and families is a significant issue. The extent of psychological trauma experienced by individuals and families is often difficult to quantify even with advanced research methods.

The economic impact of injuries is huge and phenomenal and is estimated to cost approximately 5% of the GDP, with injuries due to road crashes alone accounting for 3% of the GDP [35]. Data on this is limited in India and the selective impact of road crashes (referred as accidents also) is discussed in later sections of this report.
The Global Road Safety Report-2015 indicates that nearly 1.25 million deaths occurred worldwide due to RTIs in 2013 with a mortality rate of 17.4/100000 population. The highest fatality was observed in the African region with road deaths accounting for 26.6 per 100,000 population, while the South-East Asia region accounted for 17 per 100,000 population. The lowest rates were seen in the European region (9.3). The report also concluded that deaths from road crashes far exceed the combined deaths due to HIV, Malaria and Tuberculosis in the world. [36].

Around 97 million RTIs occurred globally in 2013 with a rate of 1081 RTIs per 100,000 population.

The Low and Middle Income Countries (LMICs) account for 82% of the population and 90% of road deaths while having only 56% of the global vehicles. This scenario is likely to change in the coming years depending on the economic growth and productivity of individual countries. Mortality in LMICs (24.1 per 100000 population) was nearly 2.5 times higher than HICs (9.2 per 100000 population). Since 2007, the deaths due to road accidents have slowed down and reached a plateau reflecting on the efforts put forth by different countries in slowing down the epidemic. Since 2007, 79 countries have seen a decrease in the absolute number of deaths while in 68 other countries, it is on the rise. [36].

*Figure 5: Population, road traffic deaths and registered motorized vehicles by country income status*
Since time immemorial, movement of people and transportation of goods have been essential neural links in the growth and development of societies. People who are road users, vehicles that are delivery channels, the road environment that is the medium of delivery and the larger systems that govern these activities are all partners of national growth and development.

Every day, millions of people ranging from the young to old, male to female, rich to poor and urban to rural use Indian roads for a variety of purposes, for varying durations, in different patterns and through different modes. Their behaviors and patterns on roads are influenced by their own knowledge, attitude and behaviour, the environment in which they travel and the type of vehicles they use amidst presence or absence of safety policies and programs. These varied moods, behaviors and road use patterns influence their safety.

Every day, more than 50 different types of vehicles of different size, capacity and power traverse through Indian roads, competing with each other in the limited existing space. These vehicles have different manufacturing processes, acceleration, speed, stability, maneuverability and come with some safety (some Indian vehicles), limited safety (imported technology!) or no safety at all (like animal drawn vehicles).

Every day, these various vehicles travel on a variety of Indian roads that are urban - municipal - rural, highway - non-highway, arterial - non-arterial, and that are constructed using different road technologies. The development, maintenance, operation, investment and certification of these roads rests with multiple agencies at different levels as safety and infrastructure is the divided responsibility of not only the central and state governments but also local district authorities. The development of public transportation facilities in urban areas through metro services and mass transport facilities though worthy of consideration, is a recent phenomenon and is far from satisfactory.

This triple combination of people, vehicles and road environments has resulted in heterogeneous transport and traffic environments and is one of the primary reasons for various types of conflict on Indian roads. These conflicts range from minor skirmishes to fatal crashes and are glaring affront on the whole country and the globe. Every day, people are angry, upset and outraged at the large number of deaths and injuries on roads, especially at times of mass casualties. It is common to see people raising slogans, marching in protest and expressing outrage in social media chats. Often vehicles are burnt, drivers thrashed, and property damaged apart from the losses inflicted by the road accidents themselves. Enquiries by authorities, investigations, visits to the site by local political leaders and administrators only result in knee jerk reactions and populist announcements. A deeper look at this societal reaction indicates the lack of safety on roads, denial of safety and limited efforts to make people safe on roads.

Multiple national and state stake holders are engaged in road safety as this area spans transport, police, health and behavioral issues and only recently are being recognized as a public health problem. In India, road crashes are medico legal offenses as per Sections 279, 304A, and 336 to 338 of the Indian Penal Code and as per the Indian Motor Vehicles act- 1988, every death gets (has to be) registered and investigated at some level (Indian Penal Code). In addition, traffic violations by road users are booked under a variety of rules which vary from state to state. The lack of coordination between multiple agencies has been found to be the single greatest problem and mechanisms are not in place to address this issues. The mechanisms to address road safety in India have also witnessed numerous guidelines, legislations, amendments, court directives, empowered and non-empowered committees at both the central and state levels.
Most significantly, road safety is a shared responsibility of nearly 15 different ministries, agencies and bodies at both the central and state levels with each sector making its own efforts. Furthermore, with health, enforcement, transport, law and welfare being on the concurrent state list, the state governments have the freedom and the independence to either abide by or modify the legal and regulatory provisions of the central government and hence, can make their own guidelines and laws. The National and State Road Safety Councils do exist, but are mere recommendatory bodies, varying in their functioning from state to state. Across the country, at both the central and state levels, there is no single responsible road safety lead organization that has the power and authority to direct, guide, fund, coordinate, monitor and supervise road safety activities. Previous attempts to establish such mechanisms have failed due to the lack of political consensus.

Amidst this chaos, Indian efforts to reduce the burden and consequences of road crashes are seriously compromised due to the lack of good quality data and evidence. Data and information systems regarding injuries and road crashes are scattered as they are generated by multiple sectors (to fulfill the objectives of their respective sectors) and are not integrated. Comprehensive data that can guide road safety policies and programs is missing as integrated data systems in the health, police and transport sectors are lacking and disjointed in nature. Amidst these chaotic, confusing and conflicting scenarios, thousands of persons get killed, injured and disabled on Indian roads. This calls for an in-depth and holistic understanding of the road safety scenario in India in order to recognize and delineate the problems, identify solutions, suggest mechanisms to bring issues to the attention of political leaders, policy makers, professionals, the media and society at large so that urgent actions can be taken. A comprehensive situation update summarizing the burden, larger impact and change in the road safety scenario that stems from existing information systems and aids in planning – implementing – funding – monitoring and evaluating road safety interventions on a broader health and social perspective is the need of the hour.
Globally, road safety in every country is largely driven at the macro level by motorization patterns consequent to globalization, industrialization, urbanization, migration and technological growth which in turn is driven by policies and programs of other sectors and vice versa. At the societal level, many factors like income levels of families, media influences, economic growth and others have an equally impacting influence. Broadly speaking, the key changes that have accompanied road safety in India can be attributed to several reforms in the Indian region and the progress made over the years. As road safety is linked to these changes it is essential to track major changes in some key domains.

**MACRO AND MICRO DRIVERS OF ROAD SAFETY**

**Indian demographics**

The population of India increased from 1,028,610,328 (1.028 billion, Census 2001) to 1,311,050,527 (1.311 billion) in the year 2015 (an increase of 27%). Apart from the increase in absolute numbers, an increase was observed in specific vulnerable groups like the elderly (from 6.4% in 2001 to 8.9% in 2011, an increase of 39%). The Indian population comprises of approximately 232 million youth (15-24 years), the proportion of which has witnessed a decadal growth of 22.5% between 2001-2011. Young people (10-24 years, youth and adolescents) constitute nearly 30% of the population [7]. Being in the formative years of their lives (in terms of education, occupation, marriage and entertainment) they are potential drivers of travel and transport in India as they regularly commute to schools, colleges, work or leisure. (Table 1).

**Industrialization**

Industrialization implies a transformation from a primarily agrarian society into one based on the manufacturing of goods and its associated services on a large scale by mechanized mass production and assembly lines[37]. The first factory in India was set up by the East India Company in Surat, Gujarat in 1608, followed by another in 1611 in Masulipatnam in Tamil Nadu. [38]. Since then, the number of industries in India has increased nearly 37 times from 6141 in 1948 to 231,519 in 2015[39]. In 2015, Tamil Nadu (36996), Maharashtra (28125), Andhra Pradesh (27708) and Gujarat (22220) were reported as the states with the highest number of industries in India. Nearly 67% of Indian industries are located in the 4 southern states (Tamil Nadu, Maharashtra, Andhra Pradesh and Karnataka [39]. Despite this growth in the organized sector, it is vital to note that the country is a witness to the unknown growth of the unorganized sector as nearly 80-90% of all workers are in this sphere [40]. Industrial zones at the time of their inception were isolated in time and space from dense human congregations, in designated industrial areas outside cities. Industrialization also catalyzes extensive motorization and road development, mainly centered around the transportation of goods, raw materials and the movement of people. These changes bring people into closer contact with vehicles and roads, thus increasing their exposure to complex familiar and unfamiliar traffic environments.

**Urbanization**

Urban areas are defined as places with a municipality, corporation, cantonment board or notified town area committee as also other places which satisfy all of the following three criteria:

a. a minimum population of 5000,

b. at least 75 per cent of the male population working mainly in non-agricultural pursuits and

c. a population density at least 400 persons per sq. km[41]. It basically implies large numbers of people become permanently concentrated in relatively small areas, thus forming cities or urban agglomerations.
Data from the Census 2011 reveals that 31.1% of the Indian population are urban residents [42]. A country is considered urbanized when over 50 per cent of its population lives in urban areas (Long 1998). Urbanization is increasing by the day owing to the migration of people for a variety of reasons like trade, education, occupation, health care as well as due to natural growth.

During the decade 2001-11, the urban Indian population increased from 27.7% in 2001 to 31.1% in 2011, an increase of 12.5% (Table 5) [43]. As of 2017, an estimated 510 million people reside in urban India. It is estimated that by the year 2030, nearly 40.76% of the Indian population would be urban and with rapid urbanization 70% of the country’s GDP would be from urban areas.[44] Rapid, unplanned urbanization places a huge burden on infrastructure and other civic amenities, including transportation. Countering the growth of vehicular density to meet the transportation needs of the growing urban population is a challenge for urban planners.

### Table 5: Population, vehicles and road growth in urban India

<table>
<thead>
<tr>
<th>Year</th>
<th>Urban population % *</th>
<th>Urban road length in km@ (%)*</th>
<th>India Vehicle population # (000's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>28%</td>
<td>252001 (10.2)</td>
<td>54991</td>
</tr>
<tr>
<td>2006</td>
<td>30%</td>
<td>291991 (9.7)</td>
<td>89618</td>
</tr>
<tr>
<td>2011</td>
<td>31%</td>
<td>411324 (8.8)</td>
<td>141866</td>
</tr>
<tr>
<td>2012</td>
<td>32%</td>
<td>464294 (9.5)</td>
<td>159491</td>
</tr>
</tbody>
</table>

* % of total road length in India

### Migration

“Movement of people to a new area or country in order to find work or better living conditions” is often referred to as migration [45] This can be internal (within the country, rural to urban areas) or external (across the borders). Internal migration especially from rural to urban areas is fuelled by the exploration of better opportunities and living standards due to the existing inequities in various socio-economic parameters like housing, health care, education, employment and others between urban and rural areas. Over the last three decades, internal migration has contributed to a 20% increase  in the urban population, while the number of migrants increased from 314 million (1991-2001) to 453 million (2001-2011) in this decade [7]

### Motorization patterns:

From horse driven carriages to hovercrafts, the transportation sector has undergone a huge technological transformation. Open market economies, liberalized trade policies, enabling environments for vehicle purchase (financing, used car market, efficient post sales service) coupled with competition among manufacturers and aggressive media promotion have enhanced the Indian's accessibility to transportation technology and vehicles.

Measures of motorization include the number of registered vehicles, vehicles per unit kilometers and vehicles per unit population. The total number of registered vehicles refers to the number of vehicles registered with the competent authority and is not indicative of the actual number of vehicles plying on the road as it does not exclude unused, damaged or condemned vehicles . As a ratio measure, vehicles per 1000 km of road network provides the information on the density of vehicles on the roads.

### Table 6: Types of vehicles and road length in India [6,46]

<table>
<thead>
<tr>
<th>Year</th>
<th>Total vehicles In million</th>
<th>Two wheelers</th>
<th>Cars, jeeps, taxis</th>
<th>Buses</th>
<th>Goods vehicles</th>
<th>Others</th>
<th>Total Road length (in 00,000's kms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>54.99</td>
<td>70.1</td>
<td>12.8</td>
<td>1.2</td>
<td>5.4</td>
<td>10.5</td>
<td>33.73</td>
</tr>
<tr>
<td>2005</td>
<td>81.5</td>
<td>72.1</td>
<td>12.7</td>
<td>1.1</td>
<td>4.9</td>
<td>9.1</td>
<td>38.09</td>
</tr>
<tr>
<td>2010</td>
<td>127.7</td>
<td>71.7</td>
<td>13.5</td>
<td>1.2</td>
<td>5.0</td>
<td>8.6</td>
<td>46.76</td>
</tr>
<tr>
<td>2013</td>
<td>182.4</td>
<td>73</td>
<td>13.0</td>
<td>1</td>
<td>5</td>
<td>8</td>
<td>54.02</td>
</tr>
</tbody>
</table>
Globally, India ranks 4th in terms of vehicular population, with 117 vehicles per 1000 population (2013). Number of vehicles has steadily increased over the past decade from 54.99 million in 2001 to 182.4 million in 2013 with the addition of 127.5 (232% increase) million vehicles added to 20.3 lakh km of new road network since 2001 in India. This is equivalent to addition of 63 vehicles for every kilometer of new road and nearly 30,000 vehicles every day, since 2001. [47] Transport year book 2015 (MoRTH) indicate that there are nearly 210 million registered vehicles as of March 2015 in India (73.5% two wheelers, 13.6% cars, jeeps, taxis, 1% buses, 4.4% goods vehicles and 7.5% other kinds of vehicles).[48]

As per the census 2011, the vehicle ownership among Indians is reported to be 117 vehicles per 1000, and this is likely to increase in the coming years which would add to the complexities of transport environments. About 21 per cent of households have two wheelers, whereas only about 4.7 per cent of households in India have cars/jeeps/vans [7]. Both the number of cars and two-wheelers have increased nearly three times since the year 2001 (Cars - 7,058,000 in 2001 to 24,853,000 in 2013, Two-wheelers- 38,556,000 in 2001 to 132,550,000 in 2013).

Figure 6: Trends in motorization in India (2001-2015)

![Figure 6: Trends in motorization in India (2001-2015)](image)

Figure 7: Distribution of different vehicle types (2013)

![Figure 7: Distribution of different vehicle types (2013)](image)

Vehicular density on Indian Roads

The number of vehicles per kilometer of road length is called vehicular density and indicates the infrastructure sufficiency for transportation. The average number of vehicles per kilometer road length has increased from 2.8 vehicles per km in the year 2000 to 31 vehicles per km in 2011[49]. Vehicular density decreases either by increasing the road network or by regulating the rate of growth of vehicles.

Vehicular growth in Indian states and cities

The motorization pattern is not uniform throughout the country with the southern Indian states undergoing motorization at a faster rate than the northern states. The Union territory of Chandigarh ranks at the top with 702 vehicles per 1000 population followed by Pondicherry with 521 vehicles per 1000 population, while the State of Bihar scores the lowest with 31 vehicles per 1000 population[50]. Among Indian cities, Delhi has the largest number of vehicles as well as vehicles per 1000 population, followed by Bengaluru. Mumbai, in spite of being the 2nd most populous city in Asia has lesser number of vehicles per 1000 population which is attributed to the wide use of the railway transport system. [50].

However, estimates from the Expert Committee on Auto Fuel Policy indicates that the actual number of registered vehicles on the road is estimated to be only 50%-55% of those on the records, as many registered vehicles are not used and condemned vehicles are not deleted from the list of registered vehicles.[51]. With regard to road safety assessments this has serious implications as the current estimates like injuries per 1000 vehicles, deaths per 1000 vehicles and even vehicular density are based on the number of registered vehicles for all calculations. Recalculation using the actual number of vehicles on the road would project much higher estimates of injuries per 1000 vehicles and fatalities per 1000 vehicles than what is currently presented in national reports.
Infrastructure growth

With 54,72,144 kilometres of roads traversing the country, India has the second largest road network in the world [6] which transports 65% of the freight and 85% of the passenger traffic. [52] The total road length increased significantly from 0.39 million kilometres in 1951 to 5.40 million kilometres in 2014 and further to 5.47 million kms in 2015. In the last decade (2001 to 2011), the road length increased from 252001 kms to 464294 kms showing an 84% increase.

The urban road network increased by 84 % from 252001 kms in 2001 to 464294 in 2012 (an increase of 212293kms), equivalent to an increase of 19300 kilometers every year or 50 kilometers every day. With the goal of the government being to add 40 kms per day (increasing at only 18 – 20 kms per day), this scenario is likely to change in the coming years. The NHAI classifies roads as national highways, state highways, other PWD roads, project roads, urban roads and rural roads. It is critically vital to note that the development, operation and maintenance of roads at the state level rests with the state road authorities, and with local administrative bodies at the district and village levels.
National highways (97991kms) and state highways (167109 kms) constitute 1.79% and 3.05% respectively of all roads in India. Together, highways (national + state) account for 4.84% of the road length in India and aid in the rapid travel of people promoting connectivity and transportion of goods. The rural road length in India is around 3.3 million (61%) kilometres.
Health impacts of motorization

While industrialization, urbanization, migration and the consequent motorization are closely interlinked and are considered to be the key determinants in the growth and development of Indian society, opinions vary on its beneficial and detrimental effects on people. This changing scenario presents several unique problems that are directly or indirectly related to these growth parameters stressing the need for integrated policies and programs.

- In the absence of well-planned, economical and safe mass public transport systems in both the urban and rural environments of India, individual modes of transport have increased resulting in the greater use of personal vehicles.
- Road users are at the forefront of complex heterogeneous, unfamiliar traffic environments that are accompanied by insufficient infrastructure, unplanned road networks, and under developed traffic management systems. An increasing number of motor vehicles in urban spaces also leads to the problem of non-availability of road spaces and limitation of existing ones, a host of parking problems, non-availability of land and limited expansion due to high prices and other issues.
- Several social determinants of health get pronounced leading to problems in housing, water supply, waste disposal, education, employment and safety. Economic disparities widen aggravating the vicious cycle of poverty in both urban and rural areas.
- Urbanization is also linked to harmful and health impacting behaviors like tobacco use, consumption of alcohol and drugs, promiscuous behaviors and dietary practices.
- Traffic congestion, air pollution, noise pollution, and other consequences of rampant motorization lead to many acute and chronic health conditions.
- Motorisation also leads to sedentary life styles that in turn lead to several NCDs like hypertension, obesity, diabetes, cardiovascular diseases, stroke etc.
- Mental health problems like anxiety, loss of concentration, irritability and even conditions like dementia are closely linked to hazardous travel environments.
- The stress of commuting in urban areas itself leads to a huge impact on the lifestyles and health of people, affecting their productivity and is linked to stress disorders, musculoskeletal problems and road rage.
- Most significantly, the absence of safety policies and programs has resulted in an increase in road crashes, deaths, hospitalization and disabilities along with huge socioeconomic costs.

These unintended consequences have been examined at the international level in greater detail and to a limited extent in India highlighting the need for holistic and integrated policies and programs in the larger developmental, social and economic areas of the country. A detailed discussion of each of these areas is beyond the scope of this report and further sections will unfurl the issues with regard to road safety in India.
SECTION B
Crashes occurring on roads are commonly referred to as ‘accidents’ and their outcomes are referred in terms of deaths, injuries and disabilities. The term accident means an act that is unknown and undefined and in which no action can be taken. Thus, in recent years, the term crash has been replacing the term accidents as most crashes are predictable and preventable. RTIs are considered a public health problem since it impacts health of people, health sector provides all required services, risk factors can be delineated and effective solutions are available.

Measures of road safety

Valid and reliable quantification of the burden of road traffic injuries is often the first step and is dependent on the availability of reliable data. This in turn is dependent on the source, depth and quality of investigation, nature of reporting and quality assurance in the reporting systems. This can be supplemented by data from additional sources like surveillance systems, in depth crash analysis mechanisms and research studies; however, these are limited in India.

Various measures (indicators) commonly used to describe the burden of road crash outcomes is presented in Table 7. The 3 commonly used methods are –deaths and injuries per 100000 population (highlights the public health burden), deaths per 10,000 vehicles (emphasizes relationship between fatalities and motorization) and deaths and injuries per million kms travelled (focuses on the risk of exposure). Accident severity as reported by MORTH indicates the severity of crashes. In medical literature, case fatality rates are also used which indicate the outcome in health care institutions. Global data from the WHO and the GBD indicate the burden in terms of DALYs (for adjusting to disability outcomes) and others have focused on the quality of life as well. [19]. DALYs is a combined measure of years of life lost due to premature mortality (YLL) and years lived with disability (YLD).
Data sources for road safety

Neither a comprehensive road safety information system(s) nor a road safety observatory that reports on all aspects of road crashes by integrating data from all sources on a regular, timely and continuous manner exists in India. Road safety related data is collected – compiled – analyzed and disseminated by multiple agencies like the police as well as the transport, health, highway and infrastructure authorities, and other agencies using their own independent methods of enquiry and procedures.

The National Crime Record Bureau (NCRB) under the Ministry of Home Affairs is the nodal agency for the collection, compilation, analysis and dissemination of data regarding road traffic deaths and injuries in India. Road crashes are one of the 18 unnatural causes of death [21]. The data on accidents is collected from First Information Report (FIRs) received by police

Table 7: Measures of burden of road traffic crashes and injuries

<table>
<thead>
<tr>
<th>Measure</th>
<th>Refers to</th>
<th>Useful to</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Road accidents</td>
<td>Absolute number of road accidents occurring at a given time point or time or period in a specified place.</td>
<td>Measure of magnitude of problem Map risk zones Planning and evaluation of effectiveness of interventions</td>
<td>Numbers limit comparability as it is affected by reporting practices</td>
</tr>
<tr>
<td>Number of persons injured</td>
<td>Absolute number of people injured (non-fatal) in road accidents at a given time point or time or period in a specified place.</td>
<td>As above Indirect measure of safety in populations</td>
<td>Most non-fatal injuries are not reported and reported numbers are an underestimate of actual scenario.</td>
</tr>
<tr>
<td>Number of deaths (fatality)</td>
<td>Absolute number of persons killed in road accidents within 30 days of a road crash</td>
<td>Helps to stratify fatality risk in different types of road users, regions, users and socio-demographic correlates. Useful for Planning interventions.</td>
<td>Depends on reporting practices and the availability and quality of data</td>
</tr>
<tr>
<td>Accident severity</td>
<td>Number of deaths per 100 road accidents</td>
<td>Indicates severity of crashes and mapping severity across regions as well as to compare trends over time</td>
<td>Not all accidents are reported and severity is often measured in different ways</td>
</tr>
<tr>
<td>RTIs per unit vehicles</td>
<td>Refers to RTIs per unit number of registered vehicles</td>
<td>Measures of injury occurrence For national and international comparison of RTIs in relation to motorization. Helps in identifying vulnerable vehicle users based on type of vehicles.</td>
<td>Underestimations of actual problem as not all registered vehicles are used.</td>
</tr>
<tr>
<td>RTIs per unit population</td>
<td>Refers to RTIs per unit population of the region.</td>
<td>Measures impact of road accidents as a public health problem and is useful for comparison across other public health problems. Yard stick for monitoring effectiveness of population level road safety interventions.</td>
<td>Not all people are at enhanced risk.</td>
</tr>
<tr>
<td>Proportional Mortality ratio due to road accidents</td>
<td>Proportion of persons dying in road crashes among all deaths due to all causes in a given year for a specific region</td>
<td>Severity of problem in the community. Helps in evaluation of population based interventions.</td>
<td>Ascertainment of cause of death is associated with some misclassification in recording cause of death</td>
</tr>
<tr>
<td>Disability Adjusted Life Years resulting from RTIs</td>
<td>Number of years lost due to ill-health, disability or early death. the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences</td>
<td>Disability-adjusted life year (DALY) is a measure of overall disease burden due to RTIs. One DALY is equivalent to one lost year of “healthy” life</td>
<td>Data regarding disability is limited in Indian settings</td>
</tr>
</tbody>
</table>
stations. Regularity, quality and completeness in the collection of these statistics are interwoven with the working of the Police. The data collected at rural or urban areas are compiled by the City Crime Records Bureau (CCRB) or the District Crime Records Bureau (DCRB) and are subsequently sent to the State Crime Records Bureau (SCRB) as per predetermined formats. All information compiled at the state level is transferred to the National Crime Records Bureau (NCRB). Data from megacities (cities having a population of 10 lakhs as per the latest Census) is collected separately. Presently the data on accidents is being collected from 35 States/UTs & mega-cities. The MoRTH compiles crash data from state police sources (using separate formats that are more detailed) along with data on registered vehicles and infrastructure, and publishes its report titled ‘Road Accidents in India’. The police data is often supplemented with data from the Office of the Registrar General, India. The accuracy of both the reports is dependent on the validity and reliability of the data provided by the nearly 14,000 police stations across the country. A few studies have examined police data and have observed that they are – grossly underreported for nonfatal injuries, and are inadequate to examine determinants. Moreover, they do not provide details on nonfatal outcomes. Since accident analysis and investigation is not an established field in India, many policy makers and researchers use data from the existing sources and at times conduct independent research. Recently, a few agencies (TRIPP, JP Research, the World Bank, the WHO CC at NIMHANS and others) have expanded this work by working closely with police agencies. Despite the availability of different data sources, the government of India uses NCRB data for all practical purposes and due to the inherent variation in data collection methodologies and analysis, the available data needs to be interpreted with caution before making broader generalizations for the country.

In an ideal situation, one would expect regular and quality data at various levels of policies, plans, safety performance, determinants, road crashes, outcomes of crashes, care systems and cost of injuries and related information [53] to be available that would drive road safety policies and programs. Currently, the main source of data in India on fatalities and injuries is the police. Other sectors provide data in patchy formats. This is disaggregated further on some variables like age, gender, urban/rural, state, road types (national, state highways, expressways and others) and road use mode of transport) categories. In recent times, MORTH has included information on some of the risk factors as well as the causes of road crashes (human, vehicle and road factors) in its annual reports. Along with motorization patterns, road lengths and population, many indicators like mortality, morbidity and accident severity are developed for national and state comparisons.

### Police data sources

As road crashes are medico-legal in nature, the primary responsibility of data collection rests with the Indian police as they investigate, compile and report all road deaths in the country. The Indian Penal code 279, 304A, 336 to 338 mandates that the offender be penalized [54]. The NCRB and MoRTH publish annual reports based on the same data source and discrepancies are seen in many areas. Many researchers, policy makers and national and international agencies rely on these sources despite the existing limitations. Since road crash data in India is predominantly driven by police data, an understanding of the sequence of events leading to the collation and transfer of data is useful for interventions for strengthening the same. The receipt of information/notification of a road crash kick starts a series of events right from the preparation of the First Information Report (FIR) to the logical process of providing justice (Figure 9). Despite technological growth, a majority of records of these activities are hand written and are not routinely available for research purposes.
Figure 11: Procedure followed by the police for investigation of a Road Crash

1. Case reported to nearest police station
2. Police receive memo of road crash
3. Police contact the RTI victim & take oral statement
4. FIR filed against the accused
5. A copy of FIR sent to the court
6. Police Conduct:
   1. Spot sketch
   2. Spot Mahajar (Survey of accident spot)
   3. Collect information from eye-witness
   4. Record statement
   5. Issue request for wound certificate from hospital
7. Charge sheet is filed against accused in the court under IPC 327/336-338 and the Indian Motor vehicle act.
8. Station/court bail issued for accused against surety
9. Court summons issued to the accused
10. Court Trial to prove the convicted guilty

- Following statement of injured FIR is booked and copy sent to court
- Steps 1 to 6 remain same as in case of injury
- In addition Mahajar of dead body done in presence of 3 witnesses
- Body sent for post mortem
- Post mortem report collected from concerned hospital
- Charge sheet is filed against accused under IPC section 304 (A) and The Indian Motor vehicle act 1988.
- Steps 8 to 10 remain the same
- Since there is no accused police perform Spot Mahajar, spot sketch and document any clue/cause for crash.
- Vehicle Mahajar is also done by RTD
- Vehicle related documents including insurance of vehicle are checked for validity.
- Case is closed stating that victim himself is responsible for the crash.
- In case of death, the case is reported and all steps till step 6 and post mortem are done. Then the case is closed as stating as "Unnatural Death".

Information is collected in a similar manner from all reported injuries and sent in predetermined format to higher levels.
Health sector sources

It is essential to note that comprehensive national and state-level data on road deaths and RTIs and their characteristics are not available in the health sector, even though information on individual cases is collected in hospitals across the country[15]. There is no uniform and standardized mechanism for recording and reporting from all public and private health care facilities in India. The current procedures that are generally performed in most health care facilities are:

- In the event of an RTI victim seeking care in the ER of a hospital (public or private), the condition of the patient is assessed and case management is initiated
- The case is considered a medico-legal case and details are entered in the medico-legal case record.
- The Police from the nearest jurisdictional police station is informed regarding the details of the person as well as the place and time of occurrence of the road crash (not always).
- After case management, if the person is discharged, a wound certificate is provided upon request from the RTI victim, legal counsel or police.

The available health sources within the country include the MCCD (latest report from 2014) and SCD (2010 – 13). Surveillance of injuries and trauma registries have been attempted in select centers by individual researchers but a concerted national effort is lacking. A centralized agency within the health sector to collect road accident data does not exist. Hospital records can provide vital information regarding pre-hospital care, types of injuries, patterns, severity, outcome, management, disability and care costs. In addition, ICD classification systems are not routinely used and the number of injury researchers in the health field is only a handful. Recently, a National Injury Surveillance centre has been established under the Health ministry of the Government of India. [55]

Beginning 2004, the WHO has been making systematic efforts to collect and compile road statistics from nearly 193 countries [36]. Recently, the Global Burden of Disease reports by the IHME, USA have been making estimates of deaths and injuries for nearly 300 + health conditions and road deaths and injuries are a part of this series. Both the WHO and the GBD use vital statistics data and independent studies and estimates are based on modeling.

Complimentary sources

Data from a population level are limited and independent researchers and agencies report data only on their focused areas of enquiry. Data from individual researchers differ in intent, place, methods, samples, quality and method of reporting. Research evidence is sporadic and limited to parts of the country where few professionals are actively involved in road safety work. Evidence obtained from published research though helpful for a broader understanding cannot be used to draw finite conclusions nor make extrapolations for the country. Nevertheless, they are useful sources to understand risk factors, issues of under-reporting and outcomes of road crashes

Data strengths and limitations

Review based studies on NCRB and MoRTH data sources have examined the available data on key outcomes and exposure indicators pertaining to road accidents (i.e., number of crashes, injuries, deaths, time of death, gender and age distribution of injuries and deaths) as well as safety performance indicators (i.e., with reference to select risk factors of speeding, alcohol, and helmet use). Information on economic impact/cost indicators (i.e., medical costs, material costs, intervention costs, productivity costs, time costs, and losses to quality of life) are not readily available on a regular basis but have to be accessed from limited independent research

Barfurr et al reported that information on outcome indicators was the most comprehensive in terms of availability. Both the NCRB and MORTH databases have data for areas specified by the WHO under ‘outcomes and exposure indicators’ and the data was available for 81 and 91 percent of specified need areas. At the state level, data on outcome and exposure indicators was available for only 54 percent of need areas. There was no data on safety performance indicators in the NCRB database. From the MORTH database, data availability on safety performance indicators was 60 % at both the national and state levels. Data availability on costs and process indicators was found to be below 20 percent at both the national and state levels. Thus the availability of data to facilitate comprehensive injury programming from currently used sources is limited, indicating an urgent need to improve the publicly available road safety data in India.[56]

Under reporting of RTIs and implications:

Reporting less than the actual occurrence of events is considered as under-reporting and it significantly underestimates the ‘true’ burden. Under reporting of road accidents is a universal problem, more so in developing countries like India and is a deterrent for the valid quantification of the RTI burden[57–59]. Gross
under-reporting of road crashes and non-fatal injuries by the police is the root cause for under-reporting in India, apart from a host of social, economic, and administrative reasons. In recent times, the data on fatal crashes and outcomes is improving but nonfatal RTI data is still a matter of concern.

As early as 1998, Gururaj et al reported that nearly 5–10% of crash deaths are under-reported while nonfatal injuries were under-reported by more than 50% and the ratio of deaths to injuries was 18:1 in police records [23]. Dandona et al from Hyderabad estimated the non-reporting of fatal crashes to be nearly 20% [60]. Bhalla et al in a recent study from Karnataka observed that 22% of fatalities in hospitals were not reported to the police [57].

The differences between official tabulations and police records were reviewed by Bhalla et al (from Karnataka state) and they reported that only 17.2% and 2.3% of non-fatal RTIs requiring in-patient and out-patient treatment, respectively, were reported to the police. Only 24.6% of the non-fatal RTI cases admitted in the hospitals were reported to the police. The study further revealed that discrepancies exist between official tabulations and police reports regarding pedestrian and two-wheeler accidents. While official tabulations for 2013 reported that pedestrian deaths accounted for only 9% of the total deaths and two wheeler fatalities for 37%, FIRs showed that these groups accounted for 21% and 49% of deaths, respectively. (Bhalla K et al, 2016). [57]

Serious differences also exist in the ratio of deaths to injuries reported by police and hospital sources. In reality, for every road death, there are several who sustain non-fatal injuries that require hospitalization, while many more seek care in the emergency rooms of hospitals. As per the WHO Global Status report, the ratio of deaths to injuries is estimated to be 1: 20 (WHO, GRSS 2015). The NCRB data reports this ratio to be 1:4 for 2015, while data collected from 25 hospitals under the Bangalore Road Safety Program revealed these numbers to be 1:35 [29]. Varghese and Mohan (1991) recorded all traffic related injuries and deaths in a population study through bi-weekly home visits to all households in 9 villages of Haryana for a year and showed that the ratio between critical, serious and minor injuries was 1:29:69 [24]. Many smaller independent studies report this ratio to vary from 1:4 to 1:10, across studies.

The significant under-reporting of RTIs is a serious challenge to quantify the real burden and to formulate road safety policies and intervention programs. Some of the reasons for under-reporting are:

1. All RTIs are not reported to the police uniformly from all parts of the country.
2. By and large, people report road crashes to the police only in situations in which the outcomes are fatal, or where compensation is expected or where a legal intervention may be required.
3. Some types of injuries like collisions with fixed and stationary objects, skids and falls, collision between smaller vehicles and night time injuries are generally not reported to the police.
4. Individuals involved in a crash often arrive at a compromise, as involving the police would lead to additional problems.
5. Even when injured persons go to the police, their complaint is not officially registered due to the paucity of time or the busy schedule of activities in police stations, compounded further by limited manpower.
6. Absence of formal reporting agreements and the sharing of information between the police and hospitals.
7. As there is no practice of reporting of all deaths and injuries to any single agency from all health care institutions, the information available is incomplete.
8. Individuals who are provided care by general practitioners; nursing homes and smaller health care institutions are not reported to the police to avoid police harassment and legal complications.
9. Deaths due to various complications of RTIs after the 30 day period are not recorded as RTI deaths and are hence misclassified.
10. Death certificates are not filled in a systematic and standardized manner in hospitals to indicate associated and antecedent causes of death.
11. The immediate procedures of burial or cremation based on local, social and cultural practices discourage families from getting involved with the police as this can delay the rituals.
12. The fear of getting involved in police investigations and long drawn out administrative and judicial processes prevents individuals from reporting road crashes. Recently, the Government of India based on the Directives of the Supreme Court has passed the Good Samaritans Act which needs to be monitored and evaluated for its impact in the coming days. [61]

While under-reporting is a major concern, the implications of the same are several, manifold and multidimensional but unfortunately, they are not often given importance. A real assessment of road crashes will help in placing road safety on the national agenda, draw the attention of policy makers and political leaders, drive policies and programs for the prioritization focus on developing interventions,
On an average, about 1400 accidents and 400 deaths occurred everyday on Indian roads translating to 57 accidents and loss of 17 lives per hour in 2015.

Nearly 177,423 traffic related deaths (including road accidents, railway accidents and railway crossing accidents) were reported to the NCRB in 2015, of which 148,707 (83.8%) were road deaths. In the same year, 464,674 road accidents were reported, resulting in injuries to 482,389 persons with a ratio of 1:4 for deaths and injuries. During the decade 2005–15, a total of 1,508,678 persons died in India due to road crashes with a continuous rise from year to year [21].

MoRTH, in its report “Road accidents in India-2015”, indicated that 501,423 road accidents were reported, out of which 146,133 people were killed and nearly 500,279 were injured. There has been a 2.5% rise in the total number of road accidents, 1.4% increase in injured and 4.6 % increase in deaths in 2015, as compared to 2014 [65].

Building the appropriate frameworks for monitoring and evaluation and most importantly for the appropriate allocation of financial resources.

In view of the above issues, data from official reports and extrapolations made, need to be interpreted with caution. Recent attempts have been made to integrate hospital and police data sources based on focus and purpose of enquiry [29]. Attempts are also being made to strengthen police documentation and reporting systems [62], undertake real time analysis [63] and use population sources of data [64]. These efforts are in the early stages and need further expansion and integration.

**ROAD TRAFFIC INJURIES: INDIAN SCENARIO**

Both the NCRB and the MoRTH reports indicate a positive correlation between increasing vehicles and road accidents. Notably, data discrepancies in numbers exist between the reports (NCRB and MoRTH), even though the data source remains the same. Reported number of deaths was same in years 2008 and 2009, following which there were differences in reported number of road deaths every year. In 2011, a difference of 5651 road deaths was reported between the two reports, with higher numbers reported in NCRB report.

**Road deaths/ fatalities**

Mortality due to road accidents was reported to be 2.9% of all deaths as per the SCD 2012. The road accident death per 100,000 population from different sources varies from 11.7 to 20.7, depending on the data sources (Table 8). It is essential to note that data from the SCD and the MCCD are based on selective reporting and has to be interpreted with caution, while both the GRSSR and the GBD reports are based on estimates arrived at by using modeling methods.

**Table 8: Mortality due to road crashes**

<table>
<thead>
<tr>
<th>SL no</th>
<th>Agency</th>
<th>Year</th>
<th>Source of data</th>
<th>% of all deaths</th>
<th>Per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCD [21]</td>
<td>2012</td>
<td>SRS units</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>MCCD [13]</td>
<td>2013</td>
<td>Reported deaths from selected hospitals</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>NCRB [22]</td>
<td>2015</td>
<td>Data from police stations</td>
<td>-</td>
<td>11.86*</td>
</tr>
<tr>
<td>4</td>
<td>MoRTH [47]</td>
<td>2015</td>
<td>Data from police stations</td>
<td>-</td>
<td>11.7 **</td>
</tr>
<tr>
<td>5</td>
<td>GRSSR India [37]</td>
<td>2015</td>
<td>Estimates from multiple sources</td>
<td>-</td>
<td>16.6***</td>
</tr>
<tr>
<td>6</td>
<td>GBD [20]</td>
<td>2015</td>
<td>Estimates from multiple sources</td>
<td>-</td>
<td>20.7****</td>
</tr>
</tbody>
</table>

* 148707 road deaths. **146133 road deaths. *** 207551 road deaths. ****264000 road deaths
B. Evidence from Independent research

<table>
<thead>
<tr>
<th>SL no</th>
<th>Author</th>
<th>Place</th>
<th>Year</th>
<th>Sample</th>
<th>Place</th>
<th>Year</th>
<th>% of all deaths</th>
<th>Per 100 injury deaths</th>
<th>Per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hsiao M et al [64]</td>
<td>India</td>
<td>2012</td>
<td>1.1 million HHs</td>
<td>CS</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>26.2 (Males) 5.7 (Females) 16.2 (Overall)</td>
</tr>
<tr>
<td>2</td>
<td>Gururaj G et al [66]</td>
<td>Bangalore</td>
<td>2004</td>
<td>96414 individuals from 19797 HHs</td>
<td>CS</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>86 – (Overall) 30 (Urban) 56 (Rural)</td>
</tr>
<tr>
<td>3</td>
<td>Joshi R et al [31]</td>
<td>Andhra Pradesh</td>
<td>2006</td>
<td>180162 persons</td>
<td>CS</td>
<td>1.6</td>
<td>12.9</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bose A et al [32]</td>
<td>Vellore</td>
<td>2006</td>
<td>108000 individuals</td>
<td>R</td>
<td>2.42</td>
<td>32</td>
<td>-</td>
<td>17.6 per 100000 person-years</td>
</tr>
</tbody>
</table>

R= Retrospective, C= Cross sectional, HHs= Households

- The number of persons killed in road crashes increased by nearly 51% from 98254 in 2005 to 148707 by 2015 with the corresponding annual death rates of 8.7 and 11.7 deaths per 100,000 population (Figure 12). Reports of the MoRTH have used the Census 2011 data to calculate the road accident death rate per population.
- A decreasing trend in road deaths per 10000 vehicles from 12.06 in 2005 to 7.53 in 2013 has been observed due to a greater increase in the number of vehicles in comparison to a slower increase in the number of road deaths. The number of vehicles reflected is also higher as it includes condemned vehicles and those that are not in use.
- Accident severity (defined by the number of persons killed per 100 accidents) increased from 21.6 in 2005 to 29.1 in 2015, an increase of 34.7% contributing to higher numbers of road deaths.[47]

Figure 12: Road deaths in India (2005-15): per 100000 population and per 10000 vehicles [21]

The Survey of Cause of Death (SCD) indicates that RTIs account for 2.9% of all deaths but data from independent researchers indicates that road deaths accounted for 1.6 – 2.4% of all deaths. Data from population based studies indicate that the mortality due to road accidents vary between 12-17.6 per 100,000 population. (Table 8). Evidence from a large scale population study in Bangalore indicated that the RTI mortality was 17.2 per 100,000 population and higher in rural areas [66] while a nationally representative MDS informs RTI mortality at 16 per 100,000 population.[64]

Nearly 17 independent hospital based studies have attempted to quantify road accident fatalities in India (either prospective or retrospective nature) with sample size ranging from 161 to 53488 study units (Table 9). The variation in sample size, study design and methodology adopted in these studies account for the wide differences in the death rates. Deaths rates were usually assessed as a proportion of deaths among people seeking care in ER or either proportional mortality due to road accidents among all deaths in hospital.
Mortality among RTI victims admitted in Emergency rooms has varied between 3-13 per 100 ER admissions. Road deaths per 100 hospital in-patients ranged between 3-46 per 100 admissions and are likely to be influenced by the nature of the health care facility, severity of injuries, pre hospital care and in-hospital management practices.

Road deaths per 100 autopsies (Proportional mortality due to RTIs among all deaths (autopsy based studies) ranged from 13% to 60.7%. A prospective study from Guwahati indicated that the proportional mortality due to RTI was 24 per 100 hospital deaths.

Studies done using police records indicate that mortality due to road accidents ranged from 6% to 38% [29,33,82,83] of all deaths recorded in police stations. The Bangalore Road Safety Programme (BRSP) conducted between the years 2008 and 2012 collected data from all 35 police stations and 25 hospitals in a prospective manner. The police data revealed that the mortality rate in the city of Bangalore was 14-17 /100,000 population per year.

Nonfatal RTIs

As the injured seek care from health care institutions, hospital registrations and admissions reflect the burden on health care systems and the investments to be made for managing trauma victims. The outcome of crashes depends on a number of factors like the severity of the crash, the amount of energy transfer, the presence or absence of specific protective devices, post-crash care and several others. The extent and number of the non-fatally injured are grossly underreported in national reports with national data indicating this figure to be 1:4 or 5. The BRSP revealed

---

### Table 9: Mortality due to RTIs – hospital based studies

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Place</th>
<th>Year</th>
<th>Sample Study period</th>
<th>Design</th>
<th>Mortality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Jha N et al [68]</td>
<td>Pondicherry</td>
<td>2004</td>
<td>752</td>
<td>P</td>
<td>3.45</td>
</tr>
<tr>
<td>3</td>
<td>Thomas V et al [69]</td>
<td>Hyderabad</td>
<td>2013</td>
<td>450</td>
<td>R</td>
<td>13.11</td>
</tr>
<tr>
<td>4</td>
<td>Gururaj G et al [70]</td>
<td>Kolar</td>
<td>2015</td>
<td>-</td>
<td>P</td>
<td>39</td>
</tr>
<tr>
<td>5</td>
<td>Gururaj et al [34]</td>
<td>Bengaluru</td>
<td>2009</td>
<td>53488</td>
<td>P</td>
<td>46</td>
</tr>
<tr>
<td>7</td>
<td>Yadukul S et al [72]</td>
<td>Bangalore</td>
<td>2016</td>
<td>7347</td>
<td>P</td>
<td>13.58*</td>
</tr>
<tr>
<td>8</td>
<td>Baruah A M et al [73]</td>
<td>Guwahati</td>
<td>2015</td>
<td>3034</td>
<td>P</td>
<td>31.3</td>
</tr>
<tr>
<td>10</td>
<td>Farooqui JM et al [75]</td>
<td>Ahmednagar</td>
<td>2009</td>
<td>349</td>
<td>P</td>
<td>28</td>
</tr>
<tr>
<td>11</td>
<td>Singh P et al [76]</td>
<td>Indore</td>
<td>2015</td>
<td>596 (2012-14)</td>
<td>R</td>
<td>60.7</td>
</tr>
<tr>
<td>12</td>
<td>Katageri S et al [77]</td>
<td>Chitradurga</td>
<td>2015</td>
<td>161 (2012-14)</td>
<td>R</td>
<td>32.2</td>
</tr>
<tr>
<td>13</td>
<td>Gannur Dayanand G et al [78]</td>
<td>Bijapur</td>
<td>2013</td>
<td>266 (2006-08)</td>
<td>R</td>
<td>22.5</td>
</tr>
<tr>
<td>14</td>
<td>Dileep Kumar R et al [79]</td>
<td>Davanagere</td>
<td>2013</td>
<td>218</td>
<td>R</td>
<td>38.5</td>
</tr>
<tr>
<td>17</td>
<td>Singh Y N et al [82]</td>
<td>Guwahati</td>
<td>2005</td>
<td>7852</td>
<td>R</td>
<td>23.8</td>
</tr>
</tbody>
</table>

P=Prospective, R= Retrospective, *deaths among two wheeler users
that the ratio of fatal to moderate to minor injuries was 1:35:70, while the WHO estimates this number to be 1:20 [29]. The case fatality rate varies across institutions ranging from as low as 3.5% to as high as 27.1% in referral institutions.

The data on nonfatal RTIs in official reports is grossly misleading due to underreporting of injuries. The incidence of nonfatal RTIs was 39/100,000 population as per MoRTH and 38.5/100,000 as per NCRB. Per 10,000 vehicles, a decreasing trend has been observed from 55/10,000 vehicles to 25.8/10,000 in 2015, once again due to under-reporting issues. In terms of road length, the number of accidents per 10000 km of road has declined over the last decade from 1462.1 accidents per 10000 km of road length to 980.8 accidents per 10000 km, by 49% since 2005[47].

RTIs accounted for 25-49% of all injured as per population based studies. A review of population based studies indicates the incidence of RTIs to vary from 2.2 to 207 per 1000 population[28,84]. A large sample study from Bangalore undertaken on 20,000 households covering 96569 individuals revealed an RTI incidence of 229 per 100,000 population with RTIs accounting for 23-25% of all injuries [66].

Table 10: Frequency of Road Traffic Injuries (per 1000 population) – Population based studies

<table>
<thead>
<tr>
<th>SL no</th>
<th>Author</th>
<th>Place</th>
<th>Year</th>
<th>Sample (Study period)</th>
<th>Design</th>
<th>Frequency of RTIs per 1000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Gururaj G et al [85]</td>
<td>Bangalore</td>
<td>2004</td>
<td>96569</td>
<td>P</td>
<td>6.50</td>
</tr>
</tbody>
</table>

RTIs among injured per 100 injuries

<table>
<thead>
<tr>
<th>SL no</th>
<th>Author</th>
<th>Place</th>
<th>Year</th>
<th>Sample (Study period)</th>
<th>Design</th>
<th>Frequency of RTIs per 100 injuries</th>
</tr>
</thead>
</table>

P= Prospective, C= Cross sectional

Injuries constituted nearly 16-68% of all ER admissions and 40-70% of all hospital admissions across studies as shown in Table 11. Nearly 16% of pediatric injury cases seen in emergency rooms were road traffic related and 72% of maxillofacial injuries seeking care in hospital were due to road traffic injuries[88-90]. These figures refer to moderate and severe injuries that necessitated intervention in health care facilities.

Table 11: Frequency of RTIs - hospital based studies

<table>
<thead>
<tr>
<th>SL no</th>
<th>Author</th>
<th>Place</th>
<th>Year</th>
<th>Sample Study period</th>
<th>Design</th>
<th>RTI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Khan MK et al[89]</td>
<td>Aligarh</td>
<td>2011</td>
<td>2850 (2008-09)</td>
<td>P</td>
<td>55.0*</td>
</tr>
</tbody>
</table>

RTIs per 100 Emergency Room (ER) admissions

<table>
<thead>
<tr>
<th>SL no</th>
<th>Author</th>
<th>Place</th>
<th>Year</th>
<th>Sample Study period</th>
<th>Design</th>
<th>RTI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Menon GR et al[92]</td>
<td>Pune</td>
<td>2010</td>
<td>19668 (2007)</td>
<td>P</td>
<td>44.0</td>
</tr>
<tr>
<td>6</td>
<td>Deshmukh BU et al[93]</td>
<td>Pune</td>
<td>2012</td>
<td>300 (2012)</td>
<td>P</td>
<td>71.0</td>
</tr>
<tr>
<td>8</td>
<td>Suryanarayana SP et al[95]</td>
<td>Bangalore</td>
<td>2010</td>
<td>1055 (2007-08)</td>
<td>C</td>
<td>65.8</td>
</tr>
</tbody>
</table>

P=Prospective, R= Retrospective, * among head injury cases, **among admissions in surgery dept only. ^among pediatric injuries, ^^ Only maxillofacial injuries studied
Several studies conducted in Bangalore city from 2004-2015 also show a high proportion of RTIs ranging b/w 34-60% of all admitted trauma cases. The BRSP which collected data from 25 urban and 2 rural hospitals of Bangalore showed that of the total 69480 injury admissions at ERs, 46.7% (32447) were due to road crashes. Nearly 35-55% of all TBIs seeking care in ERs were due to RTIs and RTIs contributed for nearly 60% of TBIs (Table 12).

Table 12: Bangalore experience: Frequency of Road Traffic Injuries

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Sample size</th>
<th>Setting</th>
<th>Design</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aeron A et al[66]</td>
<td>2004</td>
<td>96414 individuals from 19797 HHs</td>
<td>Po</td>
<td>P</td>
<td>2.2</td>
</tr>
<tr>
<td>2</td>
<td>Gururaj G et al[34]</td>
<td>2008</td>
<td>68498 individuals from 21 Hospitals</td>
<td>H</td>
<td>P</td>
<td>38.2</td>
</tr>
<tr>
<td>4</td>
<td>Gururaj G et al[97]</td>
<td>2005</td>
<td>7164 trauma cases</td>
<td>H</td>
<td>P</td>
<td>60*</td>
</tr>
<tr>
<td>5</td>
<td>Menon GR et al[30]</td>
<td>2010</td>
<td>29222 individuals from 23 hospitals</td>
<td>H</td>
<td>P</td>
<td>44</td>
</tr>
<tr>
<td>6</td>
<td>Gururaj G et al[34]</td>
<td>2011*</td>
<td>All admitted trauma cases1</td>
<td>H</td>
<td>P</td>
<td>39.2**</td>
</tr>
<tr>
<td>7</td>
<td>Gururaj G et al[70]</td>
<td>2015*</td>
<td>All admitted trauma cases 2 in Kolar</td>
<td>H</td>
<td>P</td>
<td>34**</td>
</tr>
</tbody>
</table>

Po- Population based study, H= Hospital based study, P- Prospective study* TBI cases per 100 trauma cases admitted in hospital
** Proportion of RTIs among trauma cases1= Tumkur , 2 = Kolar distric

Using data from various studies and considering the issues of under-reporting, it is estimated that in India, road crashes would have caused 175,000 deaths, injuries to 12,250,000 persons and emergency care for nearly 5,250,000 individuals in the year 2015. These figures are based on the data collected from the 5 years of the Bangalore Road Safety and Injury Surveillance Program (ratio of 1:30:70 between deaths, admissions and emergency care). On the other hand, the Global Burden of Disease (GBD) study estimates that there were 264,000 deaths in India in 2013 almost twice the deaths reported by traffic police[98]. Injury prevention programs need to consider this ratio of deaths to serious injuries to minor injuries. More community based studies need to be undertaken to know the exact burden of road accidents in India.

Disability and RTIs

With the decline in childhood communicable diseases and the growing contribution of trauma, injury related disabilities will account for a significant share of disabilities in the young population in the coming years, revealing that children saved because of advances in medicine today will become victims of RTIs in later years. Globally, nearly a billion people, or 15% of the population, experience some form of disability[99]. GRSSR -2015 informs that of all the disabilities resulting from injuries, 28% are due to RTIs[36].

The total number of disabled in India according to the 2011 census was 26,810,557 amounting to 2.21% of the population, with a decadal increase of 22.4%. Of the total disabled, 11% were in 10-59 years [100,202]. The National Sample Survey Organization(NSSO) 58th round survey in 2002 revealed that disabled individuals comprised 1.8% of the total population. Among the different types of disabilities, the prevalence of locomotor disabilities was the highest (1046 in the rural and 901 in the urban; per 100000 persons). Cause “Injuries other than burns” accounted for 4.7% of visual, 0.9% of speech, 5.3% of hearing and 28.5% of locomotor disabilities[102]. Around 27 percent of male and 14 percent of female “burns and injuries” had occurred in transport accidents [102].

Globally, RTIs are the 7th leading cause for DALYs lost. RTIs were the 16th leading cause of YLLs to premature death in 1990 and increased by 6% to become the 10th leading cause for YLLs in India by 2013[103]. The Global burden of disease 2013 shows RTIs to be 9th leading cause of DALYs in India with an increase of 15% between 1990-2013,[103]. Road crashes are the 4th leading cause of disability in the age group of 15-44 years, 9th in 50 – 69 years and are among the top 10 causes for disabilities in India [104].
In contrast to Census and NSSO data, a recent community-based study of 1000 persons from 4 villages showed a disability prevalence of 6.3% based on WHO criteria indicating the underreporting of disability in national surveys.[105]. Kumar et al., in a recent review conclude that 15% of all disabilities are due to an injury.[106]. Around 2-3% of accident victims suffer permanent disability of varying severity. Independent studies show a wide variation in disability rates varying between 1.33% to 15% among hospitalized road accident cases. In a large scale population-based study of TBIs in Bangalore, it was observed that nearly 15% of the injured had varying levels of disability at 24 months post-discharge [97]. In Hyderabad, disability rate due to RTIs was observed to be 35/100,000 population in a study of 10459 persons [84]. In specific terms, 100% of severely injured, 50% of moderately injured and 10-20% of mildly injured will have lifelong disabilities [97].

Most often, reduction in deaths should not be considered as a better safety record as it is well known that a reduction in deaths could be accompanied by increasing disability rates. In the absence of long-term hospital studies or integrated health data systems this is difficult to conclude and requires further examination.

### Table 13: Disability due to RTI's

<table>
<thead>
<tr>
<th>SL no</th>
<th>Authors</th>
<th>Year</th>
<th>Place</th>
<th>Sample</th>
<th>% Disability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gururaj G et al[97]</td>
<td>2005</td>
<td>Bangalore (2000-03)</td>
<td>607 head injury cases</td>
<td>15%</td>
</tr>
<tr>
<td>2</td>
<td>Thomas V et al [69]</td>
<td>2013</td>
<td>Hyderabad (2013)</td>
<td>450 RTIs</td>
<td>1.33%</td>
</tr>
<tr>
<td>3</td>
<td>Dandona R et al [84]</td>
<td>2009</td>
<td>Hyderabad</td>
<td>10459 individuals</td>
<td>35.1 per lakh population</td>
</tr>
<tr>
<td>4</td>
<td>Kumar SG et al[106]</td>
<td>2012</td>
<td>India</td>
<td>Review</td>
<td>15% *</td>
</tr>
</tbody>
</table>

* 15% of all disabilities are due to injuries

### RTIs in 2016 and by 2030

Using data from national sources and considering the issues of under-reporting, it is estimated that RTIs would have resulted in 175,000 deaths, serious injuries to 5,250,000 persons and minor injuries among 12,250,000 individuals in 2015 in India (Figure 13). The ratio of deaths to injuries is based on the data collected from the 5 years of the BRSP on a ratio of 1:30:70 between deaths, admissions and emergency care.

![Figure 13: Road deaths and injuries in India: 2015](image)

The forecasting of road deaths in India for the year 2030 was performed using road deaths data from the NCRB (from year 2005) using the Auto Regressive Integrated Moving Average (ARIMA) statistical method. The ARIMA model is a useful statistical method for analyzing longitudinal data with a correlation among neighboring observations and has been found useful in the analysis of multivariate time series [107]. Model estimations were done to find model coefficients with the best fit with forecasting for the best fit model. The accuracy of the models was compared using mean error (ME), root mean square error, (RMSE), mean absolute error (MAE), mean percentage error (MPE), mean absolute percentage error (MAPE).

Using the ARIMA method, based on road deaths between 2005 to 2015 (after correcting for 20% under-reporting) and assuming that present road safety scenario continues, nearly 241751 (95% CI 194102, 289399) persons are estimated to die due to road accidents in the year 2030 (increase by 35.4%). Approximately 3.2 million more lives are estimated to be lost between 2016 to 2030 (Figure 14).
State wise RTI burden in India

Transport, health law and safety in India are all state subjects under the concurrent list. As various states are in different stages of economic growth, motorization, urbanization and road safety policies / programmes, the burden of RTIs are likely to be different (more details about each state is available in the accompanying report “Facts and Figures”). State-wise differences in road safety parameters are influenced by a combination of factors like terrain, weather, road conditions, road network, highways, vehicular growth, data systems and most significantly status of road safety interventions.

An understanding of the state burden of RTIs is essential to develop state specific road safety policies and programs. A comparison of state economic growth, motorisation levels and the number of road deaths are shown in Figure 15. The size of the bubbles in the figure corresponds to the number of road deaths. States with higher GDP, greater number of vehicles reported higher number of road deaths, as visualized by bigger size of bubbles in the states, with exception of Maharashtra and Gujarat.

The top ten states in terms of the number of vehicles and road deaths coincide closely with the top ten rankings in their GDP as well, indicating that RTIs are an adverse and unintended effect of growing economies thereby indicating that safety policies and programs have received less or no attention. Where data is available, it is seen that the incidence of road deaths in these top states varies from as high as 12.1% in Uttar Pradesh to as low as 2% in Jharkhand [47].

Globally, it has been observed that the early phases of economic growth are accompanied by increasing road deaths and injuries due to rapid motorization and the absence of suitable mechanisms to address road safety. As countries begin to grow and prosper, safe infrastructure, vehicles, road user behaviors and safety programmes change leading to a reduction in deaths and injuries indicating that safety should be an integral part of the larger economic and related policies from the early stages and India should consider this as it is still in the early phases of motorization.[108]
The state wise distribution based on deaths / 100,000 population indicates that in eleven Indian states the number of deaths are higher than the national average of 11.7/100,000 population (Figure 16)[21]. Some large states with larger populations compensate for the national average with lower deaths/100,000 population; for example, Uttar Pradesh accounts for only 6% of accidents and 12.3% of road deaths with 18407 deaths (Figure 17). Differential death rates of states are coherent with the degree of industrialization and vehicular growth and road safety status as observed in Tamil Nadu, Maharashtra and Karnataka.

The state wise distribution based on deaths / 100,000 population indicates that in eleven Indian states the number of deaths are higher than the national average of 11.7/100,000 population (Figure 16)[21]. Some large states with larger populations compensate for the national average with lower deaths/100,000 population; for example, Uttar Pradesh accounts for only 6% of accidents and 12.3% of road deaths with 18407 deaths (Figure 17). Differential death rates of states are coherent with the degree of industrialization and vehicular growth and road safety status as observed in Tamil Nadu, Maharashtra and Karnataka.
A total of 23 states and Union territories reported an increase in the number of fatalities in 2015 (against previous year) with Kerala, Maharashtra, Tamil Nadu, Madhya Pradesh and Uttar Pradesh being on top of the list. North-Eastern states like Mizoram, Nagaland, Sikkim and Arunachal Pradesh had <500 accidents and related deaths. [21] The same may be attributed to lesser vehicles, lack of regular data reporting systems, hilly topography and lesser urbanization.

With the national rate of road mortality being 11.7/100,000 population[47], Uttar Pradesh topped the states with the most number of road accident deaths (18407 deaths in 2015) accounting for 12.3% of all road traffic deaths in the country. Though it ranks first in population, third in GDP and third in the number of motor vehicles, fatality rates are significantly higher. States with higher than the national level include Tamil Nadu (21.7), Goa (21.5), Haryana (19.9), Karnataka (17.8), Punjab (17.6), Chhattisgarh (16), Himachal Pradesh (16), Rajasthan (15.3), Andhra Pradesh (15), Gujarat (13.1), Madhya Pradesh (12.1), Telangana (20.1) and Kerala (11.8). States with a large population tend to have fewer accidents per lakh population and vice versa.

Time trend analysis of road deaths across selected states (random selection) indicates a disturbing picture. In the selected states as in all others, an increase in road deaths has been observed during the decadal period. The road safety status in all Indian states has been presented as state road safety fact sheets in the accompanying report. This data indicates the need to specifically examine road safety at state level to develop state specific programmes.

The States of Tamil Nadu, Karnataka and Chhattisgarh are well above the national average in terms of accidents per 100,000 population, which confirms their high share in the burden of road crashes. Figures of road accidents per lakh population are also very high for the states of Goa (222.1) and Puducherry (94.1), but in absolute numbers their share of the total accidents is 0.9% and 0.3%, respectively. Road accident deaths per 10,000 vehicles in India is observed to be 7.6/10,000 vehicles (2013) which is less than the previous year's figure of 8.7/10000 (2012). Sikkim ranks the highest with 18.7 deaths per 10,000 vehicles followed by Bihar (14), Assam (13), West Bengal (12.3), Himachal Pradesh (12) and Andhra Pradesh (11.2). This indicator is dependent on the number of vehicles registered in the state and not on current usage.

Road deaths and injuries in urban India

Since the year 2001, the urban Indian population has grown by 12.5% and every third Indian is a resident of urban India. Mumbai is the most populous Indian metropolis followed by Delhi, Kolkata, Chennai and Bengaluru. As per the 2001 census, there were 27 cities with a population of a million plus in India which increased to 53 by 2011. [7]. The 53 Indian cities contributes to total of 31% of the population, 4.6% of vehicles, 22.1% of road crashes and 11.3% of road deaths in 2015.[47] Secondly, the top 4 metropolises of India, (and Hyderabad city), (the state was recently divided in 2014) have either seen a plateauing or even a small reduction in road crashes in recent years indicating...
that increasing vehicular density and traffic congestion along with reduction in speed is a major contributor (Figure 18 and 19). Worryingly, many grade 2 and 3 cities are registering an increase in deaths and injuries due to rapid motorization, increasing infrastructure and roads that promote rapid mobility rather than safety, once again highlighting that urban planners need to consider road safety in developmental policies and programmes as well as promoting / investing in mass public transportation facilities.

The severity of accidents was maximum in Ludhiana 55.4 deaths per 100 accidents, followed by Asansol- Durgapur (47 deaths per 100 accidents)[47]. The higher severity can be attributed to a combination of greater speeds, road infrastructure and poor road safety measures.

With increasing trends in urbanization, the urban population is likely to reach 473 million by 2021 [44], thereby requiring greater emphasis on urban safety. Urban areas are characterized by greater numbers of people and vehicles competing in limited infrastructure facilities. The heterogeneous traffic and longer hours of commute results in the greater risk of exposure that can contribute to a higher number of crashes and deaths. The urban metros are also gearing up for mass public transport facilities and nearly 7 cities have metro rail and 8 more are to soon initiate (or at least considering) the development of these facilities. The safety of Indian cities rests with the way cities are designed for today and tomorrow with the ultimate aim being to promote safe mobility for all road users.

**Figure 18:** Road deaths as (per unit population and vehicles) in ten Indian cities

**Figure 19:** Trends in top 10 cities with high road deaths 2005-2015 [21].
SAFETY ON INDIAN HIGHWAYS

With 77.9% of road accidents, 88.7% of deaths and 83.6% of injuries occurring outside Indian cities [47], it is vital to identify where these events are occurring in India. An understanding of crash patterns on different types of roads is essential to plan safety interventions across different parts of the country.

India has a total road network of 5472144 km, of which, 265100 kms (4.8%) are highways. [6] Highways are primarily designed for the rapid mobility of goods and people to facilitate economic growth and development. [6] Highways are even getting replaced with expressways in some places that promote even faster travel to reduce travel time, fuel consumption and enable better connectivity. However, travel and traffic modes are different compared to urban travel in a number of ways that are critical to road safety.

The nature of traffic on highways is characterised predominantly by fast moving passenger and goods vehicles and slow moving heavy freight carrier vehicles traversing through large villages and small settlements cutting across state districts. Most significantly, pedestrians, two-wheelers and cyclists predominate on these roads.

In 2015, the percentage share of national highways and state highways to total accidents was 29%, and 24%, respectively, followed by other roads (47%). Highways (National and State), though account for 4.84% of road length, contributed to half (52.4%) of road accidents and 63% of road deaths in India [47]. Data shows that national highways contributed to around 30-35% of RTI deaths, while state highways which constitute 3.05% of total road length accounted for 28% of road deaths. Other non-highways which span major parts of the country accounted for the remaining 37-40% of road accident deaths in India. An increasing trend in the number of accidents has been observed on national highways since 2013 in contrast to a decreasing trend in state highways (Figure 20).

The state wise distribution reveals that Uttar Pradesh (7773), followed by Tamil Nadu (5752) and Rajasthan (3709) witnessed the highest number of deaths on national highways. Nearly 54-56% of all accidents in Rajasthan and Uttar Pradesh resulted in deaths, indicating poor safety measures and deficient trauma services on the state highways.
A large cross-sectional study conducted in Tumkur district during 2011 revealed that nearly two-thirds (6296) of the crashes involving bus, truck, and other heavy vehicles had occurred on three major highways passing through the district. Similarly, the majority of the car crashes (89%) also occurred on highways and city municipal roads (Gururaj G et al, 2011)[33].

In a study conducted in Kolar district, Karnataka in 2015, RTIs contributed for 39% of fatal and 34% of non-fatal injuries in the district. During the year 2014, 280 fatal road crashes were registered resulting in death of 336 persons (Ratio of deaths to injuries 1:4). The 2 national highways and 5 state highways passing through the district contributed for 37% and 25% of total road deaths respectively, with 32% of injured persons in the hospitals coming from both highways indicating the greater occurrence of road crashes on the highways as compared to rural and town roads (Gururaj G et al, 2015)[70].

Several independent hospital-based studies conducted across India also reveal higher number of deaths on highways (25-90%) compared to other roads [29,33,34,75,109–111]. Nearly 10-80% of all RTI victims were killed in crashes occurring on highways. This information is driven by the location of centers investigating this aspect as well as the proximity of hospitals to highways.

**Figure 23: Proportion of road accident deaths on highways and non-highways in hospital studies**
Some reasons for higher number of crashes, deaths and injuries on Indian highways are linked to factors listed below and needs in-depth examination.

- Since highways traverse through large number of villages and small settlements, road users residing and traveling near highways are constantly exposed to fast moving vehicles throughout the day and night. In a recent study of 410 kms of highways in the Kolar district of Karnataka state based on in-depth resource and road mapping, it was observed that nearly 297 villages were present on both sides of the highway.[70]

- Due to spatial location of villages, there is a mix of traffic with heavy vehicles, medium and small size vehicles along with vulnerable road users like pedestrians, motorbikes, bicyclists and animal drawn vehicles, each with their varied road behaviours.

- Even though incoming and outgoing traffic are separated in some highways, unsegregated heterogenous traffic is commonly seen on many highways and pose a greater risk and threat for accidents.

- The movement of heavy goods vehicles and larger passenger vehicles like buses predominate highways. Collisions between bigger vehicles and smaller sized vehicles and pedestrians, specially at higher speeds leads to the increased severity of injuries as well as deaths.

- Highways also witness longer journeys, journeys at all times that are accompanied by driver fatigue, sleeping at the wheel and reduced concentration along with other risk behaviors (like drinking and driving) leading to the enhanced risk of road crashes.

- The visibility on highways is poor and consequently smaller sized pedestrians, cyclists and motorcycle riders as well as road defects are less conspicuous and visible resulting in a greater number of crashes.

- Speeding is a commonly observed phenomenon on highways (as they are built to promote faster travel) and drivers tend to over speed to complete long journeys in a short period of time. Owing to vehicles travelling at high speeds most accidents are severe in nature.

- Driver regulation on highways unlike those in force in urban and semi-urban areas is less rigorous due to lax procedures, resource constraints and the absence of technology.

- Other risk factors like drinking and driving and drugs and driving are common on highways and legislation and enforcement are both weak links in safety on highways.

- Trauma care on highways and ambulance services are also limited and crash survivors spend longer time to reach definitive hospitals that are mostly located in nearby cities or at times in district headquarters.

- Highway crashes tend not to get reported in police stations; even though fatal crashes are more likely to get reported. Many injuries tend to get under-reported as people are rapidly shifted to hospitals, bypassing any police enquiries. Property damage and subsequent losses also tend to be higher on highways as goods transporting vehicles are relatively more on highways.
Understanding the seasonality of the occurrence of RTIs and accidents is vital for planning prevention strategies. Factors related closely to this issue are weather conditions, traffic patterns, visibility issues, topography of the region, risk factors and several others that influence crash occurrence. Day time road users are predominantly daily commuters and office goers whereas night time road users are predominantly freight, business and recreation related road users.

India has diversity in its climate throughout the year which has an impact on transport and travel. The occurrence of RTIs and deaths were more in the summer month of May. This is the time of greater travel due to holidays leading to a surge in the travel environment. RTIs were the highest during the month of May (9.4%) followed by January (8.6%), Fatalities were also the highest during the month of May (9.8%) followed by December (8.9%).[21] Independent studies conducted in Bangalore and Kolar also reported the highest rate of road accidents being in May [29,34,70]. No clear reasons can be attributed for this.

Further, most accidents (66.8%) in India in year 2015 had taken place between 9am-9pm which coincides with time where vehicle use is observed for official, school and daily routine purposes. Within this, the proportion of road accidents was highest between 15:00-18:00 hrs(17%) followed by 18:00-21:00 hrs(17%) which accounted for 1/3rd of all accidents occurring in India in year 2015 [47]. Hospital-based studies also indicate that both injuries and deaths were at the peak between 18:00-21:00 hrs. This is in line with data from national reports which state that 18:00-21:00 hrs is the second most common time of accident occurrence. Certain parts of India experience extreme weather conditions of heat and cold that might affect travel patterns. Fog, snow and rainy seasons are also accompanied by poor visibility that can result in crashes. Access to pre-hospital care, trauma care and the time taken to reach a trauma care facility is influenced by the time of occurrence, indirectly affecting post-crash survival. Preparedness of hospitals and the availability of first care respondents is also determined by the broader patterns of crash occurrence. An accident occurring late at night will suffer from the lack of immediate access to lay responders and pre-hospital care, however upon arrival of the ambulance, the chances of reaching a trauma care facility is quicker due to lesser traffic.

Figure 24: Distribution of road crashes by time of occurrence-2015
Road users are heterogeneous in nature, sharing a common road but differing in their biological, social, economic, and technological vulnerabilities to RTIs further influenced by the vehicles they use (or don't use), road conditions and the larger systems that govern their safety. Road users are broadly classified into pedestrians, bicyclists, two wheeler and pillion riders, four wheeler users (like cars, taxis, jeeps) and users of heavy goods vehicles. In India and a few other developing countries, hand pulled carts, auto rickshaws, cycle rickshaws, animal driven carts that are not seen in HICs are also included. Understanding which categories of road users are vulnerable and susceptible helps in delineating safety strategies and prioritizing interventions to protect them on the roads.

As per GRSSR-2015, car users constituted 31% of all road deaths and pedestrians accounted for 22% of deaths.[36] The region wise distribution reveals that nearly half the road accident deaths (51%) in the European region were among car users. Pedestrian deaths (39%) were the highest in the African region, while two wheeler users comprised nearly 1/3rd of all road deaths in the South Asian and Mediterranean region[36]. High death rates among particular road user categories is a reflection of the predominant mode of travel and also the level of safety measures in place to protect different users.

A vulnerable road user (VRU) is defined as a road user who is present in a crash involving vehicles which do not have a protective shell. This will primarily include pedestrians, cyclists and motorized two wheelers. A[112] MoRTH combines 24 different types of road users into six broad categories namely- pedestrians, cyclist, 2 wheeler user, cars/jeeps/taxis, goods vehicles and others. Two-wheelers accounted for the largest share of 72.4% of all vehicles, followed by cars, jeeps and taxis which form 13.5% of all registered vehicles in India[47].

Travel patterns of Indians

On a pan India basis, 80% of the households do not still own a two wheeler and 40% have no definitive mode of transport[1]. These road users commute either as pedestrians/walkers, cyclists or use other modes like public transport systems. Thus, pedestrians and cyclists form a major part of the road user community along with motorized 2 and 3 wheeler vehicles. The transportation environment in India is characterized by the presence of different kinds of vehicles (motorized and non-motorized) that do not travel at uniform speeds. Most point-to-point major roads traverse through densely populated towns and villages, wherein social and commercial establishments like schools, businesses, offices, hospitals and religious places are present on both sides of the road indicating that non-motorized modes of travel are predominant.

Modal split (as % of total trips) indicates that walking (62%), car (14.8%) and two-wheeler (9.4%) are still predominant modes of travel in cities having 5 million plus population[113–116]. Data from the Ministry of Urban Transport (Table 14), indicates that walking remains the most preferred option across all cities with differing populations (22–57 %). This is followed closely by two wheeler travel (6–29 %) because of its easy availability and ability to overcome traffic challenges. Public transport remains a major option in larger cities with higher population and availability of facilities. Car transport, though on the increase, is emerging as an important transport means, mainly in cities due to greater affordability in recent times. Mumbai, on the other hand has an increased share of mass transport use modally(25%), indicating that with increase in population and travel distances, mass transport should be the preferred mode of commute.[115] Evidence from Urban Mass Transit in the year 2011 in Bengaluru indicates that 32% of all commutes were by walking followed by public transport (27%) and motorcycles (25%). Seven percent of commutes were undertaken by auto rickshaws.[114] There is an increase in the modal share of public transportation with the increase in the population of cities and availability of mass transport systems[116].
It is well recognized now that data from official reports at both national and state levels are unreliable due to fallacies in reporting systems. As per national reports, the share of two wheeler is 73% while the medium and heavy vehicles constitute 6% of all registered vehicles. In 2015, 36803 two wheeler users and 13882 pedestrians died on Indian roads as per official reports.[47] Though 2 wheelers comprised of 72% of all vehicles, they accounted for 25% of the deaths; cars, jeeps and taxi users accounted for 19.6% of all road deaths.

Pedestrian involvement in road accidents has not been highlighted in the MoRTH report for the year 2015, as it has been merged with other non motorised vehicles. Pedestrian deaths accounted for only 4.7% (NCRB) and 9.5% (MoRTH) of road deaths in the year 2014. This is primarily due to documentation of impacting vehicle rather than the persons killed / injured. These observations indicate the need for careful data extraction from official reports by researchers rather than the interpretation of the available figures.

Figure 25 provides information on road users killed and injured in road crashes in India from different studies. In all studies, especially the prospective studies, the road user affected is documented based on direct questioning with the injured or his/her family members. Two wheeler rider deaths ranged from 13.5% to as high as 77% of all accident deaths in India, followed closely by pedestrian deaths which account for 10-55% of road deaths.

Few population based studies also confirm these findings. The million death study which surveyed 1.1 million homes indicates that among all road deaths, reported that 37% of the victims were pedestrians and 20% were two-wheeler users, which is in stark contrast to figures provided by official reports. A population based study covering 10459 persons in Hyderabad revealed that the incidence of non-fatal RTIs was 6.4 per 100 population per year among pedestrians and 6.3 per 100 population/year for two-wheeler riders. [84] Survey of nearly 20,000 households in Bangalore revealed that 41.5% of the victims were pedestrians and 38.6% were two-wheeler users.[66]
A large scale Injury/RTI surveillance in Bangalore [29, 119] over a five-year period collected road accident data from various hospitals (rural and urban) and extracted data about road deaths from police records. The results showed that RTI deaths was the highest among pedestrians (40-50%) followed by two-wheeler riders and pillion riders (25-40% and 12-15% respectively). Nearly 1-5% of road deaths involved pedal cyclists. Car occupants and auto users constituted <5% in urban and 5-10% of the rural road deaths. Data on non-fatal RTIs showed that two wheeler riders were the most affected (40-50%) followed by pedestrians (15-20%) and pillion riders (10-15%). The frequency of road injuries among cyclists, car occupants and auto users was <5% both in urban and rural Bangalore. [29] Studies indicate that even among two-wheeler deaths and injuries, most deaths (28-66%) occurred among riders. Nevertheless, pillion riders are also vulnerable to injuries and death, as pillion riders account for 4.8% - 33% of two-wheeler deaths. These findings have served as evidence for policy makers to make helmet use among pillions riders mandatory.

In conclusion, data from multiple Indian sources indicate the high involvement of vulnerable road users in road traffic deaths/injuries which is at variance with official reports and situation in HICs. India’s road safety graph is unlikely to change, if, VRUs are not given importance in road design and operations as well as ensuring their safety on roads. Recognizing the pitfalls and inadequacies in current reporting systems and to strengthen road safety data, the MoRTH has introduced the new road accident and reporting formats in March 2017.[120] The new reporting system along with better training of police involved in data collection and reporting should provide better quality data that strongly facilitates the development of scientific road safety policies, programs and interventions.
Socio-demographic correlates are important characteristics that determine safety in every society and drive the road safety indicators as well. Understanding these attributes of RTIs helps to delineate groups that are most susceptible and vulnerable to road crashes and its consequences to plan and implement interventions for prevention and care. The road safety vulnerabilities are differentially distributed across gender, age, occupation, income, place of residence and others.

Gender and RTIs: Globally, it has been observed that, males are at an increased risk of road accidents compared to females. The reasons for this include their greater travel and higher risk taking behaviours as well. As per the WHO, nearly three-quarters (73%) of all road traffic deaths occur among men [99] and this is similar across the globe with slight variations. GRSSR-2015 estimates that, in India, among the victims of road accidents (injuries/deaths), 85% are males [36]. Evidence from various national reports indicate that the incidence of road accidents among males ranges between 82-86% implying that RTAs are 5 times higher among males as compared to females. Various independent studies (population and hospital based) reviewed confirm this observation.

A higher male preponderance is observed in different age groups as well. However, accidents among males and females are nearly similar among children and the elderly as their exposure to the transport environment is low when compared to the productive age group (15-60 years). Interestingly, this observation is likely to change in the coming years. Traditionally in patriarchal Indian society, the role of women was limited in trade and commerce; however, this is changing. Today, females are better educated, their employment numbers are growing, albeit slowly. They have wide ranging roles and responsibilities, they travel more and the combined effect of all this is their greater exposure to traffic environments.

A significant aspect of this finding is the differential impact of road crashes vis-a-vis gender roles and responsibilities. As most males involved in accidents are in the productive age group (18-60 years) and are the bread winners of their families, their loss affects the family income and the employer in a number of ways. The loss of work and wages pushes families into the cycle of joblessness, poverty and debts. A disabled male member can be a burden on the family for long periods and this affects the education and growth of children. On the other hand, death or disability of a female family member affects family roles, child care, family maintenance and other areas. Limited or restricted family roles and responsibilities can push families to despair and depression as well. Whether the person is a male or female, if he/she is employed, it affects productivity, economic revenues, compensation etc. The loss of a trained team member results in the loss of productivity, work-loss days occur due to treatment and disability of the injured. There is a loss of the resources spent in the capacity building of employees and additional resources are needed for the training of new recruits.

Age and Road crashes

Globally, RTIs are the main cause of mortality of persons aged between 15-29 years [36] and all reports confirm to this finding. India is a young country where nearly one third of population is aged between 15-29 years.
As per MoRTH 2015 data, Indian adults aged < 35 years accounted for 58.2% of all road deaths in 2015. More alarmingly, reports from the MCCD based on hospital reports indicate that nearly 51% of all deaths among persons aged between 25 and 44 years were due to road traffic accidents. The SCD which is based on a nationally representative sample, indicates that 14% of all deaths in age group of 15-29 years were due to RTIs [20].

A comparison of independent studies was difficult, as different age group classifications have been used in different studies. To overcome the same, we have presented predominant age groups for RTI occurrence mentioned in various studies in traffic signal colour coded format (Table 15,16). A summary of evidence from large sample studies across India reveals that ~40% of all RTIs occur in 18 – 35 years. The proportion of the elderly (>60 years) among RTI affected individuals ranged from 1.8% to 9.6% of all RTIs. Data from an analysis of 35,000 deaths in Bangalore city showed the frequent occurrence of RTIs among children and high number of deaths in younger age groups (BRSP).

### Road accidents among children

Globally, 10 million children are killed, injured or disabled in road accidents every year, accounting for 21% of those affected [121]. The burden is much higher in the South East Asian and African regions than in the rest of the world. Reports from MoRTH and NCRB indicate that 4% of all RTI deaths occurred among children. Studies in NIMHANS, India indicate that 26% of all injury related deaths and 40% of injury related hospitalizations are due to RTIs among those <18 years of age. Most accidents occur when kids are pedestrians, cycle riders or are traveling by two wheelers [122]. The reasons for their vulnerability to RTAs and injuries include their physiological characteristics, inability to judge speed, lack of decision making, poor threat perception, softer body parts, curiosity as well as unsafe road conditions. In India, the lack of adequate play areas like sports grounds and parks force children to play on the roads, thereby increasing their vulnerability [121].

### Table 15: Age distribution of Road traffic injuries from research evidence: A traffic signal approach

<table>
<thead>
<tr>
<th>Year of publication</th>
<th>Place</th>
<th>Source of data</th>
<th>RTIs</th>
<th>&lt;18 y</th>
<th>18-20</th>
<th>21-25</th>
<th>26-30</th>
<th>31-35</th>
<th>36-40</th>
<th>36-40</th>
<th>41-45</th>
<th>46-50</th>
<th>45-50</th>
<th>51-55</th>
<th>55-60</th>
<th>&gt;60 years</th>
</tr>
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<tbody>
<tr>
<td>Menon GR et al [30]</td>
<td>2010</td>
<td>Bengaluru/Pune</td>
<td>H</td>
<td>12520</td>
<td>13.7%</td>
<td>36.6%</td>
<td>21.6%</td>
<td>13.8%</td>
<td>12.5%</td>
<td>1.8%</td>
<td>5.2%</td>
<td>4.3%</td>
<td>3.2%</td>
<td>2%</td>
<td>1%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Bayan P et al [123]</td>
<td>2013</td>
<td>Pune</td>
<td>H</td>
<td>212</td>
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<td>38.4%</td>
<td>21.6%</td>
<td>11.7%</td>
<td>5.5%</td>
<td>4.6%</td>
<td>2.8%</td>
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<tr>
<td>Jaiswal K et al [124]</td>
<td>2015</td>
<td>Uttar Pradesh</td>
<td>H</td>
<td>477</td>
<td>6.7%</td>
<td>44.2%</td>
<td>21.6%</td>
<td>13.8%</td>
<td>11.7%</td>
<td>5.5%</td>
<td>4.6%</td>
<td>2.8%</td>
<td>65%</td>
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<td>5.5%</td>
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<tr>
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<td>2013</td>
<td>Hyderabad</td>
<td>H</td>
<td>450</td>
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<td>42.8%</td>
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<td>2014</td>
<td>Ernakulam</td>
<td>H</td>
<td>7660</td>
<td>30%</td>
<td>38.6%</td>
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<tr>
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<td>2014</td>
<td>Chandigarh</td>
<td>H</td>
<td>1545</td>
<td>40.4%</td>
<td>16.5%</td>
<td>13.9%</td>
<td>9.1%</td>
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<tr>
<td>Jha N et al [68]</td>
<td>2004</td>
<td>Puducherry</td>
<td>H</td>
<td>726</td>
<td>17.5%</td>
<td>31.3%</td>
<td>22.3%</td>
<td>15.6%</td>
<td>9.1%</td>
<td>4.2%</td>
<td>4.2%</td>
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<td>2013</td>
<td>Shimla</td>
<td>H</td>
<td>401</td>
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<td>36.2%</td>
<td>23.4%</td>
<td>14%</td>
<td>5.2%</td>
<td>4.5%</td>
<td>4.5%</td>
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<tr>
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<td>2012</td>
<td>Bhopal</td>
<td>H</td>
<td>1269</td>
<td>8.7%</td>
<td>26.3%</td>
<td>26%</td>
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</tbody>
</table>

**Red colour** = predominant age group affected, **Yellow**= 2nd most common age group affected, **Green**= 3rd most common age group affected  
**H** = Hospital, **P**= Population based, **A**= Autopsy records

### Table 16: Age distribution of Road deaths from research evidence: A traffic signal approach

<table>
<thead>
<tr>
<th>Year of publication</th>
<th>Place</th>
<th>Source of data</th>
<th>RTIs</th>
<th>&lt;18 y</th>
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<th>21-25</th>
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<th>41-45</th>
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<td>Akhade SP et al [128]</td>
<td>2015</td>
<td>Maharashtra</td>
<td>A</td>
<td>202</td>
<td>3.5%</td>
<td>28.7%</td>
<td>27.7%</td>
<td></td>
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<tr>
<td>Khajuria B et al [129]</td>
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<td>Delhi</td>
<td>A</td>
<td>249</td>
<td>12.4%</td>
<td>53%</td>
<td>24.9%</td>
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<td>2015</td>
<td>Warangal</td>
<td>A</td>
<td>297</td>
<td>26.9%</td>
<td>29.6%</td>
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<tr>
<td>Hsiao M et al [64]</td>
<td>2013</td>
<td>India</td>
<td>P</td>
<td>1.1 million</td>
<td>22%</td>
<td>7.5%</td>
<td>23%</td>
<td>3%</td>
<td>2.8%</td>
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<td>2008</td>
<td>Delhi</td>
<td>H</td>
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<td>34.6%</td>
<td>20.2%</td>
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<td>Chandigarh</td>
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<td>Bengaluru</td>
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<td>29%</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Gururaj G et al [29]</td>
<td>2010</td>
<td>Bengaluru</td>
<td>H</td>
<td>770</td>
<td>5%</td>
<td>61%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13%</td>
</tr>
<tr>
<td>Gururaj G et al [33]</td>
<td>2011</td>
<td>Tumkur</td>
<td>H</td>
<td>486</td>
<td>11%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>73%</td>
</tr>
<tr>
<td>Gururaj G et al [70]</td>
<td>2015</td>
<td>Kolar</td>
<td>H</td>
<td>336</td>
<td>8%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>75%</td>
</tr>
</tbody>
</table>

**Red colour** = predominant age group affected, **Yellow**= 2nd most common age group affected, **Green**= 3rd most common age group affected  
H = Hospital, P = Population based, A = Autopsy records
Education, Occupation and Socio-economic status

Socioeconomic status, education and occupation are standalone as well as interlinked variables and in turn are related to RTIs by influencing vehicle ownership, purchasing power, transportation modes, beliefs and practices, exposure to road use, health security, outcomes and its impact. Most often, information on occupation and education serve as proxy for income levels. More than 80% of deaths due to RTIs occur in LMICs and even within HICs, people from the lower socioeconomic backgrounds are affected more [36]. Methodological difficulties often preclude researchers from drawing final conclusions, thus, highlighting the need to understand the associations between socioeconomic status, occupation and RTIs.

Table 17: Road traffic injuries by Socio-economic status

<table>
<thead>
<tr>
<th>Year</th>
<th>Place</th>
<th>Sample</th>
<th>Lower</th>
<th>Middle</th>
<th>Upper middle and Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>India</td>
<td>1.1 milion</td>
<td>79.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>Nagpur</td>
<td>423</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>Bengaluru</td>
<td>4190</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>Kancheepuram</td>
<td>200</td>
<td>76.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>Maharashtra</td>
<td>202</td>
<td>41.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>Warangal</td>
<td>297</td>
<td>63.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>Maharashtra</td>
<td>404</td>
<td>41.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Nagkarim</td>
<td>370</td>
<td>63.8%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Population based study, Red color refers to majority of RTI in that SES.

Educational levels generally reflect better understanding and awareness regarding road safety among individuals, but it need not necessarily be so. Basic schooling is a must for drivers to obtain a driving permit as they need to have an understanding of cautionary signs, instructions and safety features. Commercial drivers should have completed a minimum level of schooling for applying for a license (Govt of Karnataka mandates 8th standard completion for issuing a driver's license). As per the MoRTH report 2015, most persons involved in road accidents (43%) had an education above 10th grade as compared to 25% of them who had studied up to the 8th grade[47]. Research studies in India also indicate that the ‘Not Literate’ population involved in RTIs range from 5-20%. Though the literacy levels of the driving population has improved over the years, the number of accidents continue to increase indicating that attitudinal and behavioral change among road users are more important than literacy to reduce road traffic accidents.

Occupation can have direct influence in terms of exposure based on nature of occupation or an indirect one deciding access to comprehensive rehabilitation services. Certain categories of occupation like drivers of public transport vehicles, commercial vehicles and those in certain occupational categories are engaged in driving on roads for longer hours increasing their risk of exposure. A study conducted in Bangalore by NIMHANS, assessed road accidents in Bangalore Metropolitan Transport Corporation bus fleet and revealed that with increase in vehicles (3169 buses b/w 2001-09), drivers employed, routes travelled and passenger load, the number of road crashes also increased (476 in 2001 to 637 in 2009)[29], highlighting the for road safety fleet management in work places. On the other hand, people engaged in certain occupations that involve greater travel also have higher exposure and consequent increase in RTIs.

Injuries sustained in workplaces or work related travel constitute occupational injuries. While commuting to and fro from work, either in own or official transportation, employees are at-risk for road accidents and account for 20% and 40% of work fatalities in most industrialized countries[137]. In India, health of factory workers are regulated by Indian factories Act, and the focus is on work related injuries. A study carried out in a large automobile industry in Bengaluru [138] revealed that nearly 269(4.4%) employees had availed leave due to injuries sustained outside their workplace, of which nearly 90% were reported due to road traffic accidents. Mapping high risk occupations followed by focused training or integrating road safety training in ongoing health and safety programmes in workplaces will contribute to a reduction in RTIs.

Income levels often determine vulnerability due to the lack of safer modes of transport, the use of ill-maintained personal vehicles, high risk behavior, non-compliance with safety measures and limited awareness of traffic rules. The impact of RTIs is also disproportionately higher among low and middle income households due to the limited affordability and accessibility to post-crash care. National data is lacking in this regard. However, a survey of 19,996 households in Bangalore revealed that poor people were affected more by the consequences of road crashes [66]. This is indirectly supplemented by national reports which inform us that nearly 53.7% of crashes occurred in rural India, where the majority are from low and middle income groups [47]. Obtaining proper data on income and its association is critical for both prevention as well as compensation after road crashes.
SECTION C
The word ‘risk’ refers to increased or decreased probability of an event in the presence or absence of a given factor and thus, it is an attribute, characteristic or exposure of an individual that increases or decreases the likelihood of developing a disease or an injury. [139]. RTIs are a result of complex interactions in a heterogeneous transport environment contrary to the popular belief that road crashes are accidental and incidental. Even though millions of people travel in a variety of vehicles on a variety of roads, the risk of a road crash is elevated in certain situations. Individuals and populations are at differential risk for occurrence of road traffic injuries depending on distribution of risk factors, which generally exists in a spectrum varying from no-risk to high risk. As road crashes happen due to a complex interaction of people, vehicles and a complex road environment they are considered multi-factorial in nature. Risk, in simple terms, is usually quantified in terms of epidemiological measures of strength of association like Odds Ratio and Relative Risk.

Usha Rani, 34 years

I belong to a middle class family in Bangalore and am a house wife. I have been driving a gearless two wheeler since my college days and had never encountered any accidents as I usually drive cautiously.

On that day, I was travelling back home after picking up my 8 year old son from his tuition at around 7 pm. It was the month of November and was getting dark by 6.00pm. A stretch of road I travel daily is not well lit and is difficult to commute at night. On the same stretch, a stray dog was sleeping on the road which I could not see from a distance. As I came close, the dog got up to move. On suddenly seeing the dog, I was startled and was about to crash into it. To avoid crashing into the animal, I suddenly turned the handle and accidently accelerated the bike instead of applying break. This sudden action could not balance the vehicle.

Both of us fell off with bike that was still running and were dragged by the moving vehicle to some distance on the road. As we were dragged, the pot holes on the road, added more injury and pain. Both of us suffered severe injuries to limbs. I had fractured my left hand and my left foot got crushed underneath my bike. My son suffered lacerations on hand, leg and face.

People on the road gathered and helped us to reach the nearest government hospital where we were treated for the next 24 hours. My family was informed by the police and my husband rushed in. Fortunately, my son had not suffered any serious fractures but my left foot was completely crushed. I was referred to a private orthopaedic hospital where they performed a series of surgical procedures to fix my crushed foot bones.

I was not able to walk around for next two months. Slowly I recovered but my leg still hurts and I am not able to move my foot freely. My day to day activities are affected because of my restricted movement. On further consultation with orthopedician, he suggested another corrective surgery to get my foot better.

My family has already spent more than 100,000 rupees for my surgery and right now we are not in a situation to shell out any more. For the time being, doctor has suggested me physiotherapy that would help to improve my foot movement and will help me to get some relief.
As early as 2004, the World Report on Road Traffic Injury prevention reported that road crash occurrence and outcomes depend on the presence or absence of risk at 4 levels, viz., those factors influencing risk, linked to crash involvement, crash severity and outcomes. (Table 18) [140]. Recently, a new dimension of system related factors (enabling environments that promote or lessen safety) are also added to risk assessments. In a simplistic manner, these factors can be broadly grouped and referred to as risk factors in roads, in vehicles, in road users and systems. Despite the progress in this area over decades, research pertaining to risk factor analysis and attribution through in-depth studies are lacking in India.

Table 18: Risk Factors for Road Traffic Injuries

<table>
<thead>
<tr>
<th>Description of risk factors based on</th>
<th>Classification</th>
<th>Risk factors for Road Traffic Accidents</th>
</tr>
</thead>
</table>
| Events in road crash occurrence    | Factors influencing exposure to risk of RTA | Economic factors: Income, economic development  
Demographic factors: Age, gender  
Land-use planning: which influence length of trip and mode of travel  
Mixture of high-speed motorized traffic with vulnerable road users  
Insufficient attention to the integration of road functions with decisions about speed limits, road layout, and design. |
| Factors involving road crash involvement | Inappropriate and excessive speed  
Substance use: Alcohol, medicinal or recreational drugs;  
Driver fatigue, Night driving, unsafe driving  
Vehicle factors: braking, handling, and maintenance  
Defects in road design, layout, and maintenance  
Inadequate visibility because of environmental factors |
| Factors influencing crash severity | Human tolerance factors: speeding, use of helmets, seatbelts.  
Roadside objects not crash-protective; Insufficient vehicle crash protection for occupants  
Substance use |
| Factors influencing post-crash outcomes | Delay in detecting crash and in transport of injured; The presence of fire resulting from the collision.  
Leakage of hazardous materials; — the presence of alcohol and other drugs; — difficulty in rescuing and extracting people from vehicles; — difficulty in evacuating people from buses and coaches involved in the crash; — lack of appropriate pre-hospital care; — lack of appropriate care in hospital emergency rooms. |

In India, all national reports, several research papers and anecdotal media reports attribute nearly 90% of crashes to human errors and faulty human perceptions. Human errors are broadly labeled and grouped under careless driving, rash driving, negligent driving, etc. Consequently, efforts are being made to provide information and knowledge to road users so that they can follow safe road practices. Unfortunately, even this is being done in an isolated, sporadic and haphazard manner. Since roads and vehicles are inanimate (hence, cannot be educated; however, the makers of these products can be informed to make them safe) they need to be designed to be safe and to allow minimum room for human error, be forgiving for common and minor mistakes which people usually make and to protect them in the event of a crash. [36] Understanding the interaction between roads, vehicles and vehicle users by research studies is the key for delineating the cause of accidents as well as to develop–implement solutions. Undoubtedly, it is a specialty discipline in itself that needs to be promoted.
Road related risk factors

India has the second largest road network in the world which is of different sizes, shapes, construction methods, quality, safety criteria, visibility and other issues. Amongst these factors, it is acknowledged that safety performance, parameters and criteria are not given adequate importance at the time of design and construction. Some of the commonly observed road related risks for RTIs in India are

1. Faulty design of roads that don’t recognize safety
2. Poor maintenance of roads
3. Absence of segregation of vehicles with different speeds and non-motorized and motorized travelers
4. Non surfaced roads
5. Pot holes
6. Slippery roads
7. Narrow/steep roads
8. Poor visibility of road surface
9. Roads that are pedestrian unfriendly without proper walking and crossing facilities, and most significantly
10. Roads that promote speeding beyond limits

Road conditions in relation to accidents have been assessed as ‘accidents reported to have occurred’ on good surface roads, loose surface, roads with pot holes, road under repair/construction, corrugated/wavy roads, slippery surface roads, snowy, muddy, oily roads etc in the MoRTH report (Figure 27). Since no detailed investigations are carried out and road safety audits are only a recent phenomenon, the role of road related factors in RTIs have not been properly understood. The MoRTH (2015) recognizes that ‘defective roads’ are an important cause of road accidents, injuries and deaths, but the report mentions that only 1.45% (7314 accidents) of the 500,000 accidents in 2015 were due to defective roads. Among the 146,133 fatal RTIs in 2015, only 1.87% and 0.9% were attributed to road defects in MoRTH and NCRB reports, respectively.

Figure 27: Proportion of road deaths in different road conditions

iRAP- India, assessed and rated (up to 5 stars) nearly 10,444 kms of roads in 10 selected Indian states during 2010-13. It classified roads into various categories (low risk, low-medium risk, medium risk, medium-high risk and high risk) based on the various parameters of assessment (Details available at http://toolkit.irap.org/). Assessment revealed that none of the Indian roads could achieve a rating of 5 stars and less than 10% of the assessed roads received a 4 star rating. The assessment concluded that Indian roads need better treatment in terms of safety infrastructure and estimated that the safety treatment of roads can reduce 58% of fatalities and serious RTIs annually. [141]
Studies undertaken by the WHO CC in Bangalore and neighboring districts based on record analysis, discussion with crash victims, eye-witnesses descriptions and stake holder consultations have revealed that fatal road crashes occurred more on surfaced roads (25%), dry roads (28%) and roads with a good surface (22%). Roads without traffic separation and with limited or no pedestrian facilities (40%) were major problems [29]. Roads promoting high speeds were found to be most dangerous as observed by the fact that 60% of crashes and deaths took place on highways that promote and permit speeding beyond limits [70]. During interviews with hospital subjects in Bangalore, driving in inappropriate speeds was reported by most interviewed subjects and family members [29].

Studies undertaken by a few researchers reveal that road infrastructure alone contributed to 6% of fatal crashes and in combination with vehicles and human factors accounted for 36% of fatal crashes [142]. Similarly 8-21% of hospitalized injured persons attributed their crashes to road surface defects in various studies in India (Table 19). Evidence from independent research in India that explored the proportion of RTIs that were caused by road defects, reveal that 3-69% of RTIs may be attributed to wet road surfaces, depending on crash location as wet surface can affect vehicle balance and braking ability. Among the 297 RTI deaths in Warangal in 2015, 21.8% of these were reported due to road surface defects. Road surface not only influence the occurrence of RTIs but also impact the severity of the accident.

Unsafe roads with uneven and unpaved footpaths can be risky for pedestrians, while pot holes can pose the same risk to motor vehicle users during night times or during rainy seasons. At the same time, roads of good quality that promote speed and absence of traffic separation can be equally hazardous as well. Suffice to say, that roads that do not have safety features built-in or incorporated during design, construction and maintenance pose a great risk to road users.

### Table 19: Proportion of RTIs due to road defects: Hospital based studies

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Sample size</th>
<th>Design</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jha N et al[68]</td>
<td>2004</td>
<td>Pondicherry</td>
<td>726</td>
<td>P</td>
<td>24.5</td>
</tr>
<tr>
<td>2</td>
<td>Roy R et al[143]</td>
<td>2014</td>
<td>Noida</td>
<td>144</td>
<td>C</td>
<td>9.7</td>
</tr>
<tr>
<td>3</td>
<td>Pathak SM et al[144]</td>
<td>2014</td>
<td>Pune</td>
<td>182</td>
<td>C</td>
<td>46.7</td>
</tr>
<tr>
<td>4</td>
<td>Sangal A et al[145]</td>
<td>2015</td>
<td>Meerut</td>
<td>103</td>
<td>P</td>
<td>6.7</td>
</tr>
<tr>
<td>5</td>
<td>Utkarsh PS et al [33]</td>
<td>2010</td>
<td>Bangalore</td>
<td>251</td>
<td>C</td>
<td>69.1</td>
</tr>
<tr>
<td>6</td>
<td>Mahajan N et al[126]</td>
<td>2013</td>
<td>Shimla</td>
<td>401</td>
<td>C</td>
<td>3.7</td>
</tr>
<tr>
<td>7</td>
<td>Akhade SP et al*[128]</td>
<td>2015</td>
<td>Maharastra</td>
<td>202</td>
<td>C</td>
<td>29.7</td>
</tr>
<tr>
<td>8</td>
<td>Goswami A et al[146]</td>
<td>2005</td>
<td>Dibrugarh</td>
<td>65</td>
<td>R</td>
<td>32.3</td>
</tr>
</tbody>
</table>

<p>| Road accidents due to road surface defects (pot holes, loose gravel etc) (%) |</p>
<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Sample size</th>
<th>Design</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Roy R et al[143]</td>
<td>2014</td>
<td>Noida</td>
<td>144</td>
<td>C</td>
<td>15.3</td>
</tr>
<tr>
<td>10</td>
<td>Mahajan N et al[126]</td>
<td>2013</td>
<td>Shimla</td>
<td>401</td>
<td>C</td>
<td>8.4</td>
</tr>
<tr>
<td>11</td>
<td>Sangal A et al[145]</td>
<td>2015</td>
<td>Shimla</td>
<td>103</td>
<td>P</td>
<td>8.73</td>
</tr>
<tr>
<td>12</td>
<td>Akhade SP et al[128]</td>
<td>2015</td>
<td>Maharashtra</td>
<td>202</td>
<td>C</td>
<td>21.8</td>
</tr>
<tr>
<td>13</td>
<td>Surender J et al[130]</td>
<td>2015</td>
<td>Warangal</td>
<td>297</td>
<td>P</td>
<td>21.8</td>
</tr>
</tbody>
</table>

P= Prospective study, R= Retrospective study, C= Cross sectional study, *only head injuries studied
Safety of Indian Vehicles

India is home to nearly 210 million vehicles of differing size, shape, engine capacity, technology, standards, all vying with each other to travel in the shortest possible time on the existing roads. Nearly 40 different types of vehicles traverse our roads. Competitive markets, consumer demand, aggressive marketing and favorable financial environment have contributed to an increase in vehicular growth in India. [36] It is important to note that unlike in the west safety standards for vehicles are only beginning to emerge in India. Furthermore, technological import has brought in greater confusion with safety being compromised for cost and performance. In addition, many locally manufactured vehicles do not have adequate safety standards thereby compromising safety aspects. Issues with regard to registration, renewal of registration, certification of fitness and safety are evolving at a slow pace and have not received much prominence. Most importantly, to ensure the safety of vehicles manufactured in India, especially two-wheeler vehicles, serious attention needs to be paid by vehicle manufacturers.

It is universally acknowledged that vehicular defect(s) or poorly maintained vehicles or vehicles with fewer safety performance features add to a greater risk of accidents either alone or in combination with other factors. There are a few provisions in IMV Act that specify safety standards for certain vehicles and the new amended act aims to improve these standards. Assessment of vehicle safety is a specialized discipline and the contribution of vehicle related factors can be delineated by crash investigation and analysis that is lacking in India.

MoRTH report indicates that 2.8% of all road deaths in 2015 were due to vehicular defects (Figure 28). Serious mechanical defects were responsible for majority of deaths (48%), followed by defective brakes (20%) in year 2015.[47] A few hospital studies (interview based) indicate that vehicular defects contributed for 6 - 10 % of accidents (Table 20). These can only serve as a pointer towards the need for better research and crash analysis studies.

Figure 28: Percentage deaths due to various vehicular defects.[47]
As per WHO, vehicles sold in 80% of all countries worldwide still fail to meet basic safety standards. As per GRSSR 2015, only 40 countries met the recommended ‘seven vehicle standard regulations’ for safety, most of which were HICs.[36] In India, motorcars account for only 13% of motor vehicles and nearly 80% of them are manufactured in India; some with imported technologies based on agreed guidelines. The assessment of vehicle safety in a standardized manner is being conducted by the Global New Car Assessment Program (Global NCAP), which further disseminates their observations to the general public to enable them to make informed decisions [147]. India which is the 6th largest automobile manufacturer, started its NCAP only in 2011.

Table 20: Proportion of RTIs due to vehicular defects: Hospital Data

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Sample size</th>
<th>Design</th>
<th>% of crashes due to vehicular defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BRISPP- Feasibility study*[34]</td>
<td>2008</td>
<td>Bengaluru</td>
<td>26,191 (RTIs)</td>
<td>P</td>
<td>40*</td>
</tr>
<tr>
<td>2</td>
<td>Sangal A et al[145]</td>
<td>2015</td>
<td>Meerut</td>
<td>103</td>
<td>P</td>
<td>5.82**</td>
</tr>
<tr>
<td>3</td>
<td>Mahajan N et al[126]</td>
<td>2013</td>
<td>Shimla</td>
<td>401</td>
<td>C</td>
<td>10.1</td>
</tr>
</tbody>
</table>

P= Prospective studies, C= Cross sectional studies* due to BF, LD, TD, AC**(1.94-BF,0.97- HLD, 0.97-TLD, 1.94- FT)
BF- Break failure, HLD- Head Light defect, TLD- Tail light defect, FT- Flattening of tire, SD- Steering defect, AC- Axel Cuts, TD- Tyre Defect

Diversity of Indian vehicles

Vehicles in city traffic

Cycles, cars, two wheelers in city road

Vehicles in Indian Highways

Vehicles in Indian Highways

Three wheeler motorized transport

Bullock carts
Human factors

A multitude of human behaviors can be seen on Indian roads; some of which have proved to be fatal. 'To err is Human' is exemplified in the understanding of the epidemiology of RTIs as human behavior is closely linked to negative outcomes of mobility. Human behavior refers to actions people take in different situations and is a product of knowledge, attitude, and belief influenced largely by one’s physical, social and cultural environment amidst the presence or absence of safety regulations. Human behaviour is varied, unpredictable, difficult to understand and hard to change and is influenced by numerous factors like age, sex, education, residence, income, social status, values, nature of the product used, mindset, peer influence, and several others. The process of behavioral change to address these issues and to be safe or to make people safe is the key to address road accidents in India.

Human factors can be broadly examined under the categories of modifiable and non-modifiable risk factors. While some biological factors like age are not modifiable, other behaviors can be modified or modulated by a variety of approaches. The top 10 important human behaviors that are linked to road crashes are

1. Helmet use
2. Seat belt use
3. Drinking and driving
4. Child restraint use
5. Speeding
6. Distracted driving – cell phone use
7. Pedestrian road use behaviors
8. Driver Licensing issues
9. Drugs and driving, and
10. Fatigue and sleeplessness

Knowledge and evidence regarding the chances of accident occurrence in the presence of risk factors (relative risks, odds ratios) and the expected reduction in populations after eliminating the identified risk factors (population attributable risk) are key epidemiological measurements. Research on the influence of the above key risk factors is important in India given the huge number of road users, the vast road network and the lax attitude towards safety. A precise understanding of the extent of the problem with regard to each of these behaviors in India is limited due to the lack of good quality research and limited data in national reports or individual studies. Furthermore, the methodologies adopted for each of the risk factors are varied and the findings are not comparable necessitating the need for evolving proper methodological guidelines in the Indian context.

Helmet use

With the increase in motorcycle use in India (3/4th of all registered vehicles are two-wheelers), the number of deaths and injuries among motorcycle riders and pillion have also risen. Available data on the nature of injuries (discussed in detail in further sections) reveals that majority of motorcyclists and pillion riders in both fatal and nonfatal RTIs sustain injury to the brain resulting in higher mortality and disabilities due to TBIs.

The use of helmets while driving is one of the most proven mechanisms to prevent or reduce brain injuries in the event of a crash. Helmets act in number of ways to reduce the impact in a crash. The presence of a helmet : reduces the deceleration of the skull and hence the brain movement internally; absorbs some of the impact of crash through the cushioning effect due to the soft material incorporated in the helmet; spreads the forces of the impact over a greater surface area so that they are not concentrated on particular areas of the skull; prevents direct contact between the skull and the impacting object by acting as a mechanical barrier between the head and the object [148]. Global evidence indicates that helmet use can reduce risk of death by 40% and the risk of severe injury by approximately 70%[99]; Consequently the duration of hospitalization, neurological disability and economic impact are reduced to a great extent [149–151]. As early as 2005, the TBI registry at NIMHANS, Bengaluru showed that mortality, skull fracture and brain were less by 1.2 times among those with helmets at the time of crash [152].

The Motor Vehicle Act -1988 in its section 129, mentions that the driver and the person riding pillion on a motorized two wheeler (except in side car) in a public place, shall wear a protective head gear(Helmet) that conforms to the specifications of the Bureau of Indian Standards. Compliance with helmet use is a key factor in reducing TBIs. However, the notification and implementation of law is the responsibility of Indian states. Many states have not made notifications and even when notified, the enforcement is weak and with poor penalties. Even though the scene is improving in cities, the use of helmets is abysmally low in rural areas and on highways. Unfortunately, national reports (NCRB and MoRTH) have no data regarding helmet compliance in India. As per the GRSSR 2015, the current level of helmet enforcement law in India was rated at 4 [36]. Helmet use has been studied across general populations, among hospital based RTI studies, autopsy studies and in a few surveillance programs.
<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Size</th>
<th>Design</th>
<th>Helmets use# (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Public perception</td>
</tr>
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<td>2</td>
<td>Yadukul S et al[72]</td>
<td>2016</td>
<td>Bengaluru</td>
<td>220</td>
<td>c</td>
<td>50.9</td>
</tr>
</tbody>
</table>

P= Prospective, C= Cross sectional, R= Rider , PI= Pillion
Stakeholder and Public perceptions

In stake holder discussions in Bangalore and Hyderabad, most agreed that helmets are life savers, but emphasized that a law and implementing police are an absolute necessity. In a study of 11,000 young and middle aged adults in Bengaluru, it was reported that nearly 48% reported that they ‘always wear a helmet’ and 81% ‘want helmet laws to be implemented’. Positive and negative public opinions regarding helmet use varied with many reporting different opinions.[88] The fact that those who report “I always use” actually “do not use” was illustrated by a study in Hyderabad, where self reported and observed helmet rates was 64.7% and 29.4% respectively [154,155].

Road side observation surveys

Road side observation of 68229 motorcyclists and 217777 pillon riders in Hyderabad city revealed that only 22.6% (15426) riders and 1.1% (240) of pillion riders were wearing helmets. Compliance with helmet use was associated with the age of the road user and his/her level of education. Individuals aged >40 years and those with a higher education (OR=4.1, 95% CI: 2.5 to 6.9, P < 0.001) were more compliant than younger and less educated individuals.[154] Similarly a population based observational survey conducted at 78 traffic locations in Bengaluru covering 145,789 two wheeler riders revealed that 64% were wearing helmets. The use of helmets was significantly lower during evening and night, early morning, in residential areas, in outer and peripheral parts of the city, during weekends and holidays and for short distance travel. [29]. Helmet use among 550 students in a south Delhi school revealed that 94.5% were not in the habit of using a helmet while riding a two wheeler [160].

Hospital based studies

• Hospital based studies among persons injured in road crashes reveals that helmet use among those brought to the emergency rooms of hospitals ranged from <5% to 64%. The findings about the proportion of helmet use also varied across different study methods used in the hospital like retrospective studies (10-27%), cross sectional studies (15-66%) and prospective studies (<5% to 64%).

• Studies among RTI victims across different places in India reveal a considerable variation in helmet use. Studies on road accident deaths in hospitals and autopsy studies indicate that helmet use was 12% reinforcing the lower rates of helmet use.

• Hospital autopsy studies in Warangal and Bangalore hospital report helmet use as 12% and 50%.[130,159] while surveillance studies report 36-50% compliance with helmet use in urban areas and 20% in rural areas. Evidence from the BRSP revealed that in 64% of the RTI fatalities, were not wearing a helmet at the time of the crash.[29]

• A study comprising of 182 road accident injury patients showed a significant association between the use of protective headgear (helmet) and reduction in severity of the head injury (OR=0.1, p<0.05 [144]), NIMHANS studies on TBI revealed that mortality among riders who did not use helmets was 2.2 times higher than riders who used helmets. Series of studies undertaken by NIMHANS [152] indicated that enforcement of helmet law revealed the following:

  • Death rate among two wheeler riders due to head injuries decreased by 30-40%
  • Head injury reduced by 20-30%
  • Severity of head injury reduced by 40%
  • Consequent neurological disability reduced by 40%
  • Duration of hospitalization reduced by 20-40%
  • Cost of medical care of head injuries reduced by 25-30%
Despite wearing a helmet at the time of the crash, persons can sustain serious injuries or even die due to the poor quality of helmets. Substandard helmets are often used by riders to overcome police enforcement and the use of a helmet is influenced by its availability, cost, ease of use and enforcement checks. A multicentric study across the low and middle income nations involving 5563 helmet wearing motorcyclists showed that 54% of the helmets were not standard certified helmets. It was also found that those who bought a cheap quality (non-standard) helmet were at the greatest risk of having a head injury following a crash [161]. Furthermore, among helmet users in Bangalore city, it was observed that, 53.7% were wearing full face helmets, 11.1% half face and 31.8% open type or construction helmets. Since open type helmets do not offer any protection only 64% can be documented as ‘compliant with helmet use’ [29].

The key challenge is the effective enforcement of helmet laws and the compliance of road users with the same. In conclusion, all studies conducted on the road side or in hospitals clearly point to the fact that helmet use among riders is relatively low most of the pillion riders do not wear helmets, use varies as per time and place, the quality of helmets is still unsatisfactory, enforcement is weak and current penalty levels are negligible. Mandatory helmet legislation and its uniform enforcement are required to protect two wheeler users from brain injury. The impact of greater penalties as in the new MVA amendment needs further evaluation.

**Figure 29: Prevalence of helmet use across different studies (%)**

<table>
<thead>
<tr>
<th>Study</th>
<th>Helmet Use (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yadukul S et al (2016)</td>
<td>50.9</td>
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<td>Malathotra C ET AL (2005)</td>
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<td>35.7</td>
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<td>Thomas V et al (2013)</td>
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<td>Esser MB et al (2016)</td>
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<td>22.6</td>
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<td>64</td>
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</table>
Driving under the influence of alcohol

Consumption of alcohol affects the vision, coordination, reflexes, judgment of dangers on roads and also encourages associated unsafe practices like speeding, not using helmet and seat belt and traffic violations, thereby increasing the risk of accidents/injuries to self as well as to other road users. Furthermore, it interferes in the management of injured persons in hospitals.

Alcohol use is quite common in India and so is driving under the influence of alcohol due to its easy availability, greater use and poor enforcement of traffic laws. National Family Health Survey Report-3, indicates that 34% of adult men and 1.5% of adult women in India are alcohol users. [162] Prevalence of Alcohol use Disorder in Indian adults (as per the National Mental Health Survey of India-2016) is estimated at 4.6%[163]. Driving under the influence of alcohol is an offence in India under section 185 of the Indian Motor Vehicles act and is punishable with a minimum penalty of ₹10,000. (before 2016 the penalty was ₹2,000 only). The permissible levels of alcohol in blood is <0.03mcg/dl for driving in India [164]. Unlike other developed countries the cut off does not differ for novice drivers and experienced drivers. GRSSR 2015 rates drink driving enforcement in India as 4 which clearly indicates that enforcement of law is very poor [36].

Among the 148707 road deaths in 2015, driving under influence of drug/alcohol contributed for 2% of deaths indicating poor documentation [21]. Nearly 146059 accidents were caused due to dangerous/careless driving and 1.5% of such accidents were due to alcohol use which resulted in injuries to 6,295 persons and 2,988 deaths[21]. According to MoRTH-2015 report, accidents and deaths caused due to “Intake of alcohol/drugs” accounted for 3.3% (16,298 out of 5,01,423) accidents and 4.6% (6,755 out of 1,46,133) deaths, respectively [47].

Gross under reporting of alcohol use in RTIs is expected due to various legal, cultural, economic and societal issues as well as due to the limitations of investigative procedures. The actual figure is expected to be much higher. While all fatal road crashes are not investigated for driving under the influence of alcohol and as hospitals do not test the injured, the extent of alcohol involvement is unclear. However, hospital based studies have examined this to a limited extent through autopsy studies, surveillance studies, registries and research studies.

Public Perceptions on the evidence regarding alcohol in India are varied. Nearly 87% of the people interviewed in Bangalore opined that alcohol use is the main cause for road accidents; however, 67% reported driving a vehicle after drinking in the last two weeks. Only 12% of the respondents were aware of the penalty levels of drunken driving. A majority of the public perceived that alcohol is responsible for most accidents (23%), that a drunk person cannot control the vehicle, it makes him unfit to drive and causes impairment in decision making, following rules and concentrating[153].

Road side observation studies conducted in Bengaluru as early as 2002 reported that 80% of suspected drivers and 35% of randomly checked drivers were under the influence of alcohol. Interestingly, 90% of the drivers who had tested positive for alcohol declared themselves fit and confident of safe driving, as they were unaware of the dangers of drink driving for themselves and for others [165]. Batra and Bedi (2003) in an unpublished document noticed that 40% of trucks and matador drivers, 60% of car drivers, 65% of two wheeler drivers and 5% of pedestrians were under the influence of alcohol during the night [166].

Roadside surveys were also conducted by NIMHANS under the ‘Suraksha Sanchar Program’ for reducing drinking and driving in 2001. Road users were checked for alcohol influence at 34 randomly selected check points. For a period of 15 days, drivers were initially stopped based on ‘suspicion’ of being drunk and then randomly again for 15 days. BrAC levels were obtained using breathalyzers and the severity of intoxication was classified using the WHOY90 codes. During these 30 days samples were taken from more than 5,000 drivers. In the first round of 15 days, 3,333 riders were observed, 215 were stopped based on police suspicion of which 193(89%) tested positive for alcohol. During the second round, 1,866 drivers were observed - 491 were stopped randomly and 203 (41%) tested positive for alcohol. Since random checks are a more scientific way of assessing alcohol intoxication, it was concluded that 30-40% of night-time drivers would be in varying states of alcohol intoxication. The amount of alcohol consumption based on breathalyzer analysis revealed that 40%, 27% and 10% had moderate, severe and very severe levels of intoxication based on WHO ICD Y90 codes [165].
Hospital based studies in NIMHANS [167] reported that 28% of injured persons were under alcohol influence (40% of the above had consumed three large drinks). A review of 20 hospital based studies revealed that among RTI victims, those under alcohol influence at the time of crash ranged from 3.3% to 62% as shown in Figure 30. Most studies clustered between 18 and 23%, much higher than the reported 3% by MoRTH. Alcohol use as the cause for fatal accidents (deaths, studies on autopsies) ranged from 1.5 to 20%. The differences are due to the variation in study subjects, sample size, time period, study location and assessment procedures. Most hospitals do not use breathalyzers and the assessment of alcohol use is based on physician certification procedures, with subjectivity in assessment and reporting. Further, the use of alcohol among the impacting drivers is largely unknown. Under reporting is present to a great extent as survivors of crashes do not receive compensation if alcohol use is documented.

Driving under the influence of alcohol increases the risk of a road crash by 2.1 times in comparison to non-users. Majority of the alcohol users had sustained an injury or had been hospitalized (78% v/s 15%). The odds of a road crash was higher among men (9.8 times), persons aged 25-34 years (1.7 times) and at night (3 fold higher than day) [155]. Gururaj et al in their study based on data from 7 hospitals (n=1553), showed that 16% of hospitalized subjects were under the influence of alcohol at the time of admission. Their risk of injuries was more during evening and night times, more common among two wheeler users and pedestrians and with a higher frequency of the severity of brain injury, duration of hospital stay, death and post traumatic disabilities [168].

Series of studies undertaken by NIMHANS, a tertiary center for the management of brain injuries, concluded that nearly a third of road crashes occur during the night time and a third of these are linked to alcohol. The extent of alcohol use varied between 10–30 % in all fatal road crashes (based on 5 studies undertaken during 1994–2007). Data recorded from night time crashes reveal that alcohol use accounts for 15–25% of RTIs (based on individual's own reports and certified medical diagnosis). One out of four non fatally injured road crash patients brought to the ER of hospitals was alcohol-positive as per physician certification.[29] In Bangalore city alone, the number of cases of drunken driving booked by the police increased from 27264 in 2006 to 47289 in 2016 (SCRB).

Drinking and driving is a recognized risk factor for road crashes and road traffic injuries. Impairment by alcohol influences the risk of a road crash as well as the severity and outcome of injuries through several immediate physiological effects on routine body functions (like respiration and circulation) which can interfere and adversely affects driving performance. The consumption of alcohol, even in relatively small amounts, increases the risk of being involved in a crash for all categories of road users. Not only the person under the influence of alcohol is at risk but so is the other road users on the road. Monitoring studies have shown that alcohol use is responsible for 30-40% of fatal crashes, majority of serious injuries and 50-60% of property damage only crashes. The presence of alcohol in the bloodstream increases the risk of a crash, but the effect varies depending upon the concentration level of alcohol in the blood and duration of alcohol influence driving behaviour.[30] Drinking and driving also affects road users who are sober. Alcohol can impair attention, reaction time, judgment, decision making and coordination, difficulties in identifying dangers on roads, thus affects driving performance. In addition, it has several immediate physiological effects on routine body functions (like respiration and circulation) which can interfere and adversely affects driving performance. The consumption of alcohol, even in relatively small amounts, increases the risk of being involved in a crash for all categories of road users. Not only the person under the influence of alcohol is at risk but so is the other road users on the road. Monitoring studies have shown that alcohol use is responsible for 30-40% of fatal crashes, majority of serious injuries and 50-60% of property damage only crashes. The presence of alcohol in the bloodstream increases the risk of a crash, but the effect varies depending upon the concentration level of alcohol in the blood and duration of alcohol influence driving behaviour. [30]

Relative Crash Risk BAC 0.00=1.0

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It is still unclear whether alcohol prohibition reduces alcohol related road accidents. Data from a few states where prohibition has been in place shows the failure of such efforts with regard to impaired driving. In Gujarat, there were 361 accidents due to drunk driving that resulted in 121 deaths and left 274 injured, while in Kerala there were 49 accidents with 36 deaths and 11 injured [65]. Despite the previous experience with regard to the prohibition of alcohol, some of the Indian states are going ahead with the same and it will be useful to monitor such efforts.

Legislative and enforcement strategies that are well coordinated, target oriented, visible and with strict penalties are required along with increasing public awareness. Notably, measures to control drink driving are gaining momentum in India though it is more of an urban phenomenon. Many Indian cities have moved towards higher checks of drivers, increased penalty, stricter punishment like cancelling driver license, jail sentencing, forced education of drivers and others have been introduced along with the use of breathalyzers during testing and public campaigns.

**Speeding**

Excessive and inappropriate speeding is a key risk factor that determines the occurrence, outcomes and consequences of road crashes. An increase in 1km/hr vehicle speed results in an increase of 4-5% of fatal crashes. An adult pedestrian has less than 20% chance of dying if hit by a car at less than 50km/h but almost a risk of 60% of dying if struck at 80 km/hr [169]. Hence the WHO Best road safety practices recommends the National urban speed limit to be 50 km/hour to reduce road accidents [170].

In India, though the speed limit law is in place under the Indian Motor Vehicles Act of 1988, there is no uniform and strict enforcement throughout the country. Under sections 183, 184 and 189 of the Indian Motor vehicle act, over speeding, dangerous driving and racing are punishable with penalties ranging between Rs 1000 (For LMV) to a maximum of ₹5,000.[164]

Globally, only 47 countries, representing 950 million people, have laws for urban speed limit in line with best practices. Enforcement of speed related laws is ranked at 3 in the GRSSR 2015 showing that the speed control requires strict enforcement for better road safety results in India.[36]

MoRTH and NCRB data show that nearly 48% of all road accidents and 44% of all road related deaths were due to rash driving which is likely to involve over speeding /overtaking. Scientific studies are limited in India in this regard.

In a study of highway crashes in Kolar district of Karnataka, police personnel perceived that the collision due to over speeding heavy vehicles with other road users resulted in increasing deaths and serious injuries on National Highways.[70]Data was not available on speeding directly in police records but documented indirectly as rash driving/ careless driving etc.In Focused Group Discussion, local eye witnesses mentioned speeding as the cause for both fatal and nonfatal crashes.[70]The perception of public as regards to speeding and accident is encouraging as 76% feel that speed is a major contributor to accidents, though 17% disagreed on the same [153].

**Figure 32: Percent of RTI deaths linked to speeding at the time of crash**

<table>
<thead>
<tr>
<th>Source</th>
<th>Speeding Percentage</th>
</tr>
</thead>
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<tr>
<td>Pathak SM et al (2014)</td>
<td>37.9</td>
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<tr>
<td>Sangal A et al (2015)</td>
<td>34.9</td>
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<tr>
<td>NCRB (2015)</td>
<td>43.7</td>
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<td>MoRTH (2015)</td>
<td>47.9</td>
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</tbody>
</table>
Few hospital based studies have also examined whether speeding was a cause for accidents and the proportion of cases ranged between 10-50%.

- In a large hospital based study on 748 RTI deaths, 75.8% of the victims reported their speedy driving as a causal factor [88].
- Pathak et al (2013) studied 182 RTIs and observed significant association between speed of vehicle and the severity of injury (OR=1.37). Roads users traveling at speeds of >40kmph had 1.37 times higher odds of sustaining a severe injury [144].
- Accidents that occur on well surfaced, straight roads with little or no congestion on highways and outside the city limits or in other areas can be mainly attributed to high speeding vehicles [29].
- The District injury surveillance feasibility study in Tumkur showed that most of the road crashes occurred on straight, concrete roads at times of good visibility and no obvious road obstructions, indicating that speed is a major contributor to road crashes [33].
- Similarly, a study of highway crashes in Kolar district reveals that for all fatal crashes the police record mentioned speeding as the prime cause either directly or indirectly (overtaking, reckless driving, rash/rude driving etc) [70].

In 2002, the Supreme Court of India issued directives to install speed governors- a device installed in commercial vehicles to measure and regulate speed. Further, in April 2015, the Centre issued a notification making it compulsory for all new commercial vehicles to have speed governors by October, 2015 and all older vehicles to be equipped with them by 1st April, 2016. The Supreme Court too, in October 2015, ordered its implementation and extended the deadline for older vehicles to comply with the order by July 1, 2016 [170, 171]. Despite Supreme Court directives to all State Governments to initiate and complete the installation of speed governors in commercial vehicles, most states are yet to comply with the same. Karnataka, Jharkhand, Haryana and Odisha have initiated the process.

In conclusion, recognizing that speeding is responsible for a large number of crashes is often the first step. The problem of speeding needs to be addressed through a wide range of measures that include safe design of roads and highways, traffic separation, VRUs protection, legislations that address speed by fixing speed limits, implementation through technology aids, special focus around schools and business areas, public engagement and other measures [36, 169].

**Seat belt use**

With 13% of motor vehicles on Indian roads being cars and jeeps, and likely to increase in the coming years, protection of four wheeler occupants assumes importance. All modern day cars come with seat belts for both front and rear passenger seats and front air bags as well. In India, the Central Motor Vehicles Rules 1989, mandates use of seat belt by driver and the occupant of front seats as well as occupants of rear seat facing front, while vehicle is in motion [171]. All motor vehicles with >3 seats and a motor power of >100cc are provided with seat belts in conformity with the central motor vehicle act-1989. But seat belt use is far from universal.

A seatbelt helps to prevent injury in the event of a car crash by - reducing the velocity of the body as it experiences a sudden decrease in speed; spreads the stopping force needed to decelerate the passenger across their body and prevents the body from hitting the windshield or steering column of a car at high speed; reduces most of the stopping force and increases the time taken for the body to come to a stop [172].

The wearing of a seat belt by the driver and the front seat occupant reduces the risk of fatal accidents by 45-50% and the risk of minor and serious injuries by 20-45% respectively. In the case of rear seat passengers, the seat belt use reduces fatal and serious injuries by 25% and minor injuries by up to 75%. [172] The GRSSR 2015 data reveals that the current level of seat belt enforcement in India is rated 4 indicating poor enforcement of seat belt law in the country.
The perception of various road safety measures including seat belt use was carried out on 10,000 persons aged 16+ years from different education, income and occupation back grounds in Bangalore during 2004. The results showed that 70% of the population reported to ‘always use seat belts’ and 3% reported ‘never use seat belt while driving’. Seat belts were regarded as a safety measure that reduces the impact of crashes. Non user said that the inability to move out easily and the discomfort caused prevented them from using the same [153].

Road side observation surveys at 5 randomly selected petrol bunks in Bangalore under the BRSP revealed that only 17.1 % of drivers were belted [29]. Noncompliance to seat belt use is common among adolescents and was observed to be 52% in Delhi.[160], while Mohan et al report the use to be 72 %. Available studies report that seat belt use varied between 14-43% among RTI victims (Table 22). On scene investigation of 211 fatal accidents done by JP Researches India Pvt Ltd during 2014-15 in Ahmedabad revealed that only 14% of the victims had used seat belts at the time of crash crash [142].

### Child restraint use

Globally, around 21% of RTIs every year involve children.[121] The use of child restraints is one of the 5 legislations for behavioral risk factors recommended by the WHO to reduce the severity of injury among children while they are inside the vehicle. As seat belts cannot be used on children, use of age appropriate restraints are strongly recommended [36].

---

**Table 22: Seat belt use at the time of road crash**

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Sample Size</th>
<th>Design</th>
<th>% use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gururaj G et al[153]</td>
<td>2004</td>
<td>Bangalore</td>
<td>10,000 individuals</td>
<td>C</td>
<td>70</td>
</tr>
<tr>
<td>1</td>
<td>Mohan D et al [117]</td>
<td>2009</td>
<td>Delhi</td>
<td>-</td>
<td>P</td>
<td>70</td>
</tr>
<tr>
<td>2</td>
<td>Gururaj G [29]</td>
<td>2010</td>
<td>Bangalore</td>
<td>258</td>
<td>P</td>
<td>17.1</td>
</tr>
<tr>
<td>1</td>
<td>Sharma R et al[160]</td>
<td>2007</td>
<td>South Delhi</td>
<td>550</td>
<td>C</td>
<td>48*</td>
</tr>
<tr>
<td>1</td>
<td>Gururaj G [29]</td>
<td>2010</td>
<td>Bangalore</td>
<td>32466</td>
<td>P</td>
<td>27.1</td>
</tr>
<tr>
<td>2</td>
<td>Gururaj G et al[34]</td>
<td>2008</td>
<td>Bangalore</td>
<td>26191</td>
<td>P</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>Roy R et al[143]</td>
<td>2014</td>
<td>Noida</td>
<td>144</td>
<td>C</td>
<td>33</td>
</tr>
<tr>
<td>4</td>
<td>Shrivastva SR et al[134]</td>
<td>2014</td>
<td>Kancheepuram</td>
<td>200</td>
<td>C</td>
<td>20.6</td>
</tr>
<tr>
<td>5</td>
<td>Shah A et al[156]</td>
<td>2014</td>
<td>Lucknow</td>
<td>150</td>
<td>C</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>Tripathi M et al[125]</td>
<td>2014</td>
<td>Chandigarh</td>
<td>1545</td>
<td>P</td>
<td>12.9 (D) 3.5 (O)</td>
</tr>
<tr>
<td>2</td>
<td>Gururaj G et al[70]</td>
<td>2015</td>
<td>Kolar</td>
<td>2845</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>Chauhan A et al[157]</td>
<td>2014</td>
<td>Lucknow</td>
<td>267</td>
<td>C</td>
<td>14.3</td>
</tr>
<tr>
<td>4</td>
<td>Bali R et al[96]</td>
<td>2013</td>
<td>Harayana</td>
<td>740</td>
<td>R</td>
<td>32.1</td>
</tr>
<tr>
<td>5</td>
<td>Mahajan N et al[126]</td>
<td>2013</td>
<td>Shimla</td>
<td>401</td>
<td>C</td>
<td>14.3</td>
</tr>
<tr>
<td>6</td>
<td>Gururaj G et al[33]</td>
<td>2011</td>
<td>Tumkur</td>
<td>1276</td>
<td>P</td>
<td>&lt;2</td>
</tr>
<tr>
<td>7</td>
<td>Suryanarayan SP et al[158]</td>
<td>2010</td>
<td>Bangalore</td>
<td>694</td>
<td>C</td>
<td>19.3</td>
</tr>
</tbody>
</table>

P= Prospective studies, R= Retrospective study, C= Cross sectional study, D= Driver, O= occupants, * among adolescent drivers
Reviews show that children (unrestrained) seated in the rear seat are at 25% less risk of injury and death compared to those seated in the front seat. Among children with age appropriate restraints the risk further reduces by 15% in both seats [172]. The Amendment (2016) to the Indian Motor Vehicle act specifies the laws for safety belt use by all occupants less than 14 years of age. Failure to use a safety belt or a restraint appropriate for children is punishable under section 194 B with a penalty of 1000/- [164].

### Distracted driving with cell phone use

Increased permeation of mobile phones into the lives of people coupled with ignorance about the hazardous effects of talking while driving is a risk factor for road crashes. The use of a mobile phone while driving leads to cognitive distraction and can result in accidents. Hence, irrespective of whether the person is using a hands free (blue tooth, ear phone) or hand set, the risk of accidents is similar. Distracted cell phone users not only risk their own lives but also that of other road users [99]. National or local data on cell phone use while driving is not available.

At present, usage of mobiles while driving is an offence and is punishable under the category of dangerous driving vide Section 184 of Motor Vehicles Act. Clause 11 of the new road transport bill 2016 amends section 9 of the motor vehicle act(1988), recommending disqualification of the driving license of a person for using a cell phone while driving [164].

However, enforcement is difficult and mechanisms are weak as reported by police authorities. The GRSSR 2015 mentions the presence of laws prohibiting cell phone use while driving in India but no data is available on enforcement levels [36].

- Road side observations on a sample of 145,789 drivers under the BRSP showed that 6.5% of drivers were using cell phones while driving. This was found to be a common practice at traffic intersections as they awaited a change in signals. Many continued talking even after the lights turned green [29].

- A study undertaken in 2008 across 11 colleges in Bangalore city examined mobile phone use in an equal sample of males (209) and females (227). More than two-thirds (66%) 'Talked and walked' and more than half (52%) used their mobiles while driving; 44% had tripped, bumped into someone or narrowly missed an accident while on their mobiles (Unpublished document).

- Studies on road accident victims by Srivastava et al in Kancheepuram reported that 10 % of RTI subjects were using cell phones at the time of crash [134], while shah et al in Lucknow reported the same to be 33 % [156].

- A recent survey (Save life Foundation, 2017) revealed that proportion of mobile phone use while driving was highest in Bengaluru (83%) , Kolkata (70%) and Mumbai (65%). Further population based data is required to understand the association between cell phone use and driving as use of cell phone is on a continuous increase in India.

### Driver Fatigue

Fatigue from long hours of driving, continuous driving, driving during illness and lack of alertness while on the road cause human fatigue and road crashes and it is commonly noticed among long distance drivers. The risk is further enhanced at night due to poor visibility, glare and sleeplessness. Illness and related

### Table 23: Protection by child restraints in cars (Percentage change in risk of injury)

<table>
<thead>
<tr>
<th>Type of restraint used</th>
<th>Best estimate</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restraining children aged 0-4 years in a forward facing child restraint</td>
<td>-50</td>
<td>(-70; -30)</td>
</tr>
<tr>
<td>Restraining children aged 0-4 years in a rear facing child restraint</td>
<td>-80</td>
<td>(-90; -70)</td>
</tr>
<tr>
<td>Restraining children aged 0-4 years with a seat belt only</td>
<td>-32</td>
<td>(-35; -29)</td>
</tr>
<tr>
<td>Restraining children aged 5-9 years in appropriate child restript with seat belt</td>
<td>-52</td>
<td>(-69; -27)</td>
</tr>
<tr>
<td>Restraining children aged 5-9 years using seat belt only</td>
<td>-19</td>
<td>(-29; -7)</td>
</tr>
</tbody>
</table>

medication adds further for fatigue among drivers, especially elderly drivers.

Research is lacking from the Indian region on this issue. Indian reports (2015) suggest that a small percentage (0.004%) of deaths are attributable to fatigue or illness, whereas 1.5% was attributed to lack of alertness while driving [21]. Independent studies indicate that 11-25% of RTI victims reported driver fatigue at the time of crash [123,143]. There is a strong need to investigate this issue further in the Indian region.

Young drivers, licensing and training

The basic skills required by a driver for safe driving include visual skills (seeing - watching the road in front and around the vehicle using mirrors), auditory skills (listening to, sirens, other vehicle sounds; of course to honking on Indian roads), bio-mechanical skills (performing hand-eye co-ordination), and cognitive alertness (thinking, anticipating any future road and vehicle movements, road and weather condition)[173].

As per Indian regulations, anyone driving a vehicle on any highway or any other road as defined in the Motor Vehicles Act, 1988 is expected to carry a valid driver's license. A driving license (DL) is issued and administered by the Regional Transport Authorities/Offices (RTA/RTO) in all states and in designated centers across the country. A driving license issued for a non-transport vehicle is valid for 20 years or until the date on which the person attains the age of fifty, whichever is earlier. A person who attains 50 years of age on the date of issue or renewal of the license can obtain and renew his license for 5 more years. The validity of a transport vehicle DL is 3 years and the license to drive a transport vehicle carrying goods of a dangerous and hazardous nature is effective for one year. The eligibility for obtaining a Learner's License for a private motor vehicle for a vehicle of 50cc engine capacity and without any gear, is 16 years (if the applicant's parents or guardians give their consent) with the minimum age to obtain a permanent license being 18 years [171].

As per the Indian Motor Vehicles Act, DLs issued may be cancelled or revoked or the person disqualified from holding it as per different sections. Available data on the number of DL's issued by RTOs is an overestimation of the number of road users as licenses are not cancelled after death, severe disability or disease. The available data is also cumulative till the year of issue. Nearly 10,110,087 DLs were issued in India in 2011 with the highest being in Maharashtra (1511499) and the lowest in Sikkim (7604) [174].

Lack of requisite driving/riding skills is one of the predisposing factors for crashes. Of the total number of accidents in India in the year 2015, 3,96,381(79.1%) occurred among regular license holders, 59,435(11.9%) were among those with a learner's license and 45,191 (9%) were those without a driving license [47].

In spite of the existing legal provision (Section 5 of Indian Motor Vehicles Act) that the owner of a vehicle should not permit his vehicle to be used by any person without a valid driving license even if the person is his son/daughter, cases of accidents involving young people without a license is often reported [175]. This is substantiated by the fact that 1022 driver deaths occurred among those less than 14 years.

Teenage and novice drivers may not be physically and mentally experienced to drive and may pose a danger to themselves and to other road users. Recognizing this phenomenon, many countries have evolved Graduated Driver Licensing (GDL) system which is well proven to have positive effects. Under this system, young drivers (>15 and < 20 years old) are required to complete a period of supervised driving before getting a basic driver's license. They enroll under a mentor and maintain a log specifying the number of hours of supervised driving completed. Subsequently, they are required to pass a road test to obtain the learner's/ intermediate license which has restrictions (speed limit, passengers, night driving, etc.). The GDL system gives teenagers a stage to learn driving under supervision, increase their awareness about safe driving, delays the age of obtaining a license and imposes certain constraints on driving during the intermediate driver's phase, all of which can reduce crashes and deaths. During this phase the care taker/parent/guardian is responsible for his acts. Many studies that have evaluated the GDL in HICs have shown a decrease in the crash and fatality rates with its implementation [176,177].

Provision of information to drivers and driver training has been the hallmark of building driver knowledge and skills in the Indian region amidst lax licensing and driver training procedures. Post license driver education is carried out across several centers across the country and no formal evaluations of such driving lessons have been carried till date. Definitive evidence is lacking on driver education and training and it is also mired in controversies.

Visibility issues among drivers

Poor visibility of people, vehicles and roads is an important contributing factor to road crashes but the data concerning this is lacking in India. Data presented in the earlier sections indicates that nearly a third of crashes occur during night times when visibility is poor.
and identifying vehicles, defective road environments and the movement of people, especially on highways and in poor weather conditions becomes difficult. Poor visibility due to weather conditions was responsible for 1% of road accidents and 1.5% of road deaths in India during 2015 [21]. A hospital based cross sectional study in Pune attributed 14.9% of road accidents due to poor visibility [123].

India needs a multipronged approach to address the visibility issues of roads, vehicles and people. With specific reference to good vision among drivers, the Indian Motor Vehicles Act has provisions; but it is left to the states to implement the same. For Indian commercial licenses, an applicant requires a medical certificate attesting 6/6 or normal vision; whereas a private license only requires the applicant to say that his vision is normal.

- During the 22nd road safety week of 2010, free comprehensive eye screening camps for drivers and employees of government and private organization’s was conducted by Shankar eye hospital (Bangalore). Nearly 370 drivers of buses, cars and other vehicles were screened for visual problems of which 14% were found to have a significant visual defect with 5% of them requiring treatment.[29]

- Verma et al, assessed the visual acuity of drivers in Guwahati and reported that 12% of the drivers had ‘unacceptable’ levels of depth judgment , 7% failed in the glare recovery test, 5% were found to have a problem of tunnel vision while driving, thus making it difficult to identify obstructions on the roads. Fifteen percent of the drivers were found to have unacceptable acuity of vision in one of the eyes, 4% in both the eyes and 5% of the drivers had problems with night vision (vision in the presence of headlight) [173].

- Vision testing among 160 public transport bus drivers in Karnataka revealed that 63.75% of the drivers had at least one visual defect and did not satisfy the minimum vision requirements for driving. Comparison of road crash histories of the drivers to the vision test showed their high crash involvement rates (up to 87%). Similarly, nearly 58% of BMTC bus drivers who were involved in road crashes had unacceptable vision standards [178].

Visibility of vehicles may also be enhanced by the use of technology. Davoodi et al in a review of the implementation of motorcycle Day time Running Lights (DRLs), indicate that DRLs are an influential and effective approach to reduce the rate of collision by improving the motorcycle’s conspicuity in traffic. The motorcycle DRLs managed to reduce about 4 to 20% of motorcycle crash risk [179]. DRLs are also recommended for global use, especially in countries with high motorcycle accident rates to improve the safety of the riders as well as their pillion riders.

**Impaired driving due to drugs**

Psychoactive drug use and alcohol are known to interfere with brain functioning resulting in altered mood, delayed reaction, impaired motor coordination, reduced alertness, vision, road tracking and vehicle control [163]. Like alcohol, drugs of all types increase the probability of accidents. In 2013, illicit drug use was responsible for 39600 road deaths worldwide. [36] 159 countries address drug-driving in their road safety legislation but in most cases these laws are too vague to be effective.[36]

It is essential to note that a wide variety of licit and illicit drugs are easily available in India; and many might be using them while driving as well. Data on drugs and driving are lacking in India. However, data from other sources indicate prevalent drug use, that might also influence road safety statistics. Data from the Narcotics Control Bureau (2009-2015) indicate that nearly 94403 kilos of Ganja , 3349 kilos of Hashish and 1687 kilos of opium were seized by enforcement authorities during the year 2015[163], which otherwise would have been in use. An increased seizure compared to that of the previous year was reported for amphetamine, cocaine, morphine and methaqualone, providing coherent evidence regarding the widespread circulation and use of psychoactive substances in the Indian population. The National survey on the extent, prevalence, and pattern of substance abuse revealed that the weighted prevalence of use of any drug was 63.7%. Tobacco (56%) and alcohol (19.6%) were the most common substances of abuse followed by cannabis (3.8%), opium (0.6%) and Heroin (0.2%) [163]. The recently completed National Mental Health survey (2016) in 12 states of India estimated the weighted prevalence of other drugs (excluding tobacco and alcohol) to be 0.5 % ; most common in the younger age groups (20-35 years) and among males [163].

Accidents and deaths caused due to the ‘Intake of alcohol/drugs ’ comprised 3.3% and 4.6% of all accidents and deaths, respectively, even though the precise role of drugs was uncertain [47]. Nearly 6.4% of fatal accidents, occurred because of intake of alcohol/drugs by the driver [47]. Road side surveys of the drivers show that nearly 3.9- 20% of the drivers use psychoactive substances. A hospital based study in Greater Noida by Rupali Roy et al documented drug use among patients injured in road accidents as 18.7% [143]. Though there is collateral evidence with regard
to the sale of intoxicating illicit drugs and the use of sedative medicinal drugs (anti histamines available over the counter), their possible involvement in road accidents is not yet documented in Indian studies [180].

**Table 24: Trends of drug seizure in India (in Kilos)**

<table>
<thead>
<tr>
<th>Drugs</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opium</td>
<td>1732</td>
<td>1829</td>
<td>2348</td>
<td>3625</td>
<td>2333</td>
<td>1766</td>
<td>1687</td>
</tr>
<tr>
<td>Morphin</td>
<td>42</td>
<td>25</td>
<td>53</td>
<td>263</td>
<td>7</td>
<td>25</td>
<td>61</td>
</tr>
<tr>
<td>Heroin</td>
<td>1047</td>
<td>766</td>
<td>528</td>
<td>1033</td>
<td>1450</td>
<td>1371</td>
<td>1416</td>
</tr>
<tr>
<td>Ganja</td>
<td>208764</td>
<td>173128</td>
<td>122711</td>
<td>77149</td>
<td>91792</td>
<td>108300</td>
<td>94403</td>
</tr>
<tr>
<td>Hashish</td>
<td>3549</td>
<td>4300</td>
<td>3872</td>
<td>3385</td>
<td>4407</td>
<td>2280</td>
<td>3349</td>
</tr>
<tr>
<td>Cocaine</td>
<td>12</td>
<td>23</td>
<td>14</td>
<td>44</td>
<td>47</td>
<td>15</td>
<td>113</td>
</tr>
<tr>
<td>Methaqualone</td>
<td>5</td>
<td>20</td>
<td>72</td>
<td>216</td>
<td>3205</td>
<td>54</td>
<td>89</td>
</tr>
<tr>
<td>Ephedrine</td>
<td>1244</td>
<td>2207</td>
<td>7208</td>
<td>4393</td>
<td>6655</td>
<td>1330</td>
<td>827</td>
</tr>
<tr>
<td>Acetic Anhydride</td>
<td>658</td>
<td>74</td>
<td>62</td>
<td>363</td>
<td>243</td>
<td>54</td>
<td>4</td>
</tr>
<tr>
<td>Amphetamine type stimulants (ATS)</td>
<td>38</td>
<td>20</td>
<td>474</td>
<td>40</td>
<td>85</td>
<td>196</td>
<td>166</td>
</tr>
</tbody>
</table>

Source: Narcotics control bureau. annual report = 2015 government of India, ministry of home affairs, New Delhi

The reasons for poor documentation by authorities and other researchers could be due to the non-availability of devices that can be used in roadside surveys (similar to alcohol breathalyzer) along with required legislative support. Testing for other drugs is still laboratory based using blood and other body fluids as specimens and is done in suspicious cases. Only self-reported influence of drugs like anti-depressants, anti-histamines are documented in certain cases.

A review of risk factors and causal pathways for road crash reiterate that road crashes are multifactorial in causation due to which a straight-jacketed approach to control is not effective nor possible and is unlikely to lead towards tangible results. A multi-disciplinary approach focusing on all human, vehicle and environment related determinants, but in a prioritized manner, is the key to address RTI problem in India. However, identifying these factors require greater research through crash investigation and analysis. The recent attempts by JP researchers Pvt. Ltd in different cities have highlighted the importance as well as quantified interaction between various determinants (Figure 34).

**Figure 33: Accident case analysis**

Mumbai-Pune expressway- study of 63 accident case analysis[181]  
Ahmedabad- study of 211 accident case analysis[142]  
Kolkata- study of 81 accident case analysis[182]

Source: http://www.jpresearchindia.com/Publications.html
The above mentioned risk factors need better understanding in India for developing prevention programmes and to promote safe practices among road users. Observational studies undertaken by WHO CC at NIMHANS in Bangalore over time have revealed that use of helmets – seat belts, detection of - drinking and driving - speeding and - use of cell phones are higher wherever and whenever there is police presence, checked on roads in a visible manner (with use of technology or manually) and when penalties of a reasonably high level (that pinches the pocket) are imposed. Safe practices are markedly low during holidays and weekends; evenings or night times; in peripheral areas or in outskirts of city limits indicating that both legislation and enforcement makes people safer. For enforcement to be effective, it is the fear or chances of getting caught / being stopped, the hassles with police and courts, and the reasonably high penalty that deters people from making unsafe choices. At the same time, token implementation strategies are not known to be effective as expressed by participants of our several FGDs in different studies. Along with legislation, there is need to use greater technology (in enforcing, safety of vehicles and roads) not only to overcome human resource constraints, but also to make enforcement easy and effective.

Road crashes occur in different ways and are influenced by traffic patterns in different topographical regions, referred to as heterogeneous traffic environments. It usually involves a collision between - two or more vehicles or a vehicle and a stationary object or pedestrians with vehicles. Accidents could also be of the non-collision type like a skid, fall, overturning, and roll over, etc. Collisions in road accidents can also be of various types like front end, lateral and rear end collision. The heterogeneous traffic environment, the absence of segregation of vehicles of different speeds and the non-separation of pedestrians and bicycle riders from other speeding vehicles contribute to a larger extent for the increasing number of crashes on Indian roads. The collision patterns are primarily determined by several factors like the nature of the roads and traffic, colliding vehicles, the presence or absence of immobile objects etc. The outcomes are influenced by the size and speed of collision. For example, based on typology, pedestrians involved in road crashes are classified into four groups [183].

1. Pedestrians age 65 or over crossing the road in a built-up area
2. Children in accidents in built-up areas while walking or running or playing
3. Drunken pedestrians
4. Pedestrians in intermodal changes and secondary accidents.

In 2015, nearly 57% of all road accidents (285316) occurred due to collision and it was the predominant mode of accident [47]. As per the MORTH report, of every 10 road accidents 6 were due to collisions accounting for 55.4% of all RTIs and 54.6% of road deaths. Non collision accounted for 19.1% of all accidents in 2015, of which overturning of vehicles (72.7% of non-collision) was the most frequent [47]. The common types of non-collision are usually skid and falls and over turning of the vehicle and reasons could be several.

Among collision patterns between vehicles, hit and run and head-on collisions contributed mostly to injuries, while rear end, head on and hit and run were major patterns for fatal crashes. Head-on collisions are common in un-separated roads and in 2015, 98,134 such crashes resulted in 25,495 deaths, accounting for 19.6 % and 17.4 %, respectively. This was closely followed by 57083 hit and run type collisions (11.3%) accounting for 14.2 % of total deaths [47].

Evidence from studies done by independent researchers across different parts of India between 2004 and 2015, indicate that collision related road accidents accounted for 45-100% of all injured and nearly 58-59% of all road deaths. Non-collision mechanisms like overturning and skidding accounted for 20-50% of accidents (Figure 35).
However, it is essential to note that the national reports capture mechanisms in severe or fatal cases. Studies undertaken by the WHO CC in Bangalore and TRIPP, New Delhi as well as data from a few independent studies indicate that collisions between vehicles of different types and vulnerable road users are the commonest pattern on all types of Indian roads (Figure 36) [29,34,117]. Data from 5 years of BRSP examined crash patterns among pedestrians, two wheelers and heavy vehicles based on data extraction from police records and interviews of patients in hospitals. In addition, data also revealed that pedestrian collisions were more frequent in mid-blocks while crossing the road rather than at intersections. [29] Data on BMTC bus crashes from the BRSP indicated that >80% of collisions of buses involved pedestrians, two wheeler riders and pillion riders. With increase in two wheelers on Indian roads, pedestrian and two wheeler collision patterns or collisions between two wheelers have become common and the collision of medium and heavy vehicles like buses with vulnerable road users continues regularly (Figure 37,38). In addition, data also revealed that pedestrian collisions were more frequent in mid-blocks while crossing the road rather than at intersections.

A review of crash patterns in several Indian cities like Delhi, Mumbai, Kolkata undertaken by TRIPP, New Delhi showed that pedestrians, two wheelers and bicycles were involved in 67-86% of the total crashes [117]. Collision between heavy vehicles like buses, trucks etc. and vulnerable road users was usually fatal and was closely interlinked to the size and speed of the impacting vehicles. The over representation of VRUs in Indian cities was also reported on highways, though in varying proportions. Occupants of buses and trucks were more prone to injuries on 2 lane highways. The presence of shoulders on highways and collisions with these stationary objects were equally seen on 2 lane highways. Data from a recent highway study indicates the pattern to be somewhat similar, even though collisions between heavy vehicles in un-separated roads were a common occurrence [117]. With nearly 310 vehicles per 100 kms of road in India, preventing collision patterns of various types on different roads requires a mix of intervention strategies aimed at roads, vehicles and people.
Figure 36: Collision of different vehicles with pedestrians (2007-2010)[29]

Figure 37: Road user category and BMTC bus crashes (2007-2010)[29]
Place of death

While an understanding of the place, occurrence, and mechanism of collision patterns has implications to prioritize predominant crash patterns, information on the place of death helps in strengthening primary and secondary prevention strategies for interventions. Trunkey, an Australian surgeon, delineated this pattern as early as the 1960s and since then many studies have refined the same [185, 186]. Deaths from road crashes occur in one of the three phases.

In Phase I, death occurs immediately or quickly as a result of overwhelming injury. Due to the severity of the injury and the short time interval between injury and death, crash victims often do not have the opportunity for benefiting from medical interventions. Therefore, improvements in the quality of care do not significantly influence patients’ outcome at this stage, but can be reduced with a mix of road-vehicle engineering measures and strong regulatory mechanisms to make roads-vehicles and people safer.

Phase II includes fatalities that occur within a few hours of the event. This leaves more time for pre-hospital and hospital care providers to intervene and improve patients’ outcome. Under these circumstances, improvements in the quality of pre-hospital care and hospital care can alleviate the magnitude of trauma fatality by measures to stabilize – transfer the injured to the right place in the right manner within the right time.

Deaths in Phase III, occur days or weeks after injury usually in a health care setting or even days after discharge. Hence, patients’ outcome is highly correlated with the quality of care that they receive in hospitals. [185] The TBI registry in Bangalore revealed that 18% of hospital discharged subjects had died within 24 months due to injury complications [97]. Similarly, in a comparative study between Delhi and Seattle, it was observed that mortality and disabilities were higher in India due to post discharge complications. (Monica et al)

It is essential to note that the number of deaths in each of the peaks is determined by the primary impact of crashes while other factors like age and gender, physiological and health status, role of alcohol, use of protective devices, availability – accessibility, affordability of pre-hospital and trauma care services contribute further. The number of deaths in each wave as well as the pattern also varies across urban, rural and highway crashes in India.

Data from 5 years of the Bangalore Road safety program revealed that nearly 30-40% of deaths occur during the first wave, 10-20% during the second wave and half of the deaths during the third wave (Figure 38). This is confirmed by a few independent studies which report that 30-60% of the deaths happen at the crash site, more so in high speed and highway crashes especially due to injuries to vital organs like the brain, nervous system and internal organs (Figure 40). In a rural injury surveillance programme it was observed that nearly 15-37% died enroute to hospital. Around 33-50% of the deaths occur in the hospital due to complications and 1-3% of the deaths occur after discharge [33].

![Figure 38: Place of death in road accidents (BRSP 2007-10)[29]](image-url)
Figure 39: Proportion of on-site road deaths from different studies

- Dandona R et al (2004): 60%
- Singh YN et al (2005): 45%
- Sharma BR et al (2007): 3.38%
- Jain A et al (2009): 45.00%
- Gururaj G et al (2010): 0.038%
- Gururaj et al (2010): 30.00%
- Varma R et al (2013): 3.20%
- Hsiao M et al (2013): 62.00%
- Farooqui JM et al (2013): 64.28%
- Kumar N et al (2015): 32.00%
- Gururaj G et al (2016): 48.00%
NATURE OF INJURIES IN ROAD CRASHES

Though any part of the body can be injured in a road crash, the specific nature of injuries is primarily dependent on crash mechanisms and the presence or absence of protective devices. Apart from injuries to specific parts of the body, multiple sites are affected in road crashes, commonly referred to as polytrauma. Polytrauma can be defined as significant injury(ies) in at least two out of the following six body regions: Head, neck and spine, chest and thoracic spine, abdomen and lumbar spine, limbs and bony pelvis and extremity injuries to limbs, and external (skin) [187]. Lecky et al[196] indicate polytrauma to account for 16% of all injuries while Indian studies indicate polytrauma to account for 20 – 25% of road crashes.

Figure 40: Anatomical sites of injury in fatal and non-fatal road crashes[34]

Table 25: Anatomical site of injury in fatal road crashes from hospital studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Place</th>
<th>Design</th>
<th>Sample size</th>
<th>H &amp; N %</th>
<th>UL %</th>
<th>LL %</th>
<th>A &amp; P %</th>
<th>Chest %</th>
<th>Spine %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Room</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Gururaj G et al* 2010 [29]</td>
<td>Bangalore</td>
<td>P</td>
<td>24586</td>
<td>103</td>
<td>25</td>
<td>37</td>
<td>0.3</td>
<td>23</td>
<td>5</td>
</tr>
<tr>
<td>Reddy N B et al 2014[188]</td>
<td>Bangalore</td>
<td>P</td>
<td>100</td>
<td>47</td>
<td>33</td>
<td>13</td>
<td>49</td>
<td>73</td>
<td>11</td>
</tr>
<tr>
<td>Farooqui J Met al 2013[75]</td>
<td>Ahmedanagar</td>
<td>P</td>
<td>98</td>
<td>32.4</td>
<td>21</td>
<td>19.6</td>
<td>3.5</td>
<td>19.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Autopsy studies</td>
<td></td>
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<tr>
<td>Surender J et al 2015[130]</td>
<td>Warangal</td>
<td>P</td>
<td>297</td>
<td>56.2</td>
<td>51.5</td>
<td>47.1</td>
<td>39.7</td>
<td>37.0</td>
<td>12.4</td>
</tr>
<tr>
<td>Yadukul S et al [72]</td>
<td>Bengaluru</td>
<td>P</td>
<td>238</td>
<td>91.1</td>
<td>95.7</td>
<td>95.7</td>
<td>28.9</td>
<td>19.1</td>
<td>12.1</td>
</tr>
<tr>
<td>Singh D et al 2015[189]</td>
<td>Chandigarh</td>
<td>R</td>
<td>6307</td>
<td>41</td>
<td>3.6</td>
<td>-</td>
<td>4.5</td>
<td>1.3</td>
<td>-</td>
</tr>
<tr>
<td>Kanchan T et al 2012[81]</td>
<td>Manipal</td>
<td>R</td>
<td>879</td>
<td>85.5</td>
<td>-</td>
<td>-</td>
<td>6.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shruti P et al 2013[190]</td>
<td>Bangalore</td>
<td>R</td>
<td>225</td>
<td>30.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Singh P et al 2015[76]</td>
<td>Indore</td>
<td>R</td>
<td>596</td>
<td>38.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Dhillon S et a2007[109]</td>
<td>Shimla</td>
<td>C</td>
<td>50</td>
<td>76</td>
<td>25</td>
<td>74</td>
<td>32</td>
<td>32</td>
<td>-</td>
</tr>
<tr>
<td>Kumar N et al 2015[191]</td>
<td>Varanasi</td>
<td>C</td>
<td>100</td>
<td>64.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>21</td>
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</tbody>
</table>

Note: * Multiple response ; H & N- Head and Neck, A&P- Abdomen and Pelvis, UL- Upper Limb, LL- Lower limb ;
Fatal accidents investigated by independent studies point to head and neck injury as the major type of injury (30-91%) as well as the leading cause of death. On an average, 50 – 60 % of the fatal road accident victims suffered injury to the head and neck region. Data from available studies show that the extremities (lower limbs (49%) and upper limbs 38%), are the second most common site of injuries followed by the chest (29%), abdomen (23.4%) and spine (7.2%)(Table 24).

Usually haemorrhage, precipitating cardiac shock and arrest and sepsis are the major reasons for death in most road accidents. Brain injury (59.9%) was the most commonly reported cause of death among road accident victims followed by shock (21.6%). Chest injury caused deaths in <10% of accident deaths. Others injuries (5%) included injury to the chest and abdominal organs with or without complications. With injury to the brain being the most frequent, a large study conducted by the WHO CC showed that 79% of two-wheeler drivers and 80% pillion riders sustained a head injury, with 28% of drivers and 26% of pillion riders succumbing to death (Figure 41).

Among non-fatal road accidents, the head and neck region were once again the most common sites of injuries. Studies reported a wide variation in the head and neck injury proportion (7 to 70%) but most studies clustered around 60%. On an average, nearly 51% of all non-fatal accident victims sustained head and neck injuries. For every 10 non-fatal accidents, 5 sustain head and neck injuries. Injuries related to the extremities (Upper and lower limb) were the second most common in about 25 – 30 % of crashes. But some studies have documented injuries to the lower limb or the torso as being the most common type of injuries in road accidents.

Table 26: Anatomical site of injury in non-fatal road crashes from hospital based studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Place</th>
<th>Sample</th>
<th>Design</th>
<th>H &amp; N %</th>
<th>UL %</th>
<th>LL %</th>
<th>A &amp; P %</th>
<th>Chest %</th>
<th>Spine %</th>
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<tbody>
<tr>
<td>Emergency room based</td>
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</tr>
<tr>
<td>Shah A et al (2014) [156]</td>
<td>Lucknow</td>
<td>150</td>
<td>C</td>
<td>44.6</td>
<td>25.3</td>
<td>5.3</td>
<td>8</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Malhotra C et al* 2005 [159]</td>
<td>New Delhi</td>
<td>185</td>
<td>C</td>
<td>57.3</td>
<td>40</td>
<td>52.4</td>
<td>5.4</td>
<td>5.4</td>
<td>4.3</td>
</tr>
<tr>
<td>UlISchmucker et al (2011)[184]</td>
<td>Hyderabad</td>
<td>139</td>
<td>C</td>
<td>7.68</td>
<td>6.5</td>
<td>6.5</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jaiswal K et al 2015 [124]</td>
<td>Uttar Pradesh</td>
<td>477</td>
<td>C</td>
<td>46</td>
<td>31.8</td>
<td>73.1</td>
<td>10.6</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Hospital Admission based</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Sangal A et al (2015) [145]</td>
<td>Meerut</td>
<td>103</td>
<td>P</td>
<td>72.8</td>
<td>22.3</td>
<td>20.3</td>
<td>0.9</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Chauhan A et al (2014) [157]</td>
<td>Lucknow</td>
<td>267</td>
<td>R</td>
<td>38.9</td>
<td>30.3</td>
<td>60.2</td>
<td>8.6</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Celine TM et al (2014) [71]</td>
<td>Ernakulam</td>
<td>7660</td>
<td>R</td>
<td>62.3</td>
<td>0.2</td>
<td>2.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bali R et al (2013) [96]</td>
<td>Harayana</td>
<td>740</td>
<td>R</td>
<td>76.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * Multiple response ; H & N- Head and Neck, A&P- Abdomen and Pelvis, UL- Upper Limb, LL- Lower limb, P- Prospective, R- retrospectice, C- Cross sectional study designs
Severity of RTIs

Undoubtedly, the force of impact determines the severity of injury and this in turn dictates the range and type of medical services needed, duration of hospital stay and the final outcome of recovery, disability or death.

Injuries are measured and classified based on the purpose. An efficient injury scoring system should be simple, clear, sensitive, feasible and user-friendly. Injury assessment and scoring systems are developed to aid clinical practices and guide managerial procedures for improving patient outcomes.

At the national level, the severity of road crashes are assessed and measured as grievous, moderate and mild in police records and even in some research studies. As per Section 320 of the Indian Penal Code the following kinds of hurt only are designated as ‘grievous’- emasculation, permanent privation of the sight of either eye, permanent privation of the hearing of either ear, privation of any member or joint, destruction or permanent impairing of the powers of any member or joint, permanent disfiguration of the head or face, fracture or dislocation of a bone or tooth and any hurt which endangers life or which causes the sufferer to be during the space of twenty days in severe bodily pain, or unable to follow his ordinary pursuits’.

Data from the MoRTH 2015, indicated that 181,471 persons (36.2 % of all RTIs) sustained grievous injuries and 318,808 (67.3%) sustained minor injuries. From 2013 to 2015, there has been a modest 5-6% rise in the number of minor injuries but the proportion of grievous injuries has remained nearly the same.

Accident severity, measured as number of deaths per 100 road accidents has increased to 29.1 deaths in the year 2015 from 28.6 deaths per 100 road accidents in 2011 [47].

Several injury scoring methods, based on anatomic or physiologic criteria or a combination of both are used globally. Notable are the Abbreviated Injury Scale (AIS), the Injury Severity Score (ISS) and the New Injury Severity Score (NISS) which are anatomic-based and are applied for any injury assessment. For brain injury, the Glasgow Coma Scale (GCS) and Glasgow Outcome scales (GOS) including a modified version for pediatric populations are commonly used. The Revised Trauma Score (RTS) is a physiologic-based scoring method. A Severity Characterization of Trauma (ASCOT) and Trauma Related Injury Severity Score (TRISS) apply a combination of anatomic and physiologic criteria for injury scoring [192].

Measuring severity using an operational definition that can be applied in busy emergency room settings and allows uniform assessment in multiple study sites has also been attempted. Under the BRSP covering 25 hospitals in Bangalore, the injury severity was operationally classified as, mild (only ER care), moderate (requiring hospital stay up to 6 hours and needing investigations and expert consultation) and severe (direct admission for intensive management) [29].

Independent hospital-based studies conducted in various parts of India show that more than half of the injuries are of mild to moderate severity and only less than 20% are severe in nature requiring ICU and operative services. All polytrauma cases are severe (~20-25%) requiring advanced management.

Table 27: Road accidents by the severity of injury

<table>
<thead>
<tr>
<th>Author</th>
<th>Place</th>
<th>Sample</th>
<th>Design</th>
<th>Mild*</th>
<th>Moderate*</th>
<th>Severe*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menon GR et al (2010) [30]</td>
<td>Bangalore and Pune</td>
<td>12520</td>
<td>P</td>
<td>78.60%</td>
<td>14.67%</td>
<td>10%</td>
</tr>
<tr>
<td>Gururaj G et al (2005) [97]</td>
<td>Bangalore</td>
<td>7142</td>
<td>P</td>
<td>71%</td>
<td>15%</td>
<td>13%</td>
</tr>
<tr>
<td>BRsipp- (2007-2010) [29]</td>
<td>Bangalore</td>
<td>24586</td>
<td>P</td>
<td>34%</td>
<td>47.40%</td>
<td>18.60%</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td></td>
<td></td>
<td></td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
<td>42%</td>
<td>18%</td>
</tr>
<tr>
<td>UliSchmucker et al (2011)</td>
<td>Hyderabad</td>
<td>781</td>
<td>C</td>
<td>8.3</td>
<td>8.2</td>
<td>0.64</td>
</tr>
<tr>
<td>Gururaj G et al (2011) [33]</td>
<td>Tumkur</td>
<td>5192</td>
<td>P</td>
<td>36.60%</td>
<td>41.90%</td>
<td>21.50%</td>
</tr>
<tr>
<td>Gururaj G et al (2015) [70]</td>
<td>Kolar</td>
<td>2839</td>
<td>P</td>
<td>57.23%</td>
<td>32.65%</td>
<td>10.11%</td>
</tr>
<tr>
<td>Fitzharris M et al (2009)</td>
<td>Hyderabad</td>
<td>378</td>
<td>P</td>
<td>49.20%</td>
<td>23.60%</td>
<td>23.90%</td>
</tr>
</tbody>
</table>

*scales used to quantify severity – GCS, AIS, operational definition in BRSP

*scales used to quantify severity – GCS, AIS, operational definition in BRSP
Traumatic Brain Injury and Road crashes

'Traumatic Brain Injuries' (TBIs), also referred to as 'Acquired Brain Injuries' (ABIs) results from a sudden jolt or blow to the head which causes damage to the brain due to acceleration or deceleration forces. The external blow to the head causes brain to spin within the skull or brain may hit the bony structure of the skull and result in whiplash injuries that result in brain damage. The severity of TBI can range from mild (a concussion, which sometimes goes unnoticed) to severe (contusions or haemorrhage), often resulting in hospitalisation, comatose state or even death.

With an estimated 10 million TBI cases annually, TBI is expected to surpass all other diseases as the major cause of death and disability by 2020 (1). Good quality data on Epidemiology of TBIs in India is totally lacking. Empirical evidence from an epidemiological study of TBIs in Bangalore, India indicate that the mortality, incidence and prevalence are 20, 150 and 97 / 1,00,000 population respectively. The official figures from NCRB indicate that nearly 500,000 deaths are due to accidental injuries and estimates indicate the same to be nearly a million. Data from different studies as shown in this report reveal that nearly more than half (50 - 60%) of injury deaths are due to brain injury. This was substantiated with data from the Million Death Study that 52% of RTI deaths were due to brain damage(2). Majority of hospital studies point out that, more than half of RTIs had an accompanying brain damage at the time of ER registration and hospital admission. The number of individuals with mild TBI is unclear, but essential to note that these persons are likely to have a higher incidence of psychiatric illness compared to those individuals with orthopedic injury without TBIs (22%v/s 8%) as shown by recent study (3).

Considering these observations, it is estimated that nearly half a million deaths and 30 million admissions and 20% of injury disabilities in India are due to TBIs every year.

Young men are more frequently reported with TBIs than females. The most frequent causes of TBIs in India are Road Traffic Injuries (~ 50 - 60%), falls (15 - 25%) and Violence (5 - 10%) followed by mechanical injuries (5%). In recent times, sports related TBIs are increasing in occurrence due to greater engagement of young people in sports activities. The risk of TBI varies with the road user type. The vulnerable road users-
pedestrians (20-30%), two wheeler riders (30-50%) and bicyclist (10-20%) are at greater risk when compared to four wheeler and other motorised vehicles. This is due to their greater numbers, higher exposures, unprotected environment and related to other crash characteristics along with absence of helmets at crash times.

Outcomes of TBIs are linked to number of factors like age, injury mechanism, severity and crash patterns, presence or absence of a helmet, availability, accessibility and affordability of care as well as efficient rehabilitation services. Apart from death, nearly 100% of severe, 50% of moderate and 10 - 20% of mildly injured persons need lifelong support and care.

Cost of care for TBI are way more higher than injury to other body parts because of the complex management and diagnostic procedures. Prolonged hospital stay results in both direct and indirect costs and is an economic burden on individual, family and the nation. Duration of hospital stay ranges from several hours to several months (>30 days). The length of stay is determined by the severity of injury and patient's response to treatment. A large study on 1926 TBI victims showed inverse relation between duration of hospital stay and mortality.

Trauma Care Support

Since the primary causes of TBIs are mainly RTIs, prevention and control of RTIs is critical for reduction of the burden of TBIs. The 5 pillars of road safety (Road safety management, safer roads, safe vehicles, safe people and post crash care should be strengthened and implemented across India to reduce the burden of TBIs. Most significantly, helmet use - seatbelt use - speeding and drunk driving should be targeted.

Strengthening availability of early first aid, triage and safe transportation, ensuring preparedness of hospitals, training of doctors and allied health professionals in advanced and basic trauma care, developing and implementing standard protocols trauma care, implementing trauma team concept in medical college hospitals and all higher centers, trauma registries and injury surveillance and monitoring quality of care and real time evaluation of services on a continuous basis are required.

Rehabilitation:

The rehabilitation services in case of TBIs should cover physical, psycho – social, vocational and economic rehabilitation. With meagre data available on disability in India, it is estimated that nearly 5 million people with a TBI require rehabilitation services.

Early initiation of the service (in hospital), involvement of family members, services being provided through community leaders, teachers, ASHAs etc, creating employment opportunities are true urgent requirements.

References


Though preventing the occurrence of RTIs is the primary goal of road safety and injury prevention programs, providing timely and quality care at various levels for the substantial number of injured persons is equally important. Well established trauma care systems greatly help to reduce deaths by nearly 20–25% and serious disabilities by more than half. Trauma care systems are evolving in India but are still, more of an urban phenomenon in cities and recently in district headquarters.

The organization of trauma systems has four major domains, viz., pre-hospital care, in-hospital trauma care, referral services and rehabilitation components [193]. An integrated and coordinated approach encompassing human resources (staffing and training), physical resources (infrastructure, equipment and supplies) and the process (organization, administration and delivery) is required at all levels to deliver ideal trauma care.

Beginning with identifying the trauma victim at the site of the accident till the rehabilitation of the individual, trauma care services should be available, accessible, affordable, timely and efficient to the best possible extent and should consider the local topography, technology and resources [193]. Mock et al, compared trauma care systems between Ghana and HICs and observed that risk of death among trauma patients is 3 times more likely in a LMIC as compared with a HIC for the same level of trauma severity [194]. In a study on comparative rehabilitation services, Monica et al reported that deaths post discharge were higher in New Delhi, India as compared to Seattle in USA, indicating poor rehabilitation services. A few Indian studies have also reported high rates of mortality among hospitalized trauma subjects.

**Pre-Hospital Trauma Care**

The trimodal distribution of deaths following a road crash emphasizes the need for efficient care soon after an injury. Pre-hospital trauma care systems specifically focus on trauma care at the site of injury and en route to a fixed health facility) which provides basic first aid, triage at the site of occurrence or in first contact facility and early transportation of injured patients to the right health care facility depending on the nature and severity of the injury(WHO, 1983). The first 60 minutes following an injury within which the trauma patient should reach the right hospital is referred to as the golden hour; many controversies surround this view [195].

An assessment of emergency medical services (EMS) in 13 LMICs in Africa, Asia, and Latin America revealed that prehospital care capabilities varied significantly, but in general, were less developed in in LMICs and in rural areas, where the utilization of formal emergency medical services was often very low [196]. Commercial drivers, volunteers, police and other bystanders provided a large proportion of prehospital transport and occasionally also provided first aid in many.
locations. Although taxes and mandatory motor vehicle insurance provided supplemental funds to the EMS in 85% of the countries, the most frequently cited barriers to further development of prehospital care was inadequate funding (36% of barriers cited), lack of leadership within the system (18%) and the lack of legislation in setting standards comparable to HICs (18%) [196].

World Health Organization (WHO) report on ‘pre-hospital trauma care systems reports that “Even the most sophisticated and well-equipped pre-hospital trauma care system can do little if bystanders fail to recognize the seriousness of a situation, call for help, and provide basic care until help arrives” [197]. Bystander care is critical in the notification of the injured, first aid at the site and transportation of the injured.

A survey of 1027 road users across seven large cities in India revealed that nearly three-fourths of the bystanders (74%) reported that it is unlikely that they would assist a victim of serious injury. However, 58% reported that they were more likely to help a victim of a road accident rather than one of violence. Various barriers prevented bystanders from providing road side help which include - fear of legal complications including repeated police questioning and court appearances (88%); hassles in hospitals and the refusal of treatment if payment is not made (77%) and lack of supportive legal environment to encourage support to accident victims as a barrier to providing first aid (88%) (Figure 43) [198]. Evidence from other studies also indicates that 35% of bystanders did not extend help to the victim as they “did not know what to do” [199,200]. Thus, the absence of the enforcement of a Good Samaritans law is one of the main hindrances in saving lives and reducing accident related disabilities in India.

Figure 42: Impediments to Bystander care in India [198]
Availability of first aid services

First-aid refers to the assistance given to any person suffering a sudden illness or injury, with care provided to preserve life, prevent the condition from worsening, and/or to promote recovery. The most common first-aiders are usually the survivors of acute trauma and bystanders, police in the vicinity, drivers of vehicles and the public who may/may not be trained to provide the same.

Table 27: Distribution of RTIs according to first aid received (%)

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Author</th>
<th>Year</th>
<th>Place</th>
<th>Sample</th>
<th>Received first aid(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gururaj G et al</td>
<td>2008</td>
<td>Bangalore</td>
<td>3427</td>
<td>21.0</td>
</tr>
<tr>
<td>2</td>
<td>Kumaran N et al</td>
<td>2015</td>
<td>Varanasi</td>
<td>100</td>
<td>34.5</td>
</tr>
<tr>
<td></td>
<td><strong>Among - fatal RTAs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Gururaj G et al</td>
<td>2014</td>
<td>Kolar</td>
<td>2689</td>
<td>44.1</td>
</tr>
<tr>
<td>2</td>
<td>Celine et al</td>
<td>2014</td>
<td>Ernakulum</td>
<td>7660</td>
<td>59.2</td>
</tr>
<tr>
<td>3</td>
<td>Gururaj G et al</td>
<td>2011</td>
<td>Tumkur</td>
<td>5192</td>
<td>42.0</td>
</tr>
<tr>
<td>4</td>
<td>Gururaj G et al</td>
<td>2009</td>
<td>Bangalore</td>
<td>24586</td>
<td>55.0</td>
</tr>
<tr>
<td>5</td>
<td>Reddy GMM et al</td>
<td>2008</td>
<td>Chandigarh</td>
<td>95</td>
<td>17.0</td>
</tr>
<tr>
<td>6</td>
<td>Gururaj G et al</td>
<td>2004</td>
<td>Bangalore*</td>
<td>7142</td>
<td>84.1</td>
</tr>
<tr>
<td></td>
<td><strong>Among non - fatal RTAs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Generally, most injured do not receive good quality first aid and triage soon after an injury. However, studies indicate that the proportion of survivors of road crashes receiving first aid ranged between 21-34% in different parts of India. Among non-fatal accidents, the proportion of the injured receiving first aid varied between 17 to 84%; on an average around 45% of the injured received first aid in different parts of India. The huge variation reported in the proportion of injured receiving first aid may be attributed to the differences in the definition of first aid, sample size, types of injuries (any injury to fatal injuries), methods of assessment, study settings, and location. The time taken to receive first aid ranged from 30 to 60 min in hospital-based studies [144,201]. The type of first-aid provided by first-responders include calling an ambulance (41.5%) and nearly 90% of the participants were aware of the locally available ambulance number (108) belonging to the public ambulance system [201, 202], Gururaj et al, while examining highway accidents (2689 injured persons) in Kolar, Karnataka found that 45% of the injured received first-aid and in most instances, the first aid was provided by the doctor in the nearby government hospital.[70]

Mode of transport

The transportation of the injured to the nearest health care facility (which may not be the definitive care center) in a safe manner within the earliest possible time is critical for survival and for favorable outcomes. Most of the world’s population have limited or no access to standard modes of transport as both ‘save and stabilize’ or ‘scoop and run’ are followed in different scenarios and are even widely debated for their merits and demerits as well as the cost. In the absence of such systems, people turn to unconventional modes of transport to reach a health facility as early as possible [197].

In India, the injured are transported by a wide variety of transportation modes ranging from ambulances to animal drawn vehicles. It is felt that ambulances are the most appropriate modes of transport as required to be equipped with tools as well as personnel to provide the necessary (airway clearance, arrest bleeding, stabilizing limb etc.) support en route to the hospital. Independent studies reveal that the proportion of the injured transported in an ambulance varies from as low as 7.5% to as high as 46.5%, even though they are more commonly used for inter-hospital referrals [134,143]. Among the ambulance services, Gunapati Venkata Krishnareddy-Emergency Management and Research Institute- 108 (GVK-EMRI) is the most frequently used in India as people are familiar with its call number. Its services have expanded geographically and most importantly it is free of charge. Many private providers also operate. As per EMRI data, nearly 15 – 20 % of the case load across geographical locations is due to vehicular and non-vehicular trauma. The average call response time is 12 minutes in urban areas and ~ 20 minutes in rural areas.
Other than ambulances, the injured are usually conveyed to hospitals by private modes of auto rickshaws (a three wheeled vehicle), police vehicle, the personal vehicle of the injured or public vehicles due to their easy availability at or proximity to the crash site. Many studies note that nearly 40-70% of injury victims were transported in private vehicles (Figure 44). Auto rickshaws transported nearly 8-70% of injured victims from the site of the accident to the nearest health care facility [30,203]. The use of police vehicles to transport injury victims was also reported in a few studies (as high as 83%) [204].

Figure 43: Transportation modes of injured in Indian studies

A few states have attempted some innovations to improve prehospital care like Bike Ambulance/First Response Unit (FRU) services. The latter was initiated in Karnataka to offer Platinum 10 Minutes’ trauma care during emergencies such as accidents, heart attacks, brain hemorrhage, poisoning and fire accidents. The services are delivered by GVK–EMRI, through ‘Arogya Kavacha-108’ in the state. The Bike ambulance is meant to reach patients in 10 minutes and can negotiate narrow streets and heavy traffic in large urban areas. With a total project cost of Rs. 70 lakhs, each motorbike costs around Rs.1.50 lakhs and is fitted as per medical standards. The scheme is being piloted in Bengaluru with 21 bikes and was followed by one each in the corporations of Mysuru, Mangaluru, Kalburgi, Belagavi, Hubballi-Dharawad, Davangere, Tumkur, Vijayapura and Shimogga of Karnataka. The rider would be a paramedic and trained to handle emergencies [205].

Time Interval

The interval between injury and reaching a hospital or a definitive hospital is referred to as ‘time interval’ and is a determinant of survival and death. Wide variations occur in the time taken in reaching a hospital as it is influenced by several factors like location of the crash, availability of transport, topography of area (urban, rural, tribal, hills, plains, and desert), presence of nearby health care facilities and most importantly preparedness of hospitals and facilities / resources to manage trauma subjects.

It is well acknowledged that at least 50 percent of the fatalities can be averted if victims can reach a hospital...
within an early time [206]. Evidence from BRSP points out that 32% and 45% of RTI patients reached a hospital in less than one hour and three hours, respectively; in the city limits; delayed arrival was significantly higher in rural areas. [29] A large study on highway crashes in Kolar district showed that 96% of accident victims reached the hospital within one hour of a road accident (Figure 45), more due to easy availability and access to health care facilities [70]. In conclusion, the number reaching a hospital within 60 minutes is approximately 30% with significant variations.

**Referral Patterns**

As discussed in the sections on ‘Nature and the severity of injuries’, severe to moderate injuries account for one third of injured while polytrauma accounts for 20 - 25% of RTIs, requiring advanced care in specialized institutions [97]. On the contrary, a majority can be provided care at peripheral levels without the necessity of referrals thus saving costs, time and suffering. Available Indian studies indicate that around 10-30% of the injured had directly reached a definitive trauma care facility whereas nearly 70-90% of RTI victims had at least contacted or received care from one hospital before being finally referred to a trauma care facility (definitive center). The referral proportion (from hospitals to definitive health care facility) varied from 30-100% [33,92].

**Status of in-hospital trauma care services**

With phenomenal advances in the diagnostic, technological and managerial aspects of trauma care globally in recent years, case fatality rates are on the decline. This is true of urban India as well. The management of different anatomical injuries has evolved from the most basic to highly advanced procedures resulting in better survival rates. Several guidelines and management protocols adapted mainly from the west exist and a discussion of these is beyond the scope of this report.
Despite an increase in the number of trauma care facilities across the country, notable disparities in the mortality and recovery rates of injured patients exist in India. Mortality rates (both pre-hospital and in-hospital deaths) of all seriously injured (injury severity score of 9 or more) adults in three cities, in countries at different economic levels, increased from 35% in a high-income setting to 55% in a middle income setting to 63% in a low-income setting [193]. Among patients who reach the hospital, a six-fold increase in the mortality of patients with injuries of moderate severity (injury severity score of 15–24) increased from 6% in a hospital in a high-income country to 36% in a rural area of a low-income country. Much of the mortality and disability in developing countries are eminently preventable through investments in inexpensive improvements in trauma care [193]. WHO guidelines for ‘Essential Trauma Care’ to establish and strengthen trauma care systems outlines different measures to reduce deaths and disability from the most basic to the most advanced levels.

An Expert Group has been formed to study the existing system of trauma care. The Government of India accorded permission for the establishment of 100 Emergency Accident Relief Centers on all the national and state highways at a distance of 50 km each to give timely first aid to accident victims and to arrange for further medical treatment in hospitals. Out of the 100 centers targeted, 77 were found to be functioning, of which 41 are fully financed by private hospitals and institutions while the remaining 36 are partly sponsored by the Government which provides a monthly support of Rs.40,000/- or the actual expenditure incurred by these sponsors (not exceeding Rs. 40,000 [206].

Furthermore, under the 11th Plan it was proposed to establish 140 trauma centres (23 level I, 57 level-II, and 60 level-III) at an estimated cost of 7.32 billion along the golden quadrilateral, north-south and east-west corridors of the national highways under this Scheme. Of these 140 trauma centers, 22 trauma centres were to be established in tertiary hospitals through their

Trauma care- 10 good practices

1. National Coordinating mechanisms – lead agency
2. Training of first responders - police, drivers, teachers, health workers
3. Early first aid and safe transportation
4. Stabilization of injured
5. Triage, Assessment and referral
6. Preparedness of hospitals
7. Skilled and trained manpower
8. Increasing physical infrastructure
9. Strong legislation
10. Quality improvement programs
11. Monitoring and evaluation
own funding or through funding under the Pradhan Mantri Swasthya Suraksha Yojana - PMSSY [207].

An assessment of trauma care facilities across 50 health care institutions in India as early as 2004 revealed that ambulances lacked trained paramedics but were equipped with basic life supporting equipment to provide IV line, airway support, BP apparatus etc.). Nearly 90% of the assessed sites had no communication systems between ambulances and hospitals. Hospitals lacked trained staff to handle trauma cases in the emergency department and no triage or trauma care protocols were followed. A trauma response team was available only at medical colleges and at a few tertiary care centers [208].

In 2016, a cross-sectional assessment of trauma care systems in a 400-bedded district level tertiary healthcare centre in Southern India (using a check list based on WHO guidelines for the evaluation of essential trauma care services, in-depth interviews of stake holders and key informants) revealed the presence of the necessary physical infrastructure (emergency room, inpatient wards, operation theatres, intensive care unit and blood bank facilities). A separate building for trauma care services was not operational and there was no designated trauma team. Specialty services for managing polytrauma were deficient and the existing personnel were performing multiple tasks. Neurosurgeons and rehabilitative nursing staff were unavailable, and a radiographer was not available on a 24/7 basis. The existing nursing personnel had not received any formal training in trauma care nor were there standard operating protocols for trauma care. Resources for acute resuscitation were partially adequate. The hospital lacked adequate resources to manage head, abdomen, chest and spine injuries and most of the polytrauma cases were referred to nearby city hospitals [200].

Cost of trauma care is prohibitive especially in a situation wherein large proportion of the populations are not covered with health insurance and facilities are lacking in rural areas, highlighting the need for measures aimed at increasing public health spending for prevention of injury as well as for providing financial risk protection in India.

- Study to evaluate costs among 95 accident victims revealed that medical costs accounted for 43% of costs where the average cost of surgery was ₹4500, prosthesis was ₹2450, laboratory charges ₹1600, Medicine ₹1000 and ₹300 for hospital stay [204].
- Recent study to estimate out of pocket (OOP) expenditure for medical care for injuries (60% were RTI victims) who were admitted for at least one night in a tertiary care hospital of Chandigarh city indicated that the average OOP expenditure per hospitalization and up to 12 months post discharge was USD 388 (95% CI: 332–441) and USD 1046 (95% CI: 871–1221) respectively. Mean OOP expenditure for RTI and non-RTI cases during hospitalization was USD 400 (95% CI: 344–456) and USD 369 (95% CI: 313–425) respectively. The prevalence of catastrophic expenditure was 30%. High OOP expenditure for treatment of injury puts a significant economic burden on families. Measures aimed at increasing public health spending for prevention of injury and providing financial risk protection are urgently required in India [209].
- The prevalence of catastrophic expenditure was 30%. In a recent study of economic evaluation of RTIs in a tertiary care institution, it was estimated that the direct medical costs was ₹123,301/- which accounted for nearly 50% of total economic loss (₹244,906) (Unpublished).

**BOX 2**

Evaluation of cashless scheme for health insurance for Road Accident victims

Recognising that injured persons face difficulties in receiving appropriate trauma care due to severe financial difficulties, Ministry of Road Transport and Highways (MoRTH) initiated the scheme “Cashless scheme of health insurance for road accident victims” on a pilot basis across three sampled stretches of national highways (Gurgaon-Jaipur stretch of NH 8, Mumbai-Vadodara stretch of NH 8 and Ranchi-Mahulia stretch of NH 33) in India in 2014. The scheme was intended to provide free of cost treatment during the first 48 hours at empanelled hospitals for those who met with an accident on the selected highways. In addition, a prompt ambulance system was also out in place for timely referral during the ‘Golden Hour’.

Evaluation of the above scheme using mixed methods was undertaken by Prinja S et al in 2016 to understand the extent and pattern of utilization of services under the scheme, determine its impact on providing access and financial risk protection, and assess the implementation gaps in the scheme. Evaluation was conducted in two phases; Process evaluation in phase I and Impact evaluation in phase II.

**Scope of improvement in extent of ERS utilization and quality**

- Despite providing very timely referral service, the overall extent of Emergency Referral Service utilization was low.
Only 23% RTI victims called the toll free number 1033 after a road accident. Overall, 28% RTI victims reached the nearest hospital using the ERS ambulance. Even though quality of ambulances fared well in terms of presence of paramedical assistance during transportation, there was a need for improving provision of drugs, consumables and stabilization care during transportation.

The evaluation revealed that refresher trainings for EMTs and ambulance staff are required along with hiring additional human resources and provision of required drugs, consumables and other essential items in the ambulance.

Enhancing awareness through IEC/BCC activities and police cooperation

Only 28% of RTI victims were aware about the scheme with majority getting information only after being attended by doctor/paramedical personnel.

Low awareness was also reiterated by the insurance companies as well as empanelled hospital officials.

Beneficial impact of the scheme on reduction in Out-Of-Pocket expenditures

The current scheme was found beneficial and catered to the majority of injured in the poorest quintile.

Examining the benefits, a reduction of 97% in Out-Of-Pocket expenditure for treatment was observed among those who availed benefits (median expenditure of INR 250) as compared to those who were not entitled (INR 9800).

Effect on Health-related quality of life

No significant effect of scheme on quality of life of accident victims was attributed, probably due to lack of stabilization care in emergency referral services in patients covered under the scheme and no specific difference in quality of care at the empanelled hospitals.

Sufficient insurance cover (INR 30,000) with scope of extended time duration (>48 hours)

Almost 88% of RTI victims availing the scheme did not incur any OOP expenditure i.e. 100% of the treatment expenses were funded through the scheme.

Only 9% of the patients had to pay more than INR 1000 out-of-pocket. The reason for the same was mainly due to longer duration of hospitalization above 48 hrs indicating the need of extension beyond 48 hours.

Overall performance

Overall, the scheme had a significantly beneficial impact in the reduction of out-of-pocket expenditure with enhanced financial risk protection for those who met with a road traffic injury.

As against a median OOP expenditure of INR 9800 among those not covered in the scheme, nearly 88% of the total users of cashless insurance scheme obtained free of cost treatment, with an average OOP expenditure of INR 250. Eighty two percent of the total users of scheme belonged to poorest 20% group, signifying equitable distribution of the insurance benefits.

Provision of emergency referral services (ERS) – 90% of the road traffic victims were transported to an empanelled hospital within 30 minutes from the site of emergency. Average time taken to reach the site of emergency was about 10 minutes, whereas the average time taken to reach hospital from the site of emergency was about 12 minutes.

In view of these beneficial impacts, the study has recommended the scale-up of the existing cashless insurance scheme. The overall ceiling of the benefit package, i.e. INR 30,000 was adequate for provision of secondary trauma care, but the extent of duration over which the benefits under the scheme are applicable was recommended to be increased from 48 hours to 5 days.

Source

Road crashes leave a host of disabilities among survivors. Disabilities are an umbrella term, covering impairments, activity limitations, and participation restrictions. Impairment is a problem in body structure or function, while activity limitation is a difficulty encountered by an individual in executing a task or action and participation restriction is a problem experienced by an individual in involvement in day to day life situations. Disability is thus not just a health problem but a complex situation, reflecting the interaction between features of a person’s body and functioning and the society in which he or she lives. Overcoming the difficulties faced by people with disabilities requires multiple interventions to remove environmental and social barriers [140,210]. The rehabilitation of people with disabilities is a process aimed at enabling injury survivors to reach and maintain optimal physical, sensory, intellectual, psychological and social functional levels, enabling them to attain independence and self-determination.

Kaushik, 32 years

I am a software engineer in the Silicon city (Bengaluru). Ours is a nuclear family and we have a six year old daughter. We were a happy couple in the garden city till the day of my accident.

I was commuting to office on my bike and stopped on the way to fuel my bike in intermediate ring road. As I came out of the petrol bunk and turned left to join the main road, another speeding bike over took me from wrong side swiping off my bike handle. Immediately I fell on the road along with the bike and goods carrying vehicle ran over my right hand. In a minute people on the road gathered to help me. Due to heavy blood loss, I lost consciousness. I was shifted to nearest ...hospital by 108 Ambulance which was called by a bystander.

In the hospital, they stabilized me with procedures after examination and several procedures of X ray and MRI scans. My hand could not be saved as the major blood vessels were cut during the vehicle run over. As I was not in a condition to decide about amputation, doctors informed my family (parents and wife) and my right hand was soon amputated to save my life.

Being a software engineer, loss of right hand was an irreparable damage to my career. Following accident I incurred an expense of nearly Rs.2,00,000 for my treatment and also lost job because of my handicap. I was suddenly pushed into financial crisis along with facing the stigma of being handicapped. In the absence of proper counselling before amputation, I suffered from depression and attempted suicide thinking that I was burden to my wife. But slowly my parents and wife instilled positive thoughts in me and I have now learnt working with my left hand and am able to manage my daily routine. My wife has started working to earn for our livelihood and I take care of household chores in her absence. In the coming days we are planning for artificial hand which will help me overcome my handicap and help me get a job appropriate to my capabilities.
The impact and outcome of road crashes are dependent on a number of factors ranging from age, gender, physiological factors, socioeconomic levels, severity of crash, presence of protective devices, availability and affordability of post-crash care. All types of injuries including road accidents often result in injuries of varying severity leading to disabilities inflicting physical, psychological, social and financial losses to the individuals as well as to their families. The impact of road crashes can be broadly understood at the health (physical and psychological), social and the economic levels that through direct and indirect means affecting the individual, family and society. Data in this area is extremely limited due to the lack of good quality studies and assessment of services, even though the health sector bears the maximum brunt for service delivery and rehabilitation. The wide range of disabilities after RTIS are discussed earlier and shown in Table 28.

Table 28: Impact of road accidents

<table>
<thead>
<tr>
<th>Domains</th>
<th>Health</th>
<th>Psychosocial</th>
<th>Social</th>
<th>Economic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physical</td>
<td></td>
<td></td>
<td>Loss of wages</td>
</tr>
<tr>
<td>Individual</td>
<td>Body damage, loss of function. Cognitive deficits Risk for comorbidities like chronic conditions</td>
<td>Disability Psychological distress Stigma</td>
<td>Handicap Postponement of vital social events Loss of job, Discrimination in workplace Change in occupation Stigma due to disability Impaired activities of daily living</td>
<td>Loss of wages Cost of care Loss of potential expected earning Loss of savings Cost of care giver</td>
</tr>
<tr>
<td>Family</td>
<td>Discordance in marital life Psychological distress Care giver burden</td>
<td>Disruption of children education Care giver burden Postponement of vital and social events</td>
<td>Decrease in income Increase in care costs Deprivation of money to be spent on other needs like nutrition, education, leisure etc</td>
<td></td>
</tr>
<tr>
<td>Society</td>
<td>Rise in proportion of injured, disabled Decreased life expectancy Increase DALYs lost</td>
<td>Increase in proportion of post traumatic stress disorders, depression</td>
<td>Increase in demand for home based care services, mobility aids, rehabilitation etc</td>
<td>Increased expenditure on insurance claims, Decrease in work productivity Increased cost of care systems and services</td>
</tr>
</tbody>
</table>
A mong the four major modes of travel worldwide (road, rail, air, and marine), travel by road puts people at the greatest risk of injury. With growing worldwide understanding that road crashes and its consequences are a result of multiple and multilevel interaction of risk factors before, during, and after an event/crash, and that they are predictable and preventable, the need for a proper understanding of prevention and care began around 1960 and has only improved over time.

W illiam Haddon Jr. developed a conceptual model, the Haddon Matrix in 1970s, for applying the basic principles of public health to the problem of traffic safety and revolutionized the understanding of road crashes that helped to reduce RTIs over time. The matrix provides a compelling framework for understanding the origins of injury problems and for identifying multiple countermeasures to address them. Haddon Matrix is a multidimensional tool that combines the epidemiology in terms of human, vehicles, and the road environment with possible interventions during precrash, crash and post-crash period to aid injury prevention interventions (Figure 48) [53].

**Figure 47: Haddon’s Matrix[53]**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Factors</th>
<th>Human</th>
<th>Vehicles and Equipment</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-crash</td>
<td>Crash prevention</td>
<td>Information</td>
<td>Road worthiness</td>
<td>Road design and layout</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attitudes</td>
<td>Lighting</td>
<td>Speed Limits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impairment</td>
<td>Braking</td>
<td>Pedestrian facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Police</td>
<td>Handling</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enforcement</td>
<td>Speed Management</td>
<td></td>
</tr>
<tr>
<td>Crash</td>
<td>Injury prevention during crash</td>
<td>Use of restraints</td>
<td>Occupant restraints</td>
<td>Crash protective road side</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impairments</td>
<td>Other safety devices</td>
<td>objects</td>
</tr>
<tr>
<td>Post crash</td>
<td>Life sustaining treatment</td>
<td>First Aid skills</td>
<td>Crash protective design</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Access to medics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The public health approach strongly follows the traditional model and outlines key areas (Figure 49) [211].

1. Defining the problem in terms of mortality, morbidity, disability and impact on self, family and society through surveillance and other methods

2. Identifying risk factors for RTIs as well as quantification of risk

3. Implementation of evidence based interventions which are known to work

4. Evaluating the effectiveness and impact of implemented interventions.

**Figure 48: Public Health Approach**
The recognition of human error in the transport system: People will make mistakes in traffic that can easily lead to injuries and death. The Safe System approach does not ignore road user behaviour interventions but emphasizes that behaviour is just one of many essential prevention focus areas.

- Recognition of human physical vulnerability and limits: People have a limited tolerance to violent force, beyond which serious injury or death occurs.

- Promotion of a systems approach: Combined road safety measures yield better results than single measures.

- Promotion of a shared responsibility: Responsibility for traffic safety must be shared between road users and system designers. While road users are expected to comply with traffic regulations, system designers and operators have a responsibility to develop a transport system that is as safe as possible for user

- Promotion of ethical values in road safety: The ethical value underlying the Safe System approach is that any level of serious trauma arising from the road transport system is unacceptable. Humans can learn to behave more safely, but errors will inevitably occur on some occasions. The errors may lead to crashes, but death and serious injury are not inevitable consequences.

The scenario as in India today was very similar in many HICs of the world till the late 1970s. With the realization that road crashes are complex and multifactorial in nature, and require multisectoral actions, there was a need for human behavior to be addressed through policy frameworks, safe vehicles and roads, and continuum of trauma care. Using data for all actions, many HICs around the world changed their focus and direction in road safety activities since 1970’s. The following decades witnessed a series of actions that resulted in the gradual decline of road crashes in many countries (Figure 51), and now few countries are aiming at “zero deaths and injuries on roads” [213,214]. A detailed discussion of country-wide efforts is beyond the scope of this report and can be found in scientific literature. Some critical factors that contributed towards this development are indicated below.

1. Greater political commitment to reduce deaths and injuries
2. Development of well-defined road safety policy integrated with transport policies
3. Establishing a national lead agency to implement activities in coordination with different sectors
4. Building up of data/evidence to understand road crashes based on research

The traditional 4Es of road safety, – viz., Education, Enforcement, Engineering and Emergency care – were the commonly followed practices until WHO recommended the application of larger road management principles through the “Safe Systems approach” [59].

With progress in research and greater understanding of road crashes, it was realized that road safety needs a much broader and holistic approach considering the nature of the problem and the required response. The “Safe Systems approach” is built on the premise that “to err is human” and reaches out to build a safe system that takes human fallibility and vulnerability into account[59]. It not only accepts that people make mistakes and some crashes are inevitable but also seeks to address all determinants that make roads, road use, and vehicles safer to humans. Systems are conceptualized in a manner to prevent crashes from occurring, and in the event of crash there should be best possible protection of the people. The Safe System approach moves from “human errors and driver’s mistakes” to “making safe systems,” and thus from the traditional educational approach to implementing integrated solutions through the participation of all sectors. The key principles of safe system approach include [212].
5. Addressing the issues of energy production and transfer through integrated methods
6. Understanding multifactorial causes and risks to develop integrated approaches
7. Developing strong road safety action plans
8. Better intersectoral coordination and convergence of actions
9. Shifting focus from education alone to strong legislation and road/vehicle safety
10. Developing strong national legislations along with strict enforcement
11. Increasing funding for road safety activities at national and sub-national levels
12. Laying greater emphasis on passive counter measures like safe roads and vehicles
13. Strong advocacy activities by professionals, professional bodies, families of those affected, civil society organizations, consumer groups, individuals and others
14. Encouraging Community participation in road safety activities
15. Monitoring and evaluation of the activities for changes in actual reduction of deaths and injuries

Realizing the global and country-level impact of road crashes, especially in LMICs, the United Nations (UN) formulated the first global strategy in 1980 and the first UN resolution was passed in April 2004. All member countries followed this effort with their respective national activities and programs. Though educational efforts continue till date, primarily in LMICs, changes are seen in many countries with a focus on integrated approaches addressing key risk factors of human, vehicle, and road areas based on scientific information.

Figure 50: Change in road traffic fatalities in select countries [214]

The United Nations, launched the ‘Decade of Action for Road safety 2011-2020’ to bring in a greater focus and has encouraged countries to follow actions [215]. Global plan for the Decade of Action for Road Safety 2011-2020 provides information on evidence-based interventions to be adopted by all member countries. The target set for the decade is to reduce road deaths by 50% in all countries from the baseline scenario of 2010. The framework for the decade of action directs member countries to switch to the “Safe System” approach, which aims to develop roads and transport systems considering human vulnerability using the 5 pillars of road safety (Figure 52) [215].

The Sustainable Development Goals to be achieved by 2030 by all countries in the world have given further push to this movement, primarily with the goals of reducing road deaths and developing safe transport environments [216]. The two goals that are relevant for Road safety are

- Goal 3: Ensure healthy lives and promote wellbeing at all ages (Target 6: By 2020, halve the number of global deaths and injuries from road traffic accidents)
- Goal 7: Ensure access to affordable, reliable and sustainable modern energy for all (Target 2 By 2030, increase substantially the share of renewable energy in the global energy mix)
Recommendations of the World Report on Road Traffic Injury Prevention [53] and the Commission for Global Road Safety [217] form the basis of all activities mentioned under each pillar. Evidence-driven scientific management of road safety issues to plan, develop, and implement activities in each country is supported in a number of ways with several guidelines and best practices. Alongside, most countries, regions, and researchers have tried several interventions and their experiences to understand “What works?”, “In what manner?”, and “At what cost?” have paved the way for further improvements. Some examples of proven interventions developed in HICs and their effectiveness are provided under each of the pillars below that show the success in road safety.

**Road Safety Management**

Systematic management of road safety activities forms the first pillar for action. Recognizing that road safety needs an apex organization that can coordinate, develop, guide, formulate, fund, implement, monitor, and evaluate road safety activities, a national lead agency is mandatory for road safety given the limitations of existing intersectoral nature of activities [215]. Such an agency should/can be outside the existing ministry and work independently. The lead agency can bring all partners together with convergence of actions and provide mechanisms for continuous work in road safety activities by laying a acceptable methods, procedures, guidelines, and standards. Significantly, this agency needs to have the power, authority, funding, professional staffing, and the mandate to drive all road safety activities. The agency enables and empowers all partners amidst political diversities to strengthen road safety agenda in line with global developments based on data and evidence along with multisectoral partnerships. Delivery of national road safety strategies, plans, and targets is the responsibility of this agency and is a major requirement to overcome political hierarchies, bureaucratic hurdles, and financial constraints. The broad activities of such an agency include [211].

1. Horizontal coordination with different ministries and agencies
2. Vertical coordination within ministries at national and regional levels
3. Legislative framework
4. Resource mobilization and allocation
5. Funding mechanism
6. Delivery of interventions
7. Mechanisms for achieving results
8. Systems for monitoring and evaluation
9. Involvement of civil society and professionals
10. Research and technical base

(Source: Road safety in India: A Framework for Action-2011)
• Some HICs like Japan, the Netherlands, the UK, and the USA recognized the need for a good road safety management system as early as the 1970s and established national lead agencies to implement strong road safety policies, programs as well as set targets; success in road safety is visible in all these countries [218].

• Countries like Sweden (Vision Zero), Norway (Action plan for road safety 2002-2011), Denmark, Japan, UK (Vision Zero UK) and others realized the need to have a road safety system in place (N Mittal et al). Though program and policy are called by different names in each of these countries, they primarily aim to reduce road accidents, both in number and severity. Guidelines from the World Bank clearly specify that apart from setting up and empowering a lead agency to anchor road safety management, country-specific data systems for monitoring, evaluation, and decision making are very much required [219] for implementation and long-term sustainability.

• Similarly, development and implementation of national road safety action plans has been found beneficial in many countries. Such action plans provide direction and focus for all activities and many examples are available from HICs.

• Advocacy aimed at political leadership that places road safety on the national agenda can provide the required stimulus to drive road safety activities and the Decade of Action has catalyzed this in a significant way across the globe.

Public–private partnerships have also been strengthened at different levels to ensure funding, sustainability of programs, improvement in public participation, promotion of road safety investments, improvement in road crash injury data management, enhancement of post-crash emergency services and strengthening of socio-economic viability of road safety projects [219].

With an estimated 175,000 deaths and 5,250,000 injured, India is facing a major epidemic of road deaths and injuries resulting in a huge burden on the society. However, road safety has not received adequate attention from political leaders, policy makers and professionals to mitigate the problem.

Road safety in India is the responsibility of nearly 15 ministries and departments at central and state levels, with transport, police, health, welfare, law, industry, and road development authorities being principal partners; all these are on the concurrent list of the Indian constitution. The primary responsibility of enforcement of traffic laws rests with individual states amidst severe constraints of financial and trained human resources. All these agencies work independently without convergence of actions amidst uncoordinated mechanisms within their available resources.

There is no well-defined road safety policy and action plans at national and state levels, and targeted programs that are driven by good quality data and evidence are lacking. Some Indian states have drafted their individual policies, but these are not strong enough to guide road safety activities.

Safer roads and mobility

Road engineering measures that make people safe (irrespective of age, social status, literacy, knowledge, awareness etc.) every time they are on roads through better quality, design, and safety of roads is closely associated with reductions of road accidents. Safe infrastructure refers to safe roads and transport environments through combined measures that permit safe mobility by eliminating or reducing barriers and risks in the road environment and is the second pillar of road safety [215].

Safe roads make people safe by reducing the likelihood of a crash (e.g., raised pedestrian crossings to increase visibility and facilitate safe crossing of pedestrians) or even mitigate the severity of crash (e.g., using energy-absorbing and collapsible roadside barriers). Roads that are designed and built based on the needs of road users can provide long-term results. Roads that separate VRUs from high-speeding vehicles, that are able to modulate or regulate speeds, that have energy-absorbing materials, has increased visibility and allow all road users to travel safety are some critical requirements to avert road crashes. Existing road infrastructure should be regularly assessed for safety, with a focus on roads with highest crash risk.

• For example, the Netherlands brought in a series of changes in road infrastructure with more emphasis on safety than speed during 1996–2009. With multiple approaches in road design, roads became more walkable and thereby reduced crashes and deaths [220]. Similarly, Sweden prioritized safety over speed or convenience in road designs. Sweden built 1,500 kms of “2+1” roads – where each lane of traffic takes turns to use a middle lane for overtaking. This has saved around 145 lives over the first decade of Vision Zero. Provision of 12,600 safer crossings, which includes pedestrian bridges and zebra stripes flanked by flashing lights (better visibility) and protected with speed bumps, has halved the number of pedestrian deaths over the past 5 years [221]. In the United Kingdom, speed

• With a focus on roads with highest crash risk

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enforcement on rural roads reduced fatal crashes by 14% and injury crashes by 6% [222,223]. Some other evidence based interventions include the following

**Traffic separation**

- A systematic review indicates that area-wide traffic calming in towns and cities may be a promising intervention for reducing the number of road traffic injuries and deaths [224].

- A review of 21 intervention-based studies (20 controlled before and after study and 1 interrupted time series analysis) showed there was no evidence that cycle lanes reduce the rate of cycle collisions (rate ratio 1.21, 95% CI 0.70 to 2.08). Taking into account cycle flow, there was no difference in collisions for cyclists using cycle routes and networks compared with cyclists not using cycle routes and networks (RR 0.40, 95% CI 0.15 to 1.05). But there was reduction in the number of cyclist collisions by restricting the urban speed limit to 20 mph [225].

**Speed control mechanisms**

- An increase of 1 km/h in mean vehicle speed results in an increase of 4-5% of fatal crashes (WHO,2017).

- Speed monitoring cameras help to control vehicle speed, and evidence shows a reduction in road traffic collisions and casualties with the installation of cameras. Reductions range from 5% to 69% for collisions, 12% to 65% for injuries, and 17% to 71% for deaths [226].

- “Arrive-Alive” was an innovative practice in the Australian state of Victoria in November 2001, aimed at reducing road fatalities by 20% by 2007. As a part of the program, speed control efforts like active mobile speed cameras, new fixed speed camera locations and strict speed law enforcement were implemented. Evaluation of the program by the Auditor General of Australia showed 16% reduction in fatalities between 2002 and 2005. Most significant trauma reductions were reported in Melbourne’s low-speed zones, where 40% reduction in road fatalities was recorded [227].

- In a systematic review of 35 studies that evaluated the effectiveness of speed camera in reducing road crashes, injuries, and fatalities, a relative reduction in average speed ranged from 1% to 15% and the reduction in proportion of vehicles speeding from 14% to 65%. In the vicinity of camera sites, the pre/post reductions ranged from 8% to 49% for all crashes and 11% to 44% for fatal and serious injury crashes. Compared with controls, the relative improvement in pre/post injury crash proportions ranged from 8% to 50% [228].

- In-depth study of road infrastructure systems and crash analysis helps to delineate road-related risks and help in better understanding of road-related risks by delineating contributory factors for crashes and prioritizing for improvements. Referred to as “road audits,” they help to know the condition of existing roads and bring in appropriate and feasible corrections to avoid crashes. Currently, 147 countries require some type of road safety audit on new roads, although these vary greatly in what they cover and in quality.[36]

**Traffic lights and Red light cameras**

- Traffic signals are used to direct the right way to vehicles passing through intersections to prevent conflicting movements and road crashes [229]. Traffic signals control traffic movement and speed at intersections, thereby decreasing risk for road crashes. Red-light cameras at traffic signals provide a comprehensive enforcement, alert the road users to prevent violations, and also capture crashes too. Red-light signals reduce crash frequency, severity, as well as violations [229].
• A study to evaluate the operational and safety efficiency of installation of traffic signals at 29 intersections in Kentucky revealed that all intersections with traffic signals showed an overall reduction in crashes between 22% and 88% [230].

• Texas Crash Records Information System (CRIS) data from 56 red-light camera-equipped intersections in 10 Texas city areas revealed a 17% decrease in red-light violation-related crashes, with 6 of the 56 intersections showing a decrease. Right-angle crashes decreased from 67% of total crashes before cameras to about 55% of the total with camera enforcement. Studies in cities of Garland, Dallas, and Irving also showed a reduction in total crashes to the tune of 29%, 30%, and 56% respectively in the intersections [229].

• Evidence from controlled before/after studies reported a rate ratio of 0.71 (95% CI to 0.55, 0.93) for association between red-light cameras and incidence/severity of road crashes and casualties. Evidence suggests that red-light cameras are effective in reducing total casualty crashes. However, it is less conclusive on total collisions but conclusive for specific casualty collision types and violations, where reductions achieved could be explained by the play of chance. Larger and better controlled studies are needed [231].

Use of speed bumps

The use of speed bumps, in the form of rumble strips and speed humps, reduced traffic crashes by 35%, fatalities by 55%, and serious injuries by 76%, between January 2000 and April 2001 in Ghana, also contributing toward improving pedestrian-walkable environment [53].

Use of Global Positioning systems

Global positioning system (GPS) is a satellite-based navigation system that is widely used in vehicle-tracking systems. This helps to identify speed, type of driving, and position of vehicles. Hence, GPS is applied for automatic vehicle location, navigation, and location of accident sites [232].

With a commitment by the government to develop 40 km of roads every day, safe road environment, including design and maintenance of roads, is imperative to prevent road accidents. Features like road design, surface condition, banking, curves, signage, scientific speed breakers, soft medians, and barricades are required to make our roads safer. However, implementation and enforcement of road quality is the prerogative of both centre and states is observed to be below par and at times unscientific, thereby compromising the safety of road users. More research is required to develop cost-effective and safe road technologies that are specific to Indian roads.

On the other hand, several low-cost road engineering solutions with less investments and appropriate to the local context, especially in high-risk crash locations, are recommended by many experts and could be effective (TRIPP). Such measures include traffic separation on possible roads, incorporation of speed bumps to slow down speeding vehicles, creation of roundabouts, collapsible dividers that do not damage vehicles on collision, narrowing of the lanes, raised pedestrian crossing, 3D zebra crossing that creates illusion of obstacle and helps slow down the vehicles, etc. area-wide traffic calming that helps altering road design helps prevent congestion, limits speed, and prevents road crashes, and others.

Furthermore, road engineering requires political commitment, greater land resources, better use of technology, scientific use of data, and phenomenal resources (the proposed cost of the metro system in Bangalore was nearly 2000 million rupees per km). The standards and guidelines for safe road development in India are provided by the Indian Road Congress, Indian Road Research Institute, Bureau of Indian Standards, National Highway Authority, and other agencies.
Safe vehicles

One of the proven countermeasures (includes both passive and active) to address road safety has been improving safety criterion and standards of vehicles people use. Safer vehicles imply incorporating better safety features in the design and manufacture of vehicles that are essential and including inbuilt features that would ensure the stability and safety of vehicles. For example, the vehicle exteriors can be modified (rounded front, soft bonnet, etc.) such that in case of collision the injury caused to pedestrians are minimized, especially for children and elderly who are more fragile and vulnerable to crash. Seat belts and airbags, introduction of speed governors, radar to detect obstruction, better provision of rear view with bird’s-eye view camera, GPS vehicle tracking, etc. have aided drivers in safe driving. Many of the “add-ons” of earlier days have become must features for vehicle safety, with availability of good data to prove their efficacy.

Vehicular design and engineering measures to prevent road traffic injuries are broadly classified into prevention of road crashes (crash avoidance systems) and enhanced protection of occupants during a road crash (crash protection systems). Crash avoidance systems comprise of advanced breaking systems (ABSs), crumple zones, traction control, electronic stability control, tyre pressure monitors, rear obstacle detectors, etc. Measures to enhance protection of vehicle users include helmet, seat belts, airbags, child restraints, booster seats for children, etc. Some proven interventions are indicated below.

- The presence of airbags in passenger cars have been shown to reduce deaths and serious injuries [233].
- A dvanced use of seat belts have been proved beyond doubt to reduce serious injuries and fatalities. Studies have shown that lap-shoulder belt use reduces the overall likelihood of AIS3+ injuries by 80%. WHO (2004) reports reduction of serious and fatal injuries by 40–65% with the use of seat belts [172].
- Effectiveness of child safety seats when promoted with a combination of distribution, legislation, enforcement, incentivization, and education programs is well proven. Insufficient evidence was identified for education-only programs aimed at parents, young children, healthcare professionals, or law enforcement personnel [233].
- Booster seats are designed for use by children (aged 4–8 years) to raise the child off the vehicle seat so that the adult seat belt fits correctly and they are estimated to reduce the odds of sustaining clinically significant injuries during a crash by 59%, when compared to using ordinary vehicle seat belts. Meta-analysis to evaluate the effectiveness of interventions to promote utilization of booster seats (education, distribution of free booster seats, booster seat discounts, coupons, booster seat law) indicates that several types of interventions aimed at increasing the use of booster seats among children aged (4–8 years) are effective [234].
- A lcohol ignition inter-lock is a breath-test device connected to a vehicle’s ignition which will not start unless the driver blows into the interlock and has a blood alcohol concentration (BAC) below a pre-set low limit. Use of ignition interlocks reduces repeat offenses for driving while intoxicated (DWI) by about 70%. [235], reduces rates of recidivism (relative risk 0.36 (95% CI 0.21, 0.63)[236] and effective in reducing re-arrests Driving while impaired(DWI) by 15%–69%. A randomized, controlled trial demonstrated a 65% reduction in re-arrests for DWI in the interlock group [237].
- Drivers with the interlock were one-fifth as likely to be arrested for driving under influence during a 1 year of use of device [238].
- Vehicle data recorders are devices used in cars and commercial transport to monitor or validate new safety technology, to establish human tolerance limits, and to record impact speeds. Research indicates that data recorders fitted to trucks and vans lead to an average reduction of 20% on the number of crashes and damages. The effect derives from the driver’s knowledge that traffic law infringements can in principle be detected by examination of the driving records [239].
- Daytime running of light by two wheeler motorcycles increases visibility and has found to reduce crashes by 10-20% [240].
- Improving visibility of vehicles (front and rear) through visibility aids are found to be an effective strategy to reduce crashes. Visibility aids have the potential to increase visibility and enable drivers to detect pedestrians and cyclists earlier. Bio-motion markings, which highlight the movement and form of the pedestrian, showed evidence of improving pedestrians’ conspicuity at night. However, the effect of visibility aids on pedestrian and cyclist safety remains unknown [241].
- Seat belts, though present in cars, need to be worn by all occupants. Under the Bloomberg Global Road Safety Program – Road safety in Russian Federation I initiatives regarding seat belt compliance in 2 Oblast of Lipetsk and Ivanovo showed that in both places there was increased compliance through social marketing to use of restraint measures by
all occupants of vehicles. In Lipetskaya Oblast, use of restraints by all occupants increased from 52% in October 2010 to 75% in March 2012, and has remained stable since then. In Ivanovskaya Oblast, use of restraint by all occupants increased steadily from 48% in April 2011 to 93% in May 2013 [242].

- Improved vehicle crash protection, referred as secondary safety, has resulted in significant reduction of deaths and injuries among car occupants by >30%. This is also in line with WHO recommendation for crash protective designs among vehicles.

- Use of electronic stability control (ESC) has resulted in large reductions of single vehicle accidents (~49%; 95% CI ~55%, ~42%) and smaller but significant reductions of head-on collisions (~13%; 95% CI ~17%, ~8%). Multi-vehicle fatal accidents were also significantly reduced with the use of ESC (~32%; 95% CI ~43%-~20%). Effects observed in single vehicle accidents are in excess of that expected owing to publication bias [243].

However, as per WHO, 80% of all countries sold in LMICs fail to meet UN vehicle safety standards compromising safety of vehicle users [36]. Through NCAP (New Car Assessment Program) many countries are able to test the crash worthiness and road worthiness of the vehicles. [36] Despite the obvious advantages, safety technology comes with its own limitation of increased cost and technological availability, which should not be a limiting factor given the safety benefits.

Ensuring safety of nearly 182 million vehicles of more than 40 different categories is indeed a challenge in India. Availability, accessibility and affordability of Indian market to such technologies are a concern, especially for smaller commercial and passenger vehicles. Development of in-country technology, procedures, guidelines, and standards is critical in the coming years. At the same time, if availability of the technology goes in vain, if people are not willing to use them, or if there is a lack of supportive policy, market and legislative environment for facilitating its widespread use, it can have limited impact.

Even in cars where safety features like seat belts are available, compliance to use is of greater concern. For example, seat-belt compliance is around 25-30% in various parts of India, highlighting the need not just of technology but also of legislation, enforcement, and improving public awareness. In spite of the shortcomings, varying degree of safety measures are in place for four wheelers, but safety of two wheelers and locally manufactured vehicles that predominate Indian roads like auto rickshaws; four wheeler tempo which comprise > 70% of domestic market share (http://www.siamindia.com/) in India are still a cause of concern. Updated, uniform and specification of minimum safety standards for each category of vehicle coupled with strict enforcement at all levels is the need of the hour.

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<th>Merits</th>
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<td>Provides passive protection</td>
<td>Increased costs</td>
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<td>Impact can be measured easily</td>
<td>Availability of technology</td>
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<td>Safety comes with vehicle</td>
<td>Resource intensive</td>
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<td>Coverage of selective populations</td>
<td>Cooperation from industry</td>
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**Safe people**

The concept of safe people/road users includes improving compliance to safe practices by people through greater awareness and/or regulating their behaviors to accept safe practices using comprehensive programs and multiple approaches. It is critical that changes in road-user behavior must be sustained for visible changes. This has been achieved through the enforcement of laws and standards (immediate results), combined with public awareness/education to increase adherence and compliance. Awareness-building and legislation with enforcement remain key strategies. Use of helmets, seat belts, child restraints, overspeeding, drink driving, drugs and driving, cell phone use and other risk factors are to be addressed to make people safer [213].

Human behavior is a result arising from culmination of knowledge, attitudes, and beliefs amidst the physical and social environment in which people live. The actions that people take are primarily influenced by various factors
Like age, gender, physiological status, environment, roads and vehicles they use, and the societal level of safety awareness and practices. Road safety behavior has strong physical, social, psychological, and economic dimensions and is somewhat resistant to change [243].

Sweden in its “vision zero approach” has laid special emphasis on vulnerable road users (pedestrians, bicyclists, motor vehicles) and has incorporated features like low urban speed limits, pedestrian zones, segregation of vehicles from pedestrians and bicyclists, and others (only one child death reported in 2012). Along with this, strict enforcement of drink-driving (less than 0.25% of drivers tested were over the alcohol limit) and helmet and seat-belt use have helped to reduce road deaths [221]. Similarly, the city of Bagota in Columbia has encouraged public transportation (BRT) over private transport thereby making roads friendly for the pedestrians and cyclists [244]. Implementation of the strict helmet law in Vietnam along with investment in free helmets and education from 15th December 2007 has saved millions of lives till date [245]. As per WHO, in 2010 in Hanoi found 16% and 18% reductions in the risk of serious head injuries and deaths, respectively [245].

As no single approach can bring the desired changes, many countries have used a combination of product safety, legislation, enforcement, advocacy, awareness, and others to achieve road crash reductions over time. Some evidence-based interventions include the following.

- Motor vehicle crashes decreased following the introduction of Graduated Driver Licensing (GDL) in Massachusetts for age groups (16–17 years, from 7.6 to 4.8 per 1,000 people, p < 0.0001; 18–20 years, from 8.5 to 6.4 per 1,000 people, p < 0.0001; 25–29 years, from 6.2 to 5.2 per 1,000 people, p < 0.0001). GDL is associated with a decreased incidence of teenager total and fatal motor vehicle crashes and the effect was sustainable [246].

- Evidence from 15 RCTs of pedestrian safety education programs, conducted between 1976 and 1997, indicates that pedestrian road safety education among children helps to change observed road-crossing behavior. However, it is unclear whether the same reduces risk of collision. No large-scale trials have been conducted in rapidly motorizing LMICS. Changes in safety knowledge and observed behavior decline with time, suggesting that safety education must be repeated at regular intervals [247].

- There is no strong evidence that post-license driver education is effective in preventing road traffic injuries or crashes. Although a small reduction in the occurrence of traffic offenses is observed, this may be due to selection bias. On the contrary, an increased risk of accidents was observed as teenage drivers get license by early driver education disregarding the notion that driver education reduces road crashes [248].

- Meta-analysis of three trials examining effectiveness of school-based driver education and reduction of road crashes revealed that there is no evidence that driver education alone reduces road crash involvement and suggested that it may lead to a modest but potentially important increase in the proportion of teenagers involved in traffic crashes. (Ian R et al, 2001) [249].

- Similarly, strong evidence that advanced and remedial driver education does not reduce road traffic crashes or injuries is known based on a review of 24 trials of driver education programs that showed that no one form of education (correspondence, group, or individual) was more effective than another, nor was a significant difference found between advanced driver education and remedial driver education [250].
Children in transport systems: Ensuring their safety

Children (<18 years) constitute 37% of India's population (444 million).(1) Every day, nearly 345 million children commute by different modes of transport for education, depending on factors like topography, distance, family income and availability of local transport. Data regarding number of children travelling by specific type of transport is not available in India. Data from a cross sectional study of 5842 school children in Hyderabad revealed that walking (57%), cycling (6%), use of public transport and school vans (36%) as well as personal vehicles (8%) are the common travel modes to reach school. Use of motorised transport was found to be higher among children in private (41%) than in government schools (24%) conveying that affordability decides mode of school commuting in India.(2)

Children are more susceptible and vulnerable to road crashes due to their physical development, poor judgement of speed and short stature which affects their visibility in roads. Inherent nature of children like risk taking, impulsiveness and cognitive immaturity further increases their vulnerability. As roads are not designed and developed keeping children in mind and as children use roads in different ways, risk of RTIs is significantly higher.

As per report of Ministry of Road Transport and Highways, children accounted for 4% of total road deaths in 2015. The Bangalore Road Safety Programme indicated that 5% of all RTI deaths occurred among children. Yet another study in Hyderabad district estimated the self reported prevalence of RTI as 17% among 11-17yr olds. Indian print and visual media regularly highlight deaths and injuries among children.

A greater focus and thrust by national and state governments has ensured increasing participation of children in education. This also brings greater risks of commuting different distances and in varying modes in the absence of safe modes of travel. It is also widely reported that overloading in school transport vehicles, willful alteration in the school vehicle design to accommodate more children, disregard for school van safety norms, rash driving to meet school timings and neglect of safety by drivers contributes for frequent occurrence of road accidents among school children.

As children are future resources and road crashes are multi factorial in causation, a holistic approach with multiple interventions is the need of the hour to ensure their safety. A focus on safe systems approach is required to bring about immediate and tangible results. Interventions in roads and vehicle design, addressing road behaviour among parents, care givers, school vehicle drivers through well designed & targetted awareness programmes as well as by laws, making safe school zones and others help to reduce road deaths among children. It is well acknowledged that continuous, targeted, focused and well-designed programs are likely to show positive results when coupled with other measures like safe roads and legislative measures.

School road safety education programmes are one of the most common activities seen across the country based on the belief that early provision of safety information can bring both short term and long term positive changes. These programmes are done in most places as children are also the most easily available captive audience for such programmes. In some states, such lessons are integrated into school curriculum and also include demonstration sessions on roads.

UL India in partnership with YSA (Youth Safety of America) initiated “Safer roads, safe India” in 2015. Through this initiative UL was able to reach 33,000 children and impart road safety awareness among
6. Enhancing road infrastructure
5. Improving children’s ability to see and be seen
4. Restraining children in vehicles
3.
2.
1. Controlling speed

WHO include (4) changes. Some important measures recommended by society, moving beyond classroom sessions to societal programs. (3) Ensuring safety of school children requires community members to assess the situation in and around the school area and to introduce appropriate interventions to help children to be safe on roads.

Bangalore Traffic Police initiated “Safe Road To School” (SRTS) campaign in 16 schools in 2005 and since then has been expanded to many schools. Through this campaign, the Traffic Police have brought in measures like - segregation of school timings (8.30am-3.30pm) to avoid heavy congestion environments, ban on vehicle parking within 200 meters of school surroundings, auto rickshaws carrying >6 children to be penalized, all school bus drivers to be audited for traffic violations like over speeding, drink driving, over loading, violating traffic signals along with increasing awareness among school children through classroom sessions.

In a well organised study in Kuala Lumpur, a significant reduction in number of crashes in districts where Road Safety Education (RSE) programme was conducted for school children compared to districts without the program. (3) Ensuring safety of school children requires a much broader and holistic approach in the Indian society, moving beyond classroom sessions to societal changes. Some important measures recommended by WHO include (4):

1. Controlling speed
2. Reducing drinking and driving
3. Using helmets for bicyclists and motorcyclists
4. Restraining children in vehicles
5. Improving children’s ability to see and be seen
6. Enhancing road infrastructure

7. Adapting vehicle design
8. Reducing risks for young drivers
9. Providing appropriate care for injured children
10. Supervising children around roads

Recognising the gravity of the problem, the Hon. Supreme Court of India as early as 2010 provided guidelines for school buses to ensure safe travel of children. These guidelines highlight that

1. “School Bus” must be written on the back and front of the Bus.
2. If it is a hired bus, “On School Duty” should be clearly indicated
3. Bus must have a first aid-box.
4. The windows of bus must be fitted with horizontal grills.
5. There must be a fire extinguisher in the bus.
6. School name and telephone no. must be written on the bus.
7. The doors of the bus should be fitted with automatic doors / reliable locks.
8. To keep school bags safely, there should be a space fitted under the seats.
9. There must be an attendant from the school in the bus.
10. Any parent/guardian or a teacher may also travel to ensure these safety norms.

Provision of safe school zones though recommended as an important safety measure is yet to become a reality in India. A safe school zone provides overall safe road environment within 100 mts surroundings of school. These zones have road safety signages for slow driving, no honking, well marked lanes, pedestrian guard railings, ban on vehicle parking and speed limits of <20 kmph. Recently, the state of Kerala has taken up a large scale programme to provide safe school zones covering 115 schools spread across the state. The schools, especially those on heavily congested roads and national/state highways are likely to be benefited by this measure.

Safety education of children has been a major initiative in India for several years using variety of tools and techniques. However, these efforts require systematic evaluation for efficacy, effectiveness, sustainability and impact.

Sources
Continuous, targeted, focused, and well-designed programs are likely to show positive results. Effectiveness of Road Safety Education (RSE) in reducing accidents was assessed on a large scale in Malaysia between 2007 and 2010 by adopting an interventional study design. RSE consisted of providing knowledge by embedding road safety messages (tailored to the age range of the students) in the existing curriculum and by being taught once a week (40 minutes exposure) by trained teachers. Six intervention districts and six comparison districts were studied covering 67,232 children between 2008 and 2009. Results from the injury surveillance study showed a significant reduction in the number of crashes in intervention districts for both year 2 (age 8) and 4 (age 10) grade students after following up for two years. Results from police crash data also showed a reduction in the number of road crashes for the pedestrian age group 7–12 years in intervention districts in 2009 as compared to 2007 [251].

Communication and mass media campaigns

A systematic review of eight studies to evaluate the effectiveness of mass media campaigns for reducing alcohol-impaired driving (AID) and alcohol-related crashes revealed that the median decrease in alcohol-related crashes resulting from the campaigns was 13% (interquartile range: 6–14%). Economic analyses of campaigns indicated that the societal benefits were greater than the costs. There is strong evidence that mass media campaigns are effective in reducing alcohol impaired driving and alcohol-related crashes [252].

Both intensive (secondary school conferences) and basic road safety education programs (public campaigns, brochures, mass media communication, press conferences) were associated with decrease in incidence and severity of nonfatal road injuries in Italy. However, this overall downward trend was not a direct consequence of road safety education. Road safety education should be supplemented with other complementary activities to decrease the incidence and severity of road injuries [253].

A meta-analysis of 67 studies reported that road safety campaigns result in a 9% reduction in accidents. There is a positive association between accident reduction and use of personal communication or roadside media as part of a campaign delivery strategy. Campaigns with a drink-driving theme are associated with greater accident reduction. Campaigns are more effective in the short term if the message is delivered with personal communication in a way that is proximal in space and time to the behavior targeted by the campaign [254].

<table>
<thead>
<tr>
<th>Phase</th>
<th>Steps</th>
</tr>
</thead>
</table>
| PHASE 1 PROJECT DESIGN AND RESEARCH | 1. Project planning, including forming the project team and advisory stakeholder groups, defining the problem and policy options, and creating the budget and implementation timeframe.  
2. Desk review comprising a stock-take of existing information with the aim of understanding the environment or context in which the campaign will be implemented.  
3. Definition of core strategy and specific, measurable, achievable, relevant and time bound (SMART) programme objectives.  
4. Definition of core strategy and specific, measurable, achievable, relevant and time bound (SMART) programme objectives. |
| PHASE 2 PRODUCTION | 5. Definition of messages and materials, and where and when the messages will appear.  
6. Concept and pre-testing to verify validity of the main campaign ideas and concepts.  
7. Development of materials and pre-testing, including detailed evaluation of campaign messages and materials. |
| PHASE 3 DISSEMINATION | 8. Distribution strategy and media plan, including designing the media plan and the negotiation of airtime, and how the campaign will be launched.  
9. Campaign launch, implementation and monitoring, and identifying any necessary strategy alterations. |
| PHASE 4 EVALUATION | 10. Evaluation, measuring the impact of the campaign on people’s knowledge, attitudes and behaviours, as well as their exposure to and recall of the campaign. |

Source - Road safety mass media campaign: a tool kit, Geneva: World Health Organisation; 2016. [255]
Incentives and their effectiveness

- Tangible incentives (rewards) to promote safety belt usage show a mean short-term increase in use rates of 20.6 percentage points; the mean long-term effect was 13.7 percentage points. The main factors that influenced short-term effect were the initial baseline rate (which correlated with the presence or absence of a safety-belt usage law), type of population involved, whether incentives were delivered immediately or delayed, and whether incentives were based on group or individual behavior. Together, these four variables accounted for 64% of the variance. The relationship between incentives and long-term effects is not clear (Hagenzieker MP et al, 1997)[256]. WHO, in 2017, has provided guidelines for conducting social marketing campaigns and will be helpful for countries.

<table>
<thead>
<tr>
<th>Characteristics of successful programme</th>
<th>Characteristics of unsuccessful programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Provides information on safe practices</td>
<td>1. Passive messaging - signs, pamphlets, brochures, and buttons.</td>
</tr>
<tr>
<td>2. Communicates health knowledge not previously well known</td>
<td>2. Slogans &amp; simple exhortations.</td>
</tr>
<tr>
<td>3. Helps to support new law enforcement, publicizing the enforcement presence and result</td>
<td>3. Educating children under 8-9 years old</td>
</tr>
<tr>
<td>4. Programmes can be part of larger and longer-term community programs.</td>
<td>4. Education programs – lecture oriented, information-only in nature.</td>
</tr>
<tr>
<td>5. Programmes can be developed based on behaviour change models, teaching skills to resist social influences</td>
<td>5. Short-term programs that have low-intensity messages.</td>
</tr>
<tr>
<td>6. Education of policy makers and professionals is more vital</td>
<td>6. Use of extreme fear or scare techniques, especially when directed at adolescents.</td>
</tr>
</tbody>
</table>


In India, all national reports (MoRTH, NCRB) and hosts of independent studies firmly ascribe to the view that human errors account for >80% of accidents. Consequently, there is a greater reliance and investment in educating road users to be safe on roads. Variety of communication tools like pamphlets, posters, banners, ads in newspapers, songs, billboards, hoardings, dramas, folk plays, street theatres, films, small and lengthy videos, public seminars, school programs, newspaper articles, worker education programs, public announcements in railway stations and bus stops, public lectures, road safety rallies, campaigns on both general and specific topics, television spots, and social media communications are undertaken apart from the annual road safety awareness programs throughout the country. These programs are both individualistic (focusing on helmets, seat belts, etc.) as well as general (be safe on roads) in nature. In recent times, use of technology has gained momentum due to its greater usage, ease of communication, and growing costs of print media.

Educational approaches aim at provision of information, enhancing awareness, improving knowledge, and catalyzing translation of favorable attitudes to safe road behavior. Reviews on the effectiveness of educational interventions for road safety have shown mixed responses, indicating that IEC programs as an isolated intervention is unlikely to result in greater reduction of accident rates, but however may help to facilitate better compliance to safety behavior. Further, it suffers from its limited ability to bring change on a continuous and long-term basis and at times is likely to have unintended negative effects (educating young people about speeding and use of alcohol). Education when combined with other approaches of legislation, enforcement, product safety, road interventions, and others and implemented in a very systematic manner can be very helpful for road safety in India.
S trengthening  P ublic T ransportation and R oad Safety

A  developed country is one where rich use p ublic t ransport, not one where poor own cars- Enrique P enalosa, former M ayor of B ogotá, C olombia

M ultimodal transport systems, which are efficient, safe and economical is a key requirement to promote safe mobility. These include systems that permit use of a variety of transport modes ranging from metros to bicycles. These systems ensure connectivity, faster travel as well as economical and sustainable mobility. W orld H ealth O rganization recommends improving p ublic transportation systems as an intervention t o reduce the risk of exposure to unsafe traffic environments that lead to RTIs. Mass transport systems h ave the added advantages of reducing congestion, parking problems, pollution, fuel consumption and others. I t is well established that cities and regions with good mass transport systems also have lower rates of crashes and fatalities.

M odes of public transport

P ublic t ransport systems need to be s afe, timely, c onvenient and e conomical for p eople to use t hem r egularly. I t also requires end to end connectivity such that commuters do not feel the need to use their p ersonal modes of transport. In I ndia buses, auto rickshaws, suburban trains, trams and local trains are c ommon modes of public transportation, to which m etros and B us Rapid T ransit system have been r ecently added.

A  public transport system such as bus transport is an efficient method, especially in large and medium cities that needs to connect peripheral areas. Despite its presence, it still requires connectivity for short or long distances through walking, use of a two wheeler, three wheeler and other modes. Some problems like a vailability, access and egress, addressing special needs of children – elderly – physically challenged – sick persons, convenience, huge costs, acquisition of p ublic s pace and development of supportive technologies are some barriers that are being overcome by local g overnments. Most often, as individual vehicles directly connect point A to point B (from bed room to board room), people, especially youngsters prefer t heir own vehicles. I n recent times, many I ndian state governments and urban bodies are investing in strengthening public transport systems, albeit at a slow pace. F or example, the BM TC (Bangalore M etropolitan T ransport Corporation) has 6159 buses, operational from 43 depots and 34 bus stations, making 74,313 trips per day and transporting 5.02 million passengers daily. T he i ncome and expenditure has been 188268 l akhs and 202439 l akhs in 2016. T he fleet system has a dded on an average 400 buses every year. S afety performance of BM TC fleet has been examined in 2 studies by WHO CC and TR IPP and both have suggested several measures for improving safety performance of these fleets (3). M ost s ignificantly, s afety of p eople o utside buses has to be given i mportance.

B us Rapid T ransit (BRT) introduced in few I ndian cities has designated bus lanes that promote rapid connectivity and also incorporates technologies of off board ticketing, automatic door open and improved access for elderly, kids and physically challenged. E ven though many I ndian cities expressed willingness for implementing BRT systems, the results have been mixed. BRT is operational in the cities of I ndore, Pune, Ahmadabad and Jaipur; removed in Delhi, and recently Amritsar flagged off its BRT by incorporating changes. L essons have been learnt from the experience of cities that implemented BRT from both within and outside India.

S tory of Metro in I ndia

M etro r ail systems serve as an economical mode of transport with low energy consumption and are e co-friendly (runs on electricity, thus minimizing air and noise pollution) and saves time. B y reducing the number of vehicles on roads it averts RTIs and is efficient in terms of space occupancy. T oday, m etro r ails provide comfort with ultra-modern coaches, a utomatic ticketing and even i nternet facilities. N ewer technologies like advanced signalling systems, a utomatic t rain protection system and integrated s ecurity systems renders them safe in terms of m ishaps (derailment, collision, fire, break down etc).

K olkata was the f irst city in I ndia to start using M etro as means of p ublic t ransportation. T his was followed b
other major cities like New Delhi, Mumbai, Bangalore, Chennai and Jaipur. Tier-II cities like Lucknow, Kanpur, Patna, Ahmedabad, Surat, Indore, Nagpur and Coimbatore are in the process of setting up dedicated metro networks, while proposals are being evaluated for Chandigarh, Bhopal, Ludhiana and Kozhikode.

The Bangalore Namma Metro project was conceptualised in 2006-07 and has been implemented in phases with final connectivity across the city yet to near completion. It has a total rail length of 42.30 km (North south corridor- 24.2 km, east west corridor- 18.10 km), a total of 40 stations, rails travel on standard gauze with an average speed of 34 kmph with a total end to end travel time of 33-44 min across the Bengaluru city. The cost of metro implementation increased from 6395 crores (63950 million) in 2006 to 1 4405 crores (144050 million) by 2016, an increase by nearly 2.25 times. It was originally scheduled to be completed in year 2011 but completed in 2017. Delay was attributed to prolonged legal battles over land acquisition, hurdles in tunneling and delays in awarding tendering for underground sections. Today, metro ferries nearly 100,000 people and has record of generating revenue of around 14.5 million during Feb 2015.

Despite early limitations of cost and time investments for construction, once rolled out, the benefits are expected to be higher for mobility, safety and environmental protection. By reducing/removing many private vehicles, pollution and fuel consumption along with an expected (to be evaluated) reduction in road accidents, the benefits are expected to be greater in the long run. The success also depends on other parameters like selection of traffic corridor, land availability, capacity utilization and acceptance by the commuters (5).

Finally,

- If public transport systems are convenient, accessible, affordable and can ensure safety of people within and outside the vehicle, the acceptance by citizens is likely to be higher.
- The story is still incomplete as rural India still needs to be equipped with modern transport systems and have better connectivity with cities and towns and this will have different set of barriers and challenges to overcome.
- From a road safety perspective, the future of safety depends on strengthening multimodal mass transportation systems that are beneficial for health of people.
- The vision of creating smart cities would require the best possible integration of urban public transportation in a healthy, safe and environment friendly manner into the urban ecosystem, in a cost-effective manner.
- Furthermore, the real impact of investments in public transport and metro rail systems in India needs to be systematically evaluated for its overall and selective benefits through well designed studies.

Sources
4. Bangalore Metro Rail corporation limited. About Us.2017[Internet][cited 2017 Apr 27]. Available at http://www.bmrc.co.in/English/

Metro Rail System (Functioning/Under construction)
Regulatory and Enforcement approaches are a major strategy for environment and vehicle safety as well.

Based on larger public health experience (tobacco control, alcohol control, crime prevention, health regulations, etc.), regulatory approaches have been used in road safety as well, considering limitations of human behaviors and their risk-taking practices. Improving safety by regulating or modulating road behaviors through legislation and enforcement gained importance as people on their own do not consider safety as a perceived need. Enforcement approaches refer to refraining or restricting road users from indulging in risky behavior on roads to prevent loss to self and others, by imposing certain laws and punitive measures. Favorable regulatory environment is also an indicator of commitment of government to address road safety issues in the country.

In contrast to educational approaches, regulatory approaches bring a relatively quicker short-term change in human behavior and are also long-lasting if unchanged. Evidence suggests that the compliance of the population is short-lived when rules are withdrawn. Studies that have evaluated the impact of motorcycle helmet laws on helmet-wearing rates, head injury, or death have shown that when mandatory helmet laws are enforced, helmet-wearing rates increase to 90% or higher [245, 257, 258]; when such laws are repealed, wearing rates fall back to generally less than 60%.

- Enforcing sobriety checkpoints and random breath testing has resulted in reductions in alcohol-related crashes of about 20% and have shown to be very cost-effective [259].
- Systematic review of 34 studies to evaluate the effectiveness of Graduated Driver Licensing (GDL) to reduce crash rates among young drivers revealed there is a median decrease of 21% in population adjusted injury crash rates (median −21%, range −46 to −2%, five studies). GDL is found effective in reducing crash rates among young drivers, although the magnitude of the effect varies [250].
- A Cochrane review revealed that helmet use by motorcyclists reduces the risk of head injury by 72% (OR 0.28; 95% CI 0.23-0.35) and subsequently mortality and severe injuries [260].
- Strong evidence exists that helmet legislations mandating its use increases its use, thereby decreasing deaths and injuries, while repeal of the same leads to an increase of deaths, injuries, hospitalizations and costs of care [258].
- Researchers in Michigan, USA, observed that despite Michigan’s mandatory helmet law, 19% of RTI victims were not using helmets and failure to wear helmet adds to the financial burden due to motorcycle-related injuries. Helmet use led to average hospital costs that were about 20%, or US$ 6000, less than costs for those who did not wear helmets; the average costs for unhelmeted riders were nearly twice those of helmeted [150].
Drink drive laws

- Legislations that make it illegal to drive a vehicle with blood-alcohol levels exceeding a certain limit refer to laws against drinking and driving (CDC). Enforcing sobriety checkpoints and random breath testing have resulted in reductions in alcohol-related crashes of about 20% and have shown to be very cost-effective [259].

- Japan passed a new road traffic law in June 2002 to reduce alcohol-impaired driving by decreasing the permissible blood-alcohol level and increasing penalties. The rate of alcohol-related traffic fatalities per billion kilometers driven decreased by 38% in the post-law period. Alcohol-impaired drivers were 77% more likely to be killed in a crash than those with no detectable BAC, 53% more likely to be killed in a motorcycle crash, and 35% more likely to be killed in a pedestrian crash [260].

- WHO (2004a) reports reduction of serious and fatal injury by 40-65% by use of seat belts. Enacting seat-belt legislation as an intervention is expected to improve seat-belt use among drivers and front passengers and leads to reduction in fatalities and injuries.

- Impact of the helmet legislation resulted in an increase of helmet-wearing rates across the United States, by up to 95% in some regions; the highest increase in wearing rates occurred in areas where the adoption of the law was combined with a public media campaign and strong police enforcement. Increase in helmet compliance resulted in 66% decrease in admissions of traumatic brain injury for motorcycle and moped crashes; 31% decrease in traumatic brain injury admissions to neurosurgical hospital units; and a fall, to almost zero, in the number of blunt-impact head injuries (epidural hematomas) among injured moped riders admitted to hospitals [150].

- Review of evidence primarily from the United States, Australia, New Zealand, and other European countries indicates that laws pertaining to lowering the blood-alcohol concentration levels (BAC) limit from 0.10 to 0.08 mg/dl reduce road traffic injuries and fatalities, although the scale of effect varies. Adoption of a 0.05 BAC driving limit reduced alcohol-related driving death rates by 11.5% among young people aged 18–25 years, reduced driving fatalities among men of all ages by 5.7%, and among men in urban areas by 9.2%. There is strong evidence to indicate that lowering the BAC limit changes the drink-driving behavior of drivers at all BAC levels as the BAC law acts as a general deterrent [263].

- Review of 32 studies on police patrol programs was generally consistent in reporting beneficial effects on traffic crashes and fatalities, but study quality (methodological limitations of inadequate sample size, dissimilar baseline measures, contamination, and inadequate data analysis) and reporting were often poor. Existing evidence, although supportive, does not firmly establish whether increased police patrols, implemented with or without other intervention elements, reduce the adverse consequences of alcohol-impaired driving [264].
The Motor Vehicles (Amendment) Bill 2016

The Indian Motor Vehicles Act of 1988 has existed for several years and all Indian states adopted the same with modifications over time. In the interim, several amendments were made in 2002 as well as smaller changes over time at both central and state levels.

With worsening road safety scenario as reflected by increasing deaths and injuries, the need for revisions or a new approach was flagged by several safety professionals/organisations. The Sundar Committee report (2006), Transport safety report (2010), National Law Commission report (2008) and several independent reports have argued for revisions to Indian Motor Vehicles Act.

The unfortunate and sudden demise of Shri. Gopinath Munde, former minister of Rural Development and Panchayati Raj, in a car crash on 3rd June 2014, catalysed the whole country to re-examine the need improving road safety scenario and a new act to improve several transport and road safety problems. The Hon. Minister of Road transport and Highways, Shri. Nitin Gadkari made an announcement on June 5th 2014 that a new Road safety Bill will be brought in to improve the situation.

Expert committees drafted the new act that was discussed and debated at central and State levels by public, professionals, trade bodies, vehicle and road industry groups. Discussions ran into rough weather and till date the new bill has not seen the light of the day. To address the issue of road safety, a draft on Road Transport & Safety Bill was prepared by a Group of Transport Ministers (GoM) of the States constituted by MoRTH in 2015. The GoM strongly recommended amendment of the Motor Vehicle act-1988.

On the basis of recommendations of the GoM, MoRTH introduced the Motor Vehicle (Amendment) Bill 2016 for consideration of the Cabinet. The much awaited bill was approved on August 3rd 2016 by Hon. Prime Minister, Shri Narendra Modi and was introduced in Lok Sabha by Hon. Minister Shri. Nitin Gadkari on 9th August 2016. The bill needs approval of Rajya Sabha.

Out of 223 sections of earlier Motor Vehicle Act-1988, the new bill aims to amend 68 sections. Chapter 10 has been deleted and Chapter 11 is being replaced with new provisions to simplify third party insurance claims and settlement process. The Bill also proposes insertion of 28 new sections. The important provisions include:

- Increase in compensation for hit & run cases from ₹25000 to ₹2 lakhs.
- Provision for payment of compensation upto ₹10 lakh in road accidents fatalities.
- The amendments mainly focus on issues relating to improving road safety.
- Strengthening rural transport, last mile connectivity and public transport, automation and computerization and enabling online services.
- The State Government can specify a multiplier, not less than one and not greater than ten, to be applied to each fine under this Act.
- The State Government can regulate the activities in a public place for pedestrians and such means of transport.
- The guardian/ owner shall be deemed to be guilty in cases of offences by the Juveniles and Juvenile to be tried under JJ Act. Registration of Motor Vehicle to be cancelled.

Road safety:

- To ensure better compliance to road safety rules among citizens, the amendment has increased penalties to act as deterrent against traffic violations.
Stricter provisions are being proposed in respect of offences like juvenile driving, drunken driving, driving without license, dangerous driving, overspeeding, overloading etc.

Stricter provisions for helmets have been introduced along with provisions for electronic detection of violations using CCTV cameras, blueberry mobiles, etc.

Good Samaritan guidelines (section 134A) encourages providing voluntary help to the road accident victims without being subjected to civil or criminal action.

Replacement of Chapter XI mandates the doctors/health facility to give free medical treatment to the accident victim without waiting for legal (police) enquiries or the relatives to pay.

Under Section 164 B, there is provision for creating the Motor Vehicle Accident Fund, which will compulsorily cover all road users. However, the fund can be utilized only in cases where no person can be held liable for the accident.

With effect from 1st October 2018 it is mandatory for all vehicles to undergo automated fitness testing.

The penalties are also proposed to be increased for deliberate violation of traffic/safety/environmental regulations as well as body builders and spare part suppliers. Road builders and vehicle manufacturers are also being accountable.

The process for testing and certification for automobiles is proposed to be regulated more effectively. The testing agencies issuing automobile approvals have been brought under the ambit of the Act.

Bill provides an internationally accepted definition for ‘road crash death’ as one where a person dies within 30 days due to injuries sustained in a road accident. This will improve the state of accident reporting across India(1,2).

National Authority for road safety:
The present bill proposes establishment of a National Authority responsible for road safety by central Government within 6 months of act commencement. This National Authority will be known as “Vehicle regulation and Road Safety Authority” whose objective will be to promote road safety and regulate motor vehicles. This body shall be responsible to Government of India, with its head office at New Delhi and branch offices deemed fit to carry out its activities. The authority shall include a chairperson being a member and not less than 4 and not more than 8 members excluding the chairperson.

There are some concerns in the latest Bill like:

- Penalties for several life-threatening offences such as over-speeding have been drastically reduced to up to ₹2,000.

- In the previous drafts, violations by HMVs were treated differently from LMVs given the much higher damage a violating HMV could cause. New Act ignores the same.

Despite these shortcomings, Motor vehicle act - 2016(The New Road Transport and Safety Bill,) is a step in the right direction and must not be opposed in its entirety. It addresses necessary advancements in the sector towards a safe-system approach, where design-thinking and accountability take precedence over arbitrary, uncoordinated steps to address the issue(3). A serious political commitment to implement the amendment is the need of the hour, to tackle the consistent threat of death and serious injury due to road accidents in India.
### Comparison of penalties under old and new Motor Vehicle act

<table>
<thead>
<tr>
<th>Section</th>
<th>Old Provision/ Penalty (in ₹)</th>
<th>New Proposed Provision / Minimum Penalties</th>
</tr>
</thead>
<tbody>
<tr>
<td>177</td>
<td>General</td>
<td>₹500</td>
</tr>
<tr>
<td>New 177A</td>
<td>Rules of road regulation violation</td>
<td>₹500</td>
</tr>
<tr>
<td>178</td>
<td>Travel without ticket</td>
<td>₹500</td>
</tr>
<tr>
<td>179</td>
<td>Disobedience of order of authorities</td>
<td>₹2000</td>
</tr>
<tr>
<td>180</td>
<td>Unauthorized use of vehicles without licence</td>
<td>₹5000</td>
</tr>
<tr>
<td>181</td>
<td>Driving without licence</td>
<td>₹5000</td>
</tr>
<tr>
<td>182</td>
<td>Driving despite disqualification</td>
<td>₹10,000</td>
</tr>
<tr>
<td>182 B</td>
<td>Over size vehicles</td>
<td>₹5000</td>
</tr>
<tr>
<td>183</td>
<td>Over speeding</td>
<td>₹1000 for LMV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>₹2000 for Medium passenger vehicle</td>
</tr>
<tr>
<td>184</td>
<td>Dangerous driving penalty</td>
<td>₹5000</td>
</tr>
<tr>
<td>185</td>
<td>Drunken driving</td>
<td>₹10,000</td>
</tr>
<tr>
<td>189</td>
<td>Speeding / Racing</td>
<td>₹5000</td>
</tr>
<tr>
<td>192</td>
<td>A Vehicle without permit</td>
<td>₹10,000</td>
</tr>
<tr>
<td>193</td>
<td>Aggregators (violations of licencing conditions)</td>
<td>₹25,000 to ₹1,000,000</td>
</tr>
<tr>
<td>194</td>
<td>Overloading</td>
<td>₹20,000, ₹2000 per extra tonne</td>
</tr>
<tr>
<td>194 B</td>
<td>A Overloading of passengers</td>
<td>₹1000 per extra passenger</td>
</tr>
<tr>
<td>194 C</td>
<td>Overloading of two wheelers</td>
<td>₹2000, Disqualification for 3 months for licence</td>
</tr>
<tr>
<td>194 D</td>
<td>Helmets</td>
<td>₹1000 Disqualification for 3 months for licence</td>
</tr>
<tr>
<td>194 E</td>
<td>Not providing way for emergency vehicles</td>
<td>₹10,000</td>
</tr>
<tr>
<td>196</td>
<td>Driving Without Insurance</td>
<td>₹2000</td>
</tr>
<tr>
<td>199</td>
<td>Offences by Juveniles</td>
<td>Guardian / owner shall be deemed to be guilty. ₹25,000 with 3 years imprisonment. For Juvenile to be tried under JJ Act. Registration of Motor Vehicle to be cancelled</td>
</tr>
<tr>
<td>206</td>
<td>Power of Office to impound documents</td>
<td>Suspension of driving licenses u/s 183, 184, 185, 189, 190, 194C, 194D, 194E</td>
</tr>
<tr>
<td>210 B</td>
<td>Offences committed by enforcing authorities</td>
<td>Twice the penalty under the relevant</td>
</tr>
</tbody>
</table>

**Sources**


Indian Motor Vehicles Act of 1988 is the primary tool for enforcing road safety rules and regulations in India and a silver lining has arrived in the form of the new Motor Vehicle Amendment act 2016. However, the implementation or enforcement of the several provisions in the act has been very weak in India due to numerous factors like poor coordination between center and state, human resource constraints (272 traffic police per 1000 population), lack of training, multitasking by enforcement officials, limited public awareness, limited use of technology (speed cameras, a lcohol breath analyzers, interceptors, and CCTVs), faulty or misinterpretation of laws, ineffective penalty levels (offenders do not fear being caught or being fined), delayed judicial reaction, corruption, and absence of strict monitoring and evaluation. Enforcement officials are too few, vehicles and violations are too many, and majority of people are unaware of the law and its advantages.

For legislations to be enacted, strong political commitment, a responsive judiciary, consensus among participating stakeholders, and good quality data are essential. Further, for legislations to be effective, enforcement by police is mandatory in a random, visible, and noticeable manner, along with reasonably higher level of penalties. Public awareness and cooperation are vital. Experience from other countries indicates that traffic laws and their strict – continuous enforcement along with visible punishment (stiff penalties, cancelation of license, short-duration imprisonment, seizure of vehicle) help in reducing injuries and deaths. (Refer to section on risk factors, safe systems approach). In many HICs, road safety regulations are data-driven, well crafted (with less ambiguities), public are made aware, carry stiff penalties, enforced in a uniform manner, use technology to a greater extent, and periodically reviewed – modifications made and monitored in terms of actual reductions in deaths and injuries.

<table>
<thead>
<tr>
<th>Merits</th>
<th>Demerits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide information and focus on behaviour change</td>
<td>Needs development of programmes based on situation and context</td>
</tr>
<tr>
<td>Helpful in one time interventions</td>
<td>Immediate changes are not visible</td>
</tr>
<tr>
<td>Cover wide variety of behaviours through targeted programmes</td>
<td>Difficult to evaluate effectiveness</td>
</tr>
<tr>
<td>Increase societal awareness</td>
<td>Difficult to sustain</td>
</tr>
<tr>
<td>Possible to combine with other interventions</td>
<td>Needs huge resources to cover large populations</td>
</tr>
<tr>
<td>Enhances individual and societal commitment and responsibility</td>
<td>Time consuming</td>
</tr>
<tr>
<td>for road safety</td>
<td>Needs skilled human resources to develop programmes</td>
</tr>
<tr>
<td></td>
<td>Needs individual efforts even with acquisition of knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Possible with prioritization</td>
<td>Works only when respect and fear of law present in society</td>
</tr>
<tr>
<td>Needs political commitment</td>
<td>Needs human resources to enforce</td>
</tr>
<tr>
<td>With education can have long lasting effects</td>
<td>Needs technology to enforce</td>
</tr>
<tr>
<td>Can be supplemented with technology</td>
<td>Compliance to laws needs to be present</td>
</tr>
<tr>
<td>Impact can be measured</td>
<td>Requires preparation of society</td>
</tr>
<tr>
<td>Changes visible even in short term.</td>
<td>Society should be convinced about laws</td>
</tr>
<tr>
<td></td>
<td>Provides scope for corruption</td>
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<td></td>
<td>Subject to commitment of enforcement agencies to enforce</td>
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### Post-crash care

Post-crash care begins with identifying injured in crash situations, providing first aid and triage, arranging for transport, reaching them to appropriate facility at the earliest time, appropriate management in the hospital, and continued care for recovery and rehabilitation. This pillar of road safety aims to increase responsiveness to post-crash emergencies and improves the ability of health-care systems to provide appropriate emergency treatment and longer-term rehabilitation for crash victims. Trauma care activities are a continuum of activities beginning at the crash site and continue till the return of the injured to optimum levels of functioning. This includes identifying the trauma victim, shifting the right patient to the right place, in the right time, for the right treatment (Mock et al, 2004). Pre-hospital trauma care, care in hospital, and disability limitation comprise the three broad domains of trauma care and should cover care for all types of injuries as parallel systems will only duplicate efforts.

**Ten good practices of trauma care are:**

1. A national agency that coordinates all trauma care activities
2. Training first responders at community level – police, drivers, teachers, health workers
3. Provision of early first aid and safe transportation
4. Stabilization of the injured
5. Triage, Assessment and referral
6. Preparedness of the hospital to receive trauma cases
7. Availability of skilled and well trained hospital staff
8. Improving physical infrastructure (Operating facilities, Blood banks, CT and MRI scans etc)facilities
9. Strong legislation to help the crash victims, doctors and the first responders.
10. Monitoring and evaluation of all trauma care activities

Quality trauma-care systems reduce fatality and disability in road crashes as well as all other injuries, as shown by a WHO study across 11 hospitals in 9 countries with improvement in consistency of trauma care (using WHO trauma care check list) that was provided to injured patients and which resulted in 49% reduction in the mortality rates among the most severely injured patients with multiple injuries [194] in reduced mortality among individuals with severe injuries. Developing trauma care systems that include established guidelines-standards - protocols, trained staff, dedicated resources and customized specifically to suit the geography and needs of the target population and well-coordinated are very much required. WHO has designed a simple tool – “WHO Trauma care checklist” – for use in emergency care that has been validated through a large global collaboration that emphasizes the key life-saving elements of initial injury care.

Advanced and Basic trauma life support training

- Training of first responders in basic trauma care and rescue skills along with provision of required tools for basic life support reduced mortality from 22.6% to 13.7% in Cambodia and Iraq [265].
- Review to assess the impact of training of ambulance crews in advanced life support (ALS) versus crews without ALS training on reducing mortality and morbidity in trauma patients revealed that none of the reviewed RCTs demonstrated evidence to support ALS training for pre-hospital personnel. In the uncontrolled before-and-after study, “a priori” sub-group analysis showed an increase in mortality among patients who had a Glasgow Coma Scale score of less than nine and received care from ALS-trained ambulance crews [266].
- Trauma outcomes before and after the institution of the Advanced Trauma Life Support (ATLS) for the largest hospital in Trinidad and Tobago were assessed for all dead or severely injured patients (ISS > or = 16). Trauma mortality decreased post-ATLS training of physicians (33.5% from earlier 67.5%) throughout the hospital, including the ICU (13.6% post-ATLS vs. 55.2% pre-ATLS). Reduction in mortality was observed across different ISS categories as well. For each ISS category, mortality was greater in the pre-ATLS group (ISS > or = 24 pre-ATLS mortality 47.9% vs. 16.7% post-ATLS; ISS 25-40 pre-ATLS mortality 91.0% vs. 71.0% post-ATLS). ATLS training for physicians as an intervention helps to reduce trauma mortality [267].

Trauma care in India is largely an urban phenomenon due to misdistribution of resources and facilities. Quality trauma care facilities are still skewed towards urban areas, private sector hospitals, thereby resulting in huge out of pocket expense and unrecoverable debt in many cases. Trauma care is largely delivered by nearly 763 district hospitals, 462 medical college hospitals, trauma care centers and thousands of smaller primary care health institutions in rural parts of India. Interestingly, these resources are spread over public and private care agencies without proper guidelines and coordinated mechanisms. A complete evaluation of these institutions has not been done till date to assess their performance for quality trauma care.
Despite the enormity of the problem, attempts to strengthen road safety in India have been limited till recent times. Reasons for this are several and discussed in various platforms. This scenario has begun to change and an understanding of all possible reasons is vital to overcome the limitations and to build a strong foundation.

- Traditionally and for too long, RTIs in India are considered as human, behavioral, legal and transport issues undermining its health implications and impact on individuals, family and society. As a public health problem, it has not drawn the attention of all decision makers as noticed for other health issues. Even within health, only trauma care has gained attention.

- Road safety has not been considered and developed as a scientific discipline and has remained as a fringe discipline across transport, health, engineering, law and other disciplines. Consequently, decisions in road safety have been ad hoc, unscientific and knee jerk reactions embracing public populism.

- Lack of comprehensive and good quality national – state data that can drive road safety policies and programmes has been missing. Information that is critical in terms of burden, impact, risk factors, interventions and the larger policies and programmes is totally absent consequent to which road safety decisions have not been effective nor yielded any results.

- Macroeconomic and developmental policies and programmes in many sectors of transport, urban development, industries and others have not assessed the impact of their policies on health of people. On the other hand, health professionals have also not shown keen interest in measuring this impact over time.

- As road safety is the shared responsibility of nearly 15 – 20 ministries and departments at both centre and state levels, a responsible agency that can guide, support, facilitate, coordinate, fund, implement, monitor, evaluate road safety activities has been absent in India.

- Comprehensive national or state road safety action plan(s) with clearly defined activities, targets, coordination, implementing agency, funding, timelines, monitoring steps, indicators and others with a common vision and convergence of actions is largely missing.

- Larger coordination mechanisms between different ministries at the centre, between centre and state, and between different agencies at state is largely absent, thereby resulting in lack of programme implementation and inordinate delays.

- Till date, there is no dedicated ring fenced funding for road safety and a loose mechanism between centre and states operates in specific areas with funds made available as and when required.

- Human resources across a wide range of areas covering health, transport, police, law, vehicle and road engineering are grossly inadequate to meet the requirements. Road safety human resource development activities are restricted to few centers in the country.

- The legal frameworks to address road safety have been weak and coordinated mechanisms do not exist till date. Most states are yet to notify crucial legislations with regard to helmets, drink driving, speed and others. The Motor Vehicles (Amendment) bill 2016 is still awaiting approvals as on April 2017. The need for wide ranging consultations are crucial, but the process has been time consuming and lengthy.

- The enforcement machinery at the state and district levels is weak and lax in terms of human resources, technology, penalties, and enforcement process and burdened with multiple tasks with limited focus on enforcing road safety legislations.

- In the absence of proper road safety research, the emphasis for long time has been on fixing human errors through awareness and punitive programmes without realizing that road safety requires systematic and scientific inputs to make roads and vehicles safe, systems need to be built, responsibilities have to be shared and system limitations need to be overcome. With major efforts on changing human behaviours through sporadic and isolated efforts, the results are evident as seen with increasing number of deaths, injuries and disabilities.
• Even within health sector, emphasis has been on strengthening care that too in tertiary care. With care being provided to nearly 5.25 million injured, proper data collection systems in terms of regular reporting systems, surveillance, registries and even on different components of trauma care are totally missing.

• Societal perceptions and participation are important contributors of road safety programmes. With the popular perception that road crashes don't happen to me, societal participation has been limited to attending public awareness programmes.

• Lastly and most significantly, monitoring and evaluation of road safety activities has long been overdue. Every intervention whether in terms of policy or an intervention, needs to be monitored and measured for its impact and outcomes on road safety scenario that has been missing.

Salient features on Report of Working Groups on Road Safety

The Ministry of Road Transport & Highways had formed five separate working groups on four E's of Road Safety viz. (i) Education (ii) Enforcement (iii) Engineering (roads as well as vehicles) and (iv) Emergency care to lay out the macro and micro dimensions with potential solutions to road safety and to suggest short term and long term measures to curb road accidents in the country (Nov 2011). The aim was to develop a comprehensive plan to reduce number of road accidents and fatalities to half in the year 2020 [268].

Select key recommendations are listed below

• Education: Formulate National Road Safety Policy and supporting laws, establish and strengthen State and District Road Safety, devote 50 percent of all fines collected to road safety activities and implement separate Road Safety Education and Awareness programmes.

• Engineering: Implement signages and road marking in highways as per standards, conduct road Safety Audits in highways, implementation road safety engineering measures (speed management, service roads, pedestrians/cattle crossings, truck lay bays and Closure of unauthorized median openings. Research on road safety and setting up Centres of Excellence.

• Emergency care: Review & Audit of the Existing Schemes, enunciate a National Accident Relief Policy & a National Trauma System Plan and deployment of a Pan-India Pre-Hospital Emergency Medical Care Network. Ensure availability of one emergency care facility at every 50km along the national highways. Capacity building and regular training in EMS to all involved in trauma.

• Enforcement: Key enforcement interventions include amendment of Motor vehicles Act, strengthen laws related to safety belts and drunken driving, database of violations, digitization of licenses, GPS in commercial vehicles, traffic management systems in cities etc.

Ongoing initiatives

Acknowledging the existing barriers, gaps and challenges, slow pace of reforms in the past, limited impact and effectiveness of past interventions and realizing the huge loss of enormous deaths and injuries, recent years have seen the growing importance of road safety in India. These initiatives are based on some learning's, past failures, international experiences and need to drive road safety for the coming years. Apart from larger national initiatives and select state developments, few visible programmes and promising initiatives have also come up in few cities across the country. The public demand for road safety has also grown as seen with proponents and opponents views on select topics of debate. The combined effect of all these has been the felt need to scale up road safety initiatives in recent times. Need to recognize that these have not been uniform across states or districts and it is hoped that these developments will get strengthened in the coming days. Capturing all such ongoing efforts is once again difficult and few are highlighted below.

• The most visible and significant development has been the passage of the Motor Vehicles (Amendment) Bill 2016 by Lok Sabha and awaiting approval of Rajya Sabha as on 10 April 2017. The MoRTH has issued several guidelines in the past and the passage of an amended act will be a big boost for road safety in India. The bill has 92 clauses with 16 new insertions, 4 omissions and 72 amendments. The bill has been debated and discussed and is likely to undergo further discussions before it is passed. The bill has many provisions with regard to establishing a road safety board (as the lead agency), stiff penalties for traffic violators, driver licensing and training reforms, fixing accountability for road builders and vehicle manufacturers, revised compensatory mechanisms for accident victims, good Samaritan law and several others. The timeline and developments till date are shown in Figure 53.
MORTH has also introduced a new accident data collection and reporting format in March 2017 to strengthen data collection practices and training programmes are underway for implementing the same [120].

Nearly 20 Indian cities are also investing heavily in developing mass transport systems like Metro systems to promote transport services that will also have an effect on road safety.

In case of a crash with the driver not holding a valid DL, the owner of the vehicle is held responsible for the crash and is liable to pay penalty as per the
Motor Vehicle act 1988. The recent supreme court order on Sept 24th 2008, directed that if a minor causes an accident, the parent is responsible for the act and is liable to pay compensation as directed by the court to the victim/kith and kin of the deceased.

- As early as 2002, the court issued directives to install speed governors- a device installed in commercial vehicles to measure and regulate speed [170]; most states are yet to comply with the same. Karnataka, Jharkhand, Haryana and Odisha have initiated the process. Further in April 2015, the Centre issued a notification making it compulsory for all new commercial vehicles to have speed governors by October, 2015 and all older vehicles to be equipped with them by April 1, 2016. The Supreme Court too, in October 2015, ordered its implementation and extended the deadline for older vehicles to comply with the order by July 1, 2016 [170].

- To curb the menace of drink driving, based on a public interest litigation filed by a Punjab based NGO, the court banned all liquor shops within 500 meters of national and state highways across the country. These directions issued under Article 142 of the Constitution specifies that licenses of existing shops are not to be renewed after March 31, 2017[269], extended to September 2017. The order also specifies that states shall forthwith cease and desist from granting licenses for the sale of liquor a long national and state highways. The current order also extends to and include stretches of such highways which fall within the limits of a municipal corporation, city, town or local authority; all signages and advertisements of the availability of liquor shall be prohibited and existing ones removed forthwith both on national and state highways. No shop for the sale of liquor shall be (i) visible from a national or state highway; (ii) directly accessible from a national or state highway and (iii) situated within a distance of 500 meters of the outer edge of the national or state highway or of a service lane along the highway. All states have been directed to comply with and monitor implementation on strict terms. Wide ranging discussions are ongoing at the state level considering the economic fallout of this decision.

- Hon’ble Supreme court of India vide judgment dated 16/12/97 in WP (Civil) 13029 of 1985 in the case of Sh M C Mehta VS Union of India, issued orders for safe plying of school buses and to ensure safety of school children travelling in buses. Rules prescribe nature and specifications of transport vehicle to be used, permit regulations, seating capacity, presence of first aid box and seat-belts. Driver of school vehicles should have minimum 5 years experience and no history of traffic offences [270].

- Beginning with the landmark judgement in Pt.Parmanda Katara vs Government of India in 1986, the situation with regard to Good Samaritan law based on ground realities had not changed because of the failure to implement the same. To protect bystanders (good Samaritans) from harassment and to promote more and better Samaritans to come forward willingly to help trauma victims, a Good Samaritan law was a felt need. A Good Samaritan is a person who, in good faith, without expectation of payment or reward and without any duty of care or special relationship, voluntarily comes forward to administer immediate assistance or emergency care to a person injured in an accident, or crash, or emergency medical condition, or emergency situation. [61]

- In 2012, Save LIFE Foundation, an NGO, filed a Public Interest Litigation (PIL) in the Supreme Court of India, requesting the Hon’ble court to safeguard Good Samaritans coming forward to help the injured. On March 30, 2016, the Supreme Court of India gave ‘force of law’ to the guidelines for the protection of good Samaritans issued by the Ministry of Road Transport and Highways. The Gazette of India published the same on May12th 2015 and the state of Karnataka has become the first state in India to come out with legislation for the Good Samaritan law [61].

- Good implementation of the law requires the creation of better awareness among the public through programs, directives by the concerned ministries to change existing practices, cooperation from police and hospitals to implement and mechanisms to monitor progress.

- The standards and guidelines for safe road development in India have been provided by the Indian Road Congress, Indian Road Research Institute, Bureau of Indian Standards, National Highway Authority and other agencies. The recent guidelines also make road safety audits mandatory for all new roads.

- Recently, the Government of India, has decided to mandate incorporation of Anti-lock Braking system and Combined Braking System in all two wheelers irrespective of the engine capacity by April 2019 [271].

- The Government of India has issued a notification to all manufacturers to have Automatic Head lamp On (AHO) in all two wheelers manufactured from April 2017. The AHO makes the headlamp come on automatically when the engine is turned on and stays lit till the ignition is put off. This helps to improve the visibility of two wheelers and is proven to be efficient in reducing road crashes [272].
As India still lacks a New Car Assessment Program (NCAP), though the 11th five-year plan provides for the establishment of 11 vehicle inspection and development centers throughout the country, under the guidance of ARAI, Pune, 2-3 such facilities are coming up in Trivandrum and Manesar, respectively.

All cars manufactured in India are expected to comply with Bharat four stage (BS-IV compliant) and no vehicles with BS-III would be sold by auto companies from April 1st 2017.

Health sector has also initiated a few programmes like National Highways Trauma Care Project (NHTCP), National Highways Accident Relief Services Scheme (NHARSS), NHAI Incident Management System, Operational guidelines for trauma care on national highways, proposal of a uniform number for emergency care, increasing number of ambulances under 108 programmes, recognition of emergency medicine as a speciality, and several others.

An expert group constituted by Ministry of Health and Family welfare, Government of India in 2014 recommended the development of National Accident relief Policy – free accessibility to trauma care for all; Hospital based Emergency Medical Care (every 50 kms); Capacity building and training of trained emergency medical technicians (EMTs); Research and development in post crash response as well as cross linkages with other departments/groups.

The growing costs of trauma care that result in greater referrals and loss of precious time necessitated government of India to introduce pilot cashless insurance schemes for victims affected by accidents. An evaluation of this has shown positive as well as beneficial effects in terms of time and costs and referrals.

States like Karnataka have also introduced “Mukhya Mantri Santhwana - Harish Scheme on somewhat similar lines for management of accident victims.

The implementation of all these initiatives, scaling up of programmes and strengthening related road safety mechanisms is directly dependent on establishing implementation mechanisms at national and state levels. The implementation of these measures happens in Indian cities and districts. The process of implementation lies in building consensus between centre and states, establishing appropriate institutional mechanisms, engagement of agencies in enforcement, use of appropriate technology, availability of human and financial resources, and other measures; all these needs to be strictly monitored to see visible changes in road safety. Future evaluation studies should reveal the efficacy and effectiveness of these interventions and initiatives to see visible changes in road safety scenario in India.

### Trauma care services in India

#### Emergency Care in India’ set up by the Ministry of Road Transport and Highways’ emphasizes developing

1. National Accident relief Policy – free accessibility to trauma care for all
2. National Trauma System Plan- efficient and cost-effective inclusive trauma system
   - a. Pan India Pre Hospital Emergency Medical Services Network (EMS)
   - b. Hospital based Emergency Medical Care (every 50 kms)
     - Health facility networking
   - c. Capacity building and training of trained emergency medical technicians (EMTs)
   - d.
3. Research and development in post crash response
4. Cross linkages with other departments/groups
Given the knowledge that RTIs are predictable and preventable, recent developments in India, commitment of political leaders, policy makers, professionals and the public on variety of platforms, the time is appropriate to move towards a system building endeavor for road safety in India. Efforts till date have focused on individual, short term and limited impact approaches rather than sustainable strategies and efforts. It is amply clear and evident that "no single solution is enough" and requires"multisectoral actions that are data driven and implemented in true spirit". Undoubtedly, this requires Consensus building, Greater Coordination, Convergence in actions, and Critical inputs by all stake holders to implement policies and programmes.

In such a scenario, a framework for road safety that broadly delineates various activities and components is required for the consideration of parliamentarians and policy makers. Development of such a framework is the beginning of activities and not an end by itself as it lays down "what needs to be done in India in the coming days to save lives".

India being a federal state, the roles and responsibilities is the shared responsibility between centre and the state. Hence, there needs to be a framework for activities at the central level with corresponding activities at the state level. Furthermore, at the state level, implementation of many activities is also subject to coordination between state and districts, as the last point of implementation of all activities on the ground are the Cities and districts of India.

It is essential to highlight that the activities and components provided in the framework are neither hierarchical nor exhaustive and is not all inclusive. In overall terms, they indicate the wide range of activities rquired to promote, strengthen and implement road safety activities at national and state levels. Prioritization of activities should be considered at the highest level by concerned ministries/departments based on global understanding, evidence basis, technological availability, existing expertise and capacity, required finances and current administrative and legislative frameworks keeping the principles of sustainability and cost effectiveness.

Lead national coordinating agency for road safety is an absolute necessity at national and state levels

To move the road safety agenda forward, there is a need for Commonality in vision, Convergence in action, Consolidation of resources, Clearly defined roles and responsibilities, as well as Common objectives and programs. Intersectoral mechanisms for road safety is critical to speed up activities, share resources, and bring convergence in action. It is essential to realize that each intervention strategy has multiple arms, several partners, and needs one mechanism for implementation. The proposed National Road Safety Board with similar bodies at state levels is critical for all future activities. This body should be provided adequate authority, power, finances and run by professionally competent teams to carry out its responsibilities. Some actions required to be performed by such an agency would include:

- Formulating well defined road safety policies, setting goals, and elaborating strategies;
- Guiding the national road safety effort
- Making appropriate evidence-based decisions
- Setting standards, guidelines, protocols and mechanisms for all road safety activities
- Coordinating efforts by all governmental and nongovernmental agencies
- Managing and commissioning specific road safety activities
- Obtaining, generating and funding road safety activities
- Compiling and analyzing national statistics
- Ensuring data and evidence are available for road safety planning
- Monitoring implementation process and facilitating actions and
- Evaluating efficacy and effectiveness of implemented interventions
Scientific road safety policy (ies) are essential

A policy is a statement of intent and sets out a road map for activities. A national road safety policy with clearly stated objectives with defined subcomponents of action plans and mechanisms for implementation that moves beyond a simple statement of intent needs to be developed by revising the existing road safety policy. National and road safety policy statements should move beyond terms like “education will be done for all road users” to more defined terms. In addition, road safety components should be implemented and integrated in all existing national level policies and programs of urban development, transport, health, welfare, infrastructure, education, and other national and state policies. Specifically, a National Road Safety and Injury Prevention Policy in India is necessary to

- Obtain and raise political commitment
- Identify and articulate principles that should justify and guide action
- Generate a consensus vision on the future actions to be undertaken
- Provide a framework for action
- Engage all partners and stakeholders toward a common goal
- Highlight roles and responsibilities of individual partners
- Evolve mechanisms of coordination
- Provide mechanisms for specific funding for road safety activities
- Rationalize the use of the resources and reduce duplication of efforts
- Identify measures which are likely to produce good results
- Set attainable and measurable targets for action and
- Monitor progress and effectiveness of strategies

Road safety funding is critical

Road safety needs dedicated funding, and current mechanisms are ineffective to address this issue as there is no dedicated ring-fenced budget for road safety in India. (All state governments collect huge amounts just from violators of traffic rules by issuing challans and are considered for revenue generation). Currently, limited activities are carried out within the available budget, often subject to availability within each ministry and department. Even the allocated budget in health is largely for acute hospital-based trauma care and these are utilized for the construction of new hospitals and purchase of hi-tech equipments. Financial resources are required for the preparation, developing, implementation, and evaluation of road safety programs. Many previous expert groups have suggested several mechanisms like cess on petrol, road tax, violator’s money, corporate social responsibility, and insurance funds for road safety funds; and in recent times, public-private partnership is being promoted. As it exists in other programmes, dedicated funding at central and state levels are critical for success of road safety.

Capacity strengthening and human resources for road safety

Enhancing knowledge, developing skills, and strengthening systems and structures in which road safety can be implemented that will have a larger impact are an important requirement for road safety. Specific human resource development programs within each sector are required and should include

- Identifying regional institutions in the country as national resource centers
- Capacity strengthening of policy makers, decision makers, and professionals in police, law, health, and other ministries at national and state levels through short-term sensitization activities
- Short-term training programs in selected and focused areas for professionals in health, police, transport, urban development, and other sectors
• Networking for capacity strengthening and human resource development within and across ministries, departments, institutions and agencies

• Strengthening and inclusion of road safety across a wide variety of disciplines in undergraduate and post-graduate courses in all related disciplines

• Greater dissemination of WHO Teach VIP and Mentor VIP programs across medical and allied disciplines

**Road safety advocacy**

A combination of individual and social actions is required to gain political commitment, policy support, social acceptance, and developing systems for road safety and injury prevention and control programs, especially for implementation at state level. Advocacy is required for

• Positioning road safety and injury prevention on the public health agenda

• Mobilizing specific influential individuals, constituencies, and/or the public to take action

• Influencing agenda-setting, policy design and implementation, and resource mobilization

• Lobbying with the governments and private partners at national and local levels to take all possible actions.

**Strengthening data for road safety is an absolute requirement**

A well-designed road accident information system is a prerequisite for India to

• Develop evidence-based comprehensive road safety policies and programs

• Quantify the burden of road crashes and to track changes over time

• Understand regional and local distributions

• Identify characteristics of crashes, risk patterns, and risk locations

• Identify modifiable risk factors within roads, vehicles, and road users

• Delineate high-risk locations within areas

• Targeting road safety interventions to defined categories

• Measuring the impact of interventions over time, and

• Monitoring trends and progress over time

Data management involves several steps of systematic data collection – analysis – scientific interpretations, and utilization. It is essential to note that different types and levels of data are required at national, state, and local levels for specific and defined purposes. National level data are required for larger policy, planning, investment, monitoring and evaluation purposes, while state data are required on all these and several others to identify areas for population level interventions. Ultimately, local data for local agencies are required for action at district and city levels. For example, information of accident black spots and on helmet use is more essential at state and local levels, while larger number of deaths on highways is useful for improving safety on all national and state highways. Consequently, it is essential to delineate data collection mechanisms. The recent MoRTH proposed data collection format and reporting mechanisms should be examined for completeness, coverage and quality. While the efforts are laudable, it needs to be supplemented with systematic training of police at all levels, timely reporting and scientific analysis along with timely dissemination for continuous action. Furthermore, police reporting systems need to be supplemented with data from in-depth crash investigation and analysis with the involvement of academic and research institutions. In addition, data from health sector through surveillance, registries, population studies and hospital information systems is vital to delineate specific interventions. Focused research activities can be undertaken within all sectors to identify and define selective issues. Collaboration of government departments as well as researchers with different knowledge and skills drawn from universities and academic institutions in engineering, health, transport, urban management, and others should be promoted with financial and human resources. In addition, a centralized agency at the national and state level is required to collect, compile, analyze, disseminate, and evaluate road crash data derived from all sources for providing policy and program inputs.
Bangalore Road Safety and Injury Prevention Program (2007-2012)

The Bangalore Road Safety and Injury Prevention Program (BRSP) supported by WHO and ICMR and implemented by the WHO Collaborating Centre for Injury Prevention and Safety Promotion at NIMHANS is a unique attempt to strengthen road safety programme through integrated public health approaches. It was a collaborative activity between Bangalore City Police, 25 leading hospitals, city transport department, City civic administration agencies and NGO's with the broad goals of developing – implementation – and monitoring road safety programme in a continuous and integrated manner based on data and evidence. Unlike other adhoc short term road safety activities this program aimed at establishing a well-coordinated system based on a surveillance approach.

The Beginning

Following a national workshop organized by ICMR in 2007, it was recommended that surveillance programmes should be established that will drive road safety and injury prevention activities. The programme initiated in Bangalore and pune, was continued only in Bangalore. The workshop developed some broad guidelines for developing programmes.

Stake holder’s engagement

A stakeholders consultation represented by police, BMTC, Transport and 25 hospitals was held at NIMHANS, Bangalore on Feb 3, 2007. The meeting reviewed the current scenario with regard to RTI and other injuries and agreed on developing a programme that will be based on data collected at local levels, prioritization and continuation of activities, regular feedback to all stake holders, annual review of all road safety activities and monitoring the progress of work.

Surveillance

Two types of surveillance formats were developed for fatal and nonfatal RTIs and other injuries, respectively, to be used in all 34 police stations and 25 selected hospitals. The data formats were finalized in joint consultation with stake holders with regard to content and process of data collection. The decision was to collect small quantities of good quality data that are essential for road safety and injury prevention activities. It was felt that this process could be supplemented with additional research activities based on the need and purpose.

Starting with a feasibility study, data collection was initiated from April 2007 from both police and hospital sources in a prospective manner as shown in the figure. Information on all road deaths was extracted by trained research officers using validated data formats from all police stations in the city. Beginning with a paper – pencil format, this was later transformed to online formats with support from National Informatics Centre. Subsequently, two persons in each police station were trained in data extraction and online submission to a central server over several rounds. Non fatal injury data was collected from selected 25 hospitals (who were invited and agreed to participate) on a regular basis. The paper versions of forms were completed by nursing staff / medical records person or at times by the designated duty doctor in the emergency room (except a few centers where the coordinating centre staff took up the responsibility as the casualty staff is overloaded with patients). Quality checks were ensured with manual checks and comparison of transferred data and reviewed for completeness and quality of data.

Data pooling

In addition to routinely collected data, relevant information was collected from BBMP hospitals, transport department, welfare department, public works department and Census and a centralized mechanisms was developed for data management purposes.
Monitoring and quality checks

Ensuring good quality and reliable data collection required conducting several rounds of training to computer programmers in police stations and hospital staff to ensure uniformity. These programmes were conducted almost every month in the beginning and at periodical intervals later by working with designated officials in respective institutions. The training focused on purpose of the programme, nature of information being collected, coding patterns and ensuring safety of completed forms. The police training (35 traffic and 103 law and order stations) was done using local data and in colloquial terms, clearing all doubts arising therein. In hospitals, the casualty staff (nurses) and medical records personnel were trained in data collection, storage and its utilization.

Data management and feedback

The coordinating center also undertook data management, analysis and reporting responsibilities. The data was analysed regularly and summary information was provided to all partners at 3 monthly intervals. In addition, a complete collaborative report was published annually and a stake holders consultation was held every year. These meetings reviewed data from the previous year, identified action areas for the successive year and identified stake holders or joint mechanisms for implementation. In addition, all data of respective institutions was made available to the coordinating officer to be used for academic and research purposes. Furthermore, data was made available to all stake holders as and when asked for. This process further strengthened data collection mechanisms in the upcoming years and several more institutions were willing to join the programme.

Strengthening implementation

A key strategy identified during the stake holders consultation was to scale up enforcement of key road safety legislations by city police. The goal was to expand and intensify legislations with regard to helmet use, seat belt use, drink driving, cell phone use and reduce speeding. To strengthen capacity, knowledge and skills of enforcement officials, training programmes were held for police officials in middle and higher ranks to focus on public health benefits of enforcement as well as the need for people friendly practices. These programmes were continuous and integrated with regular training of police officials at the Traffic Training Institute. Most interestingly, the training was based on local data and to be enforced by local enforcement officials using a roster method.

Advocacy activities

Number of advocacy activities with the support of locally trained media was undertaken using local data on a regular basis. Apart from political advocacy, these were also aimed at number of professionals from diverse disciplines. In addition, campaigns to promote helmet and seat belt use as well as reducing drink driving were conducted at periodical intervals. Several newspaper articles and TV programmes on road safety were developed and aired to the public. These activities were continuous and undertaken at regular intervals.

Strengthening trauma care services

Using the data collected in hospitals, hospital administrators were encouraged to undertake training programmes for nurses, medical officers and trauma care physicians in the emergency rooms to improve quality of care, introduce protocols for management and to reduce referral of injured persons. Several major hospitals strengthened their activities during the programme implementation period.

Expanding research

To supplement routinely collected data, focused research activities were undertaken by the coordinating centre. These include a study on road crashes involving public transport BMTC buses, population based observational surveys on helmets, seat belts and drink driving, key information interviews with stake holders, expanding surveillance to the neighboring district of Tumkur, and review of trauma care facilities. Data of these supplementary studies was fed into and integrated with the main programme.

Capacity strengthening programmes

In addition to empowering city police and health professionals, the programme also undertook sensitization programmes for road engineers and journalists. Many road safety information materials were circulated amongst stake holders and made available to all members.

Monitoring the programme

An inbuilt monitoring mechanism was developed in the program at every level of data collection. In hospitals and ERs the data collected was cross checked
with medical record statistics to ensure coverage all cases and to fill in if any data was missing. The periodic meeting with nodal officers helped to identify the problems and remedial measures and ensured better cooperation for better data collection. The programme was monitored through a set of simple indicators that were mainly aimed at improving different programme components. The progress made on these indicators was reported during stake holders annual meetings.

Lessons learnt

The 5 years of Bangalore Road safety and injury Prevention Programme aimed at developing integrated – data driven – participatory and continuous road safety activities in Bangalore City. The major strength of the programme was its ability to develop data driven programmes at city level to be used by local agencies for scaling up implementation, integration of different programme components, strengthening capacity of all stake holders, strong road safety advocacy and systematic monitoring of all activities. The challenges were several in different administrative, financial, technological and other domains with the primary one being the absence of a responsible agency for road safety at state and city levels.

Recommendations

Injuries are multi factorial in causation multiple approaches through intersectoral coordination are required. Programme recommends strengthening of surveillance, need for capacity building, systematic training, advocacy, increasing public awareness, facilitating interventions, and monitoring of all activities. It also expresses the need for more research activities to be undertaken for risk factor delineation and finding solutions through both ongoing and new activities.

Defined and targeted programmes are effective

Based on the availability of good quality data, there is need for programs toward safety of vulnerable road users by focusing on targeted interventions like road design and changes, vehicle safety, speed reduction, helmet use, seat-belt use, preventing cell phone use, drinking and driving, pedestrian safety, emergency and trauma care, and other areas. This requires a combination of implementation strategies like awareness and campaigns, strengthening and implementing legislations, training of police, transport, health, and others to implement interventions, promoting use of technology, improving public awareness, overseeing implementation along with monitoring and evaluation. Programs should be clearly developed in targeted areas for road safety with objectives, identified strategies, chosen interventions, mechanisms of implementation, intersectoral mechanisms with shared responsibilities, and timelines along with indicators. The programs should be specific, focused, and targeted (eg., highway safety programmes, reduction of drink driving programme, child safety programme, etc.,) to achieve desired results. Individual components need to be worked out in detail for the same.

Choosing the appropriate interventions

A growing body of knowledge exists based on the experience of HICs in the last two to three decades. A detailed outline of interventions is beyond the scope of this report and a few examples as effective interventions are given in Table 30.
While considering the choice of interventions, the focus should be on:

- Laying a greater focus on passive interventions and combined countermeasures through integrated approaches.
- Adequate scientific information on importance, scope, and feasibility of implementing interventions.
- Developing a strategy and implementation plan for each intervention.
- Undertaking advocacy activities for people to accept laws and changes.
- Ensuring sustainability of interventions.
- Supporting the intervention with data for needs assessment and monitoring.

Implementing road safety legislations is the key

Legislations are an effective tool to address road safety. Legislations have the unique power to focus on safety, decide on procedures, fix penalty levels, and are uniformly applicable to all. However, it has to cover all areas and be less ambiguous and uniformly applicable to the country as well as individual states. Furthermore, mere legislation is of little help and should be implemented by all concerned stakeholders at national and state levels and accompanying guidelines are critical. Global experience and past lessons from India indicate that legislation and enforcement should deter people (through police presence, appropriate checks, and reasonable penalties) from taking unsafe and risky behaviours. The federal nature of government in India allows for changes and modifications in the interpretation of laws and brings in laxity in implementation. With the revision of the Indian Motor Vehicle Act and proposed amendments in final stages of approval, state wise implementation mechanisms are required. Effective implementation on the ground requires necessary guidelines, sensitization and training, use of technology, support from judiciary, public information and awareness and uniform - random - visible activities on the ground.

Intersectoral approach – key to success

As RTIs are multifactorial in nature, road safety requires multisectoral actions. Cooperation between ministries and departments at central and state levels and convergence of actions is critical for road safety. Road safety is the collective and joint responsibility of government, ministries, industry, international organizations, and the community. It requires active support and participation of Political leadership, Policy makers, Professionals from health and related sectors, Public at large, and the Press. The approach calls for recognition of roles and responsibilities in different sectors and identifying a unified way to address the problem. The single most demonstrated way of building intersectoral approach is through the development of an independent road safety lead agency with authorized powers, mandate, funding, and should have the powers to implement programs that are driven by data and evidence.

Integrated approaches

Developing and implementing all measures to see that road crashes do not occur in the first place are called primary prevention approaches (e.g., legislation for speed control, enforcement for pedestrian safety, etc.). Secondary prevention aims at the provision of early care for the injured (e.g., prehospital and

### Table 30: Examples of effective interventions in road safety

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing the legal age of motorcyclists and drivers from 16 to 18 years</td>
<td>Effective</td>
</tr>
<tr>
<td>Enforcing motorcycle helmet laws</td>
<td>Effective</td>
</tr>
<tr>
<td>Graduated driver licensing systems</td>
<td>Effective</td>
</tr>
<tr>
<td>Traffic-calming measures</td>
<td>Effective</td>
</tr>
<tr>
<td>Daytime running lights on motorcycles</td>
<td>Effective</td>
</tr>
<tr>
<td>Introducing and enforcing seat-belt laws</td>
<td>Effective</td>
</tr>
<tr>
<td>Child-passenger restraints</td>
<td>Effective</td>
</tr>
<tr>
<td>Enforcing drink-drive laws</td>
<td>Effective</td>
</tr>
<tr>
<td>Speed control measures</td>
<td>Effective</td>
</tr>
<tr>
<td>Restricting use of cell phones while driving</td>
<td>Effective</td>
</tr>
</tbody>
</table>
emergency care), while tertiary prevention addresses rehabilitation services for those injured.

- Primary prevention includes better design and use of roads, vehicles, and products along with legislative and regulatory approaches combined with public awareness activities.
- Strengthening emergency and prehospital care in terms of coverage, quality, and delivery is crucial to save lives.
- Rehabilitation needs a greater thrust to bring back the injured for optimal functioning.

Delivery and implementation of these approaches need a judicial and cost-effective combination of Engineering (vehicles/roads/products), Enforcement (safety laws and regulations in all places), and Education (incorporating safety behaviors in day-to-day practices) along with timely Emergency care. Combined approaches and passive countermeasures are found to be beneficial in the long run.

**Strengthening trauma care services**

Efficient trauma care soon after the occurrence of injury can result in significant decline in mortality and reduce disabilities [202]. Preventing secondary injuries after occurrence of injury requires development of good-quality emergency and prehospital care. Some strategic approaches include development of

- Efficient trauma care systems through trauma care guidelines
- Basic first-aid courses for health and first-aid responders in the community like police, teachers, commercial vehicle drivers, students, and others in a prioritized manner
- Strict implementation of Good Samaritans Act at peripheral levels
- Safe transportation services that can deliver basic care and early transfer of injured persons to definitive hospitals
- Minimum guidelines and standard operating procedures for management of persons that are followed in different in all health care institutions
- Training of emergency care physicians and nurses in a uniform manner along with provision of required facilities with a combination of ATLS and BTLS programs
- Introduction of trauma audits in all major academic institutions
- Costs of trauma care to be addressed through the involvement of health, judiciary, and insurance sectors along with evaluation of ongoing pilot projects
- Developing national trauma registry in select institutions.

**Rehabilitation of the injured**

Advances in technology, diagnostics, and management of injured has resulted in greater survival of injured and has also increased the disability load on the society. Nearly one-third of disabilities are because of injuries. Every injury results in physical, social, or emotional disability, resulting in poor quality of life among the survivors. There is no data available to examine the rehabilitation needs of injured persons in India. Strategic approaches include:

- Undertaking an assessment of the situation with regard to the burden of disabilities and availability of services for injured.
- Strengthening availability of services at district level with human and financial resources

Supporting the injured with appropriate welfare measures and increasing opportunities in education and employment.

**Empowering the civil society**

In India, there are few Civil Society Organizations like Save Life Foundation, SAFE, IRTE, Arrive SAFE, Muskaan, Indian Federation of Road Safety, and others working to promote and strengthen road safety. NGOs at different levels both within and outside the health sector, including those from social welfare, education, and others can be involved effectively as they are closer to communities, work at local levels, and are in a better position to influence interventions at different levels. NGOs can help in advocacy, campaigns, increasing awareness, and community participation.

**Promoting community participation**

Participation of Indian society is crucial for the success of road safety. In many HICs, people demand safety on roads as road deaths and injuries are found unacceptable. By demanding safety from governments, people can exert pressure on national and local governments to provide safe roads and vehicles and help in designing safe traffic environments. The special needs of children, elderly, and other vulnerable members can be highlighted and brought to the notice of governments by working with NGOs. This process of community participation requires educating communities to demand and promote road safety by moving beyond mere provision of information on few behaviors.
Monitoring and Evaluation

The word “Monitoring,” though used commonly in road safety parlance, is the regular and systematic observation and recording of activities by routinely gathering information on all aspects to ascertain progress. The quintessential question in monitoring of road safety situation is the delineation of indicators which are timely, valid, reliable, sensitive, and specific, keeping in mind the available data sources and resources. Road safety monitoring indicators further depend on the properties of existing or new data sources in terms of availability, accuracy, timeliness, recording methods, transfer of data, periodicity of transfer, notification, and others. The WHO Road Safety Data Systems manual specifies various indicators for monitoring road safety situation. These include:

- Safety performance indicators (speed, alcohol, helmets, vehicle safety, trauma care)
- Outcome indicators (deaths, accidents, injured, disability)
- Indicators related to medical, social, and economic costs (medical costs, loss in productivity, socio-economic costs, etc.)

**Figure 53: Data systems for road safety**

Monitoring through select indicators requires continuous data from multiple sources based on uniform definitions. From an Indian context, the non-availability of good quality, reliable, and valid data precludes from drawing any conclusions on monitoring of the road safety scenario. There is a greater reliance on only mortality (deaths) and morbidity (injuries) indicators, and even this does not go beyond comparisons in national reports amidst issues of underreporting, as there is no single nodal agency for road safety monitoring in India. Mortality recording and validation has scope for strengthening data collection in both police and hospital sources along with data pooling from multiple sources at police stations and hospitals, using standardized methods. With the implementation of the road safety bill in the near future at central and state levels, the scenario could improve.

Evaluation refers to an assessment of input, process, and outcome indicators in relationship to stated objectives of the program by examining how the implemented activities have affected the outcomes as well as their impact in the short, medium and long term. Evaluation should show changes in crashes, deaths, disability, hospitalizations, and economic benefits to the country as interventions get implemented. Evaluation focuses more on outcome indicators and impact indicators (effect on program on long term within and beyond the sector). Evaluation projects or systems are required to understand the cost-benefit and cost-effectiveness of interventions in a comparative manner.
Multiple road safety interventions are being implemented (road engineering, widening, segregation, vehicle safety, helmet legislation, drunk and drive enforcement, trauma centers, and insurance to name a few) and all these needs to be evaluated for efficiency, effectiveness, sustainability and cost effectiveness.

Role of health sector in road safety and injury prevention

The objectives of health systems are to promote health, prevent illness, impart care, and improve quality of life. In road safety and injury prevention the objectives will be to promote safety, prevent injuries, provide timely care, and improve quality of life of those afflicted. To deliver these, the health sector spends an enormous amount of resources for investigation, hospitalization, management, rehabilitation, judicial processes, documentation, and several other components. Due to difficulties in assessment and lack of monitoring costs, the burden on the health sector is not clearly known.

With the understanding that RTIs are predictable and preventable, the role of the health sector has undergone changes. From being a recipient of the burden, the health sector and professionals have taken active roles of catalysts, facilitators, and advocates in prevention through a number of strategies. In road safety, the impact of many policies, programs and developments in related sectors of transport, development, police, judiciary, economic growth, and others are felt and absorbed by the health sector.

WHO (2007) in a review of the health sector's contribution for road safety and injury prevention has outlined six major activities that need to be undertaken by the health sector; these include advocacy, data management, policies and programs, capacity strengthening, monitoring, and evaluation along with provision of curative and rehabilitative services. As per WHO, “the ministry of health is uniquely positioned to collect data, analyze risk factors, provide emergency and long-term care, coordinate multisectoral prevention efforts across a range of sectors, and campaign for political and legislative change. In many countries, if the ministry of health does not conduct these activities in the field of violence and injury prevention, no other body will.”

Health sector needs to reorient its role and extend beyond the provision of acute and rehabilitative care into the areas of prevention and promotion through policies and programs. In many developed countries, injury prevention has been the primary focus of health agencies providing requisite inputs toward planning, programming, implementing, and evaluating road safety and injury prevention programs.

Specific activities which health sector can undertake include

1. Improving data collection systems and building capacity for data management along with making data available for everyone to act.
2. Building organized systems of emergency and prehospital care.
3. Developing integrated trauma care systems by addressing equity in health care.
4. Organizing delivery of rehabilitation services for critically injured.
5. Facilitating a national plan within MOPH and within the national governments.
6. Strengthening existing or new legislations for road safety and injury prevention
7. Identifying key interventions that work based on understanding of injuries
8. Strengthening capacity of policy makers in health and related sectors to scientifically address the injury burden through policies and programs.
9. Building human resources for road safety and injury prevention through variety of training programs.
10. Supporting a public health approach for prevention of RTIs and other injuries
11. Conducting advocacy and awareness activities
12. Monitoring and evaluation through data on effectiveness of interventions and keeping track of changing trends
13. Facilitating greater participation of society in road safety by addressing RTIs as a public health problem.
Injury surveillance

Surveillance is defined as “the continuous scrutiny of the factors that determine the occurrence and distribution of disease and other conditions of ill health”. Surveillance activities have been widely used in prevention and control of infectious diseases and has been expanded in recent years to include Noncommunicable diseases and their risk factors as well as injuries.

‘Injury surveillance ’ is the systematic collection, analysis, interpretation and dissemination of data for taking actions to reduce the burden and outcome of injuries. Surveillance implies collection of small quantities of good quality data (in contrast to registries and research studies that collect large volumes of information) for effective action to develop policies and programmes as well as targeted interventions.

The core component of any injury surveillance programme is data and action. In the field of injury prevention and control, the programmes can include all types of unintentional injuries like road traffic injuries, falls, burns, drowning, poisoning, sports injuries as well as intentional injuries like violence, suicide, and others. Alternatively, focused programmes as in road traffic injuries, drowning, and suicide also exist. The scope, extent and purpose of an injury surveillance programme depends on various factors like the purpose, interest and commitment of agencies / partners, a nodal -centralized agency for surveillance, nature and quality of data collection, availability of expertise and utilization of data for action along with several others. Several examples of establishing injury surveillance programmes are available from HICs and even a few LMICs in recent years. In some countries, the word surveillance is not used, but called differently as information systems.

The scope of Injury surveillance needs to be defined in the first step and can include collection of data on number of deaths and injuries, risk factors/ causes, outcomes (injured, dead and disabled) followed by analysis, interpretation and dissemination of information to all stakeholders for taking actions. Use of data in planning and implementation helps to reduce the burden injuries in the community.

Most significantly, an injury surveillance system needs to be simple, acceptable, sensitive, reliable, representative, timely, useful, cost effective and sustainable.

Steps of injury Surveillance

The steps of injury surveillance and guidelines for implementation were developed by WHO as early as 1998 to help countries for setting up systems (2). The different steps of an injury surveillance programme are shown in the Figure.

Data sources for injury surveillance

WHO has defined different types of data that are required at different levels for different purposes (WHO data manual). The field of Injury prevention and control requires data of different types and from multiple agencies. There is no single source that provides comprehensive injury information in India and in most countries.

As most of the injuries and deaths are considered medico legal in India, the major source of injury data are the police. Several studies have informed the quantity, quality, nature and reliability of information in police records (3-6). While the existing national reports generally indicate the profile and patterns, several limitations exist in the quality of data and hence, generalizations and conclusions need to be made with caution. Recently, the Tamil Nadu Government has established an online portal (e-pathai) for strengthening data on road accidents (http://www.tnhighways.gov.in/epathai.html) which can be used for surveillance purposes as well.

As most of the injured are provided care in hospitals of both public and private nature, hospital records form a good source of information. For a variety of reasons, data from the health sector is often limited, of poor quality, non-representative and of limited help. Recently, the Ministry of Health has established a National Injury Surveillance Centre and it is hoped that the situation will improve in the coming years.

Feasibility studies have demonstrated the possibility of establishing injury surveillance programmes using data from police records, from emergency rooms and wards of hospitals as well as mortuary centers in India (7). Other data sources include transport departments, insurance departments, social welfare department (disability data) etc.

Most significantly, none of these data collecting systems have mechanisms for comprehensive analysis of collected data.

Indian examples

- India does not have a well defined injury surveillance programme. However, attempts have been made in a few centers to examine the feasibility of developing such programmes.
- Between 2007 – 2012, the WHO CC at NIMHANS, Bangalore, developed the Bangalore Road safety and Injury Prevention Programme which had
surveillance as the foundation with a primary focus on RTIs. Data was extracted from police records (shifted from paper-pencil to online transmission) and collected prospectively in 25 large hospitals (9). The programme had the essential components of data management mechanisms including training, computerization, data extraction and collection steps, quality checks, analysis, reporting, dissemination and feedback to all partners. (11)

- The feasibility of using mortuary data for surveillance purposes has also been possible (10) as revealed by the fact that trained mortuary personnel collected essential data under the supervision of trained staff from 8 locations in the city.

- In parallel to the urban programme, a District Injury surveillance programme was initiated in the district of Tumkur in 2011-12 with data extraction from police and prospective data collection from district hospital (12).

These different programmes resulted in development of number of road safety activities, primarily due to data dissemination, utilization, feedback and follow-up activities.

- RS10-India project funded by Bloomberg Philanthropies was implemented in the cities of Hyderabad and Vizag of the state of Andhra Pradesh (2012 – 16) and in Jalandhar, Punjab (2012). In both places, the feasibility of establishing a hospital based injury and RTI surveillance programme was clearly demonstrated (13).

- The feasibility of establishing a RTI surveillance programme was also undertaken across 3 districts of Karnataka under the World Bank Road Safety project. Using paper and Pencil formats, manual data collection was done in district and Taluka hospitals.

- The Ministry of Health also introduced injury and RTI surveillance formats at the national level across trauma care centers since 2013. Due to lack of strict monitoring, the programme has not been uniform and has ended in a non-uniform manner.

- The Strengths of an injury surveillance lies in the presence of a system that helps in guiding road safety policies and programmes by quantifying the burden and informing changing trends, prioritizing the problems and identifying new ones, identifying patterns- risk factors and their regional variations, developing priority areas of interventions and evaluating the impact of implemented interventions. Success of surveillance system depends greatly on the existence of an authority that has the mandate to use data and act.

The Limitations of injury surveillance lies in the failure to use data in situations of poor or absence of political will in favor of injury prevention, in situations where injury is not considered as a priority issue and if data collected does not lead to any actions. If data collection is the only intent and no further actions are possible, alternative data systems need to be considered. (14, Barry Pless et al, 2008).

Several challenges exist in less resource settings like absence of well-established systems, lack of human, financial and technology resources, absence of well defined mechanisms, frequent change of officials, poor commitment of partners and towards ensuring sustainability of the programme. Mere data collection without support systems is of limited help.

The Ministry of Health, Government of India has recently established the National Injury Surveillance Centre in Delhi, and it is hoped that India will have better quality data for prevention, policies and programmes towards road safety and injury prevention (http://www.nisc.gov.in/injury_surveillance.aspx).

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Injuries in general and RTIs in particular impose significant burden on Indian society. While a million deaths and 30 million injuries are estimated for all types of injuries, RTIs alone account for an estimated 175,000 deaths and 5 million injured persons in 2015 in India. Based on a review of Indian road safety scenario with regard to burden and characteristics, progress made in the past few years, and lessons learnt from global experiences, India needs to formulate and implement several road safety initiatives based on prioritization of issues. Greater political commitment, revisions to the Indian Motor Vehicles Act, interest across sectors to promote and implement road safety, recent judicial directives, and a wider debate in Indian society are some rays of hope to improve the scenario in the coming years. Whether India will be able to achieve the stated 50% reduction in deaths by 2020 can be left to the imagination all concerned.

A scientific approach to road safety that goes beyond adhocism, knee jerk reactions, populist measures and undecided debates is the need of the hour. As mobility, safety and economy are all essential requirements for India’s growth in coming years, “Safe Mobility” should be the focus in the interest of road users.

**Vision Zero**

‘Vision Zero’ is a concept that aims to achieve a system with no fatalities or serious injuries in a given traffic environment. Vision zero is based on the ethical principle that “it can never be ethically acceptable that people are killed or seriously injured when moving within the road transport system”. Vision Zero in road accident means achieving ZERO DEATHS. “No Human Being should be seriously injured or killed as result of road crash” is the presumed notion in Vision Zero or Towards Zero policy. It is based on the principles of “the safe system approach” to tackle the epidemic of road crash, which emphasis on building a system that can accommodate human errors rather than blaming them.

Initiated in Sweden during 1990’s, it has the long term goal of eliminating death and serious injury from the road transport system. Like safe systems approach, vision Zero places emphasis on safety that is a shared responsibility of transportation system designers and road users. Vision Zero suggests that “possible long term maximum travel speeds related to the infrastructure, given best practice in vehicle design and 100% restraint use”.These speeds are based on human and automobile limits. For example, the human tolerance for a pedestrian hit by a well-designed car is approximately 30 km/h. If a higher speed in urban areas is desired, the option is to separate pedestrian crossings from the traffic.

Vision zero approach is now operational in many other countries like Sweden, Netherlands, Canada, United Kingdom, Australia and others. Sweden has become country with lowest annual rates of road deaths in the world (3 out of 1,00,000). Fatalities involving pedestrians in Sweden have fallen by almost 50% since 1997 in spite of increasing traffic volume.
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Socioeconomic losses. In 2009, it is estimated that nearly 1,50,000 road deaths and 2,00,000 suicides would have occurred in India. Injuries have emerged as a leading public health problem, with over 700,000 road traffic injuries reported every year. The majority of these injuries are due to complex interactions of human, vehicle-product, and environmental factors. In India, it is estimated that injuries contribute to nearly a million people being affected, with one third of total disabilities. According to the Indian Road Safety Policy 2010, 5.5 to 6.5 people are affected per road traffic death. Injuries to the head are the commonest cause of death and 30-50% of road traffic injuries lead to hospitalisation.

Injuries to the head cause unexplainable suffering along with a huge economic, social, and psychological impact. We are all aware that an injury to a person can change her/his life. After an injury, the injured returns to optimum functioning and is a successful government, communicable and noncommunicable diseases affect the head and brain. Head injuries are one of the major causes of disability in India. The current estimate is that there are over 4.5 million people in India with a history of head injury. This includes mechanical energy as in crashes, radiant forces beyond the physiological tolerance of the body, it results in tissue and organ damage.

This interaction in a crash results in death or hospitalization or disability. Thus, reducing the consequences of road traffic injuries is critical. With policies and programmes of prevention, we can achieve a successful government, communicable and noncommunicable diseases in India. The risk of injury occurrence as roads and other environments may be unsafe, products may be injury producing, and or taking nature of individuals and less importance is given to safety. The risk of injury occurrence is generally assumed that as vehicles increase and road network expands, road deaths will increase. During these interactions, injuries of varying nature occur, related to energy transfer in crashes. In India, it is not there. Being nonrandom events, injuries happen predictable and can be prevented. The risk of injury occurrence is generally assumed that as vehicles increase and road network expands, road deaths will increase. Injuries are not random events, they happen predictable and can be prevented. The risk of injury occurrence is generally assumed that as vehicles increase and road network expands, road deaths will increase. Injuries are not random events, they happen predictable and can be prevented.