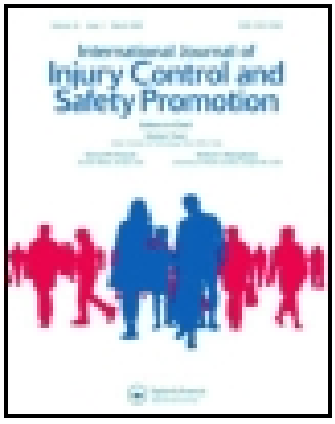

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Burden, pattern and outcomes of road traffic injuries in a rural district of India

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Burden, pattern and outcomes of road traffic injuries in a rural district of India

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Road traffic injuries (RTIs) are a leading public health problem and the understanding of RTIs in rural India is limited. The present report documents the burden, pattern, characteristics and outcomes of RTIs in a rural district of India using combined data sources: police and hospital. RTIs contributed for 38% of fatal and 39% of non-fatal injuries with an annual mortality rate of 18.1/100,000 population/year. Young males were affected most and two-wheeler users and pedestrians were involved in 45% and 20% of fatal crashes, respectively. Nearly half (51%) of fatal RTIs occurred on national highways of the district; 46% died immediately at the site. Among those hospitalised, 20% were under the influence of alcohol while use of helmets and seat belts was <5%. Trauma care was deficient in the district leading to greater number of referrals. Road safety should be given high importance in rural India with a focus on safe roads, safe vehicles and safe people along with trauma care.

Keywords: road traffic injuries; vulnerable road users; risk factors; trauma care; rural India

Introduction

The socio-economic and epidemiological transition along with unprecedented motorisation has seen a phenomenal increase of road crashes, deaths and injuries in India and other low and middle income countries (LAMICs) (Lozano et al., 2010; Peden et al., 2004). Currently, more than 80% of road traffic injury (RTI) deaths and injuries occur in developing countries. By 2030, road traffic crashes are predicted to be the fifth leading cause of death and third leading cause of disability-adjusted life years worldwide (Peden et al., 2004; www.who.int/violence_injury_prevention/road_safety_status/2009). While there has been a significant decline of road deaths in high income countries, India and other LAMICs are witnessing a continuous increase in the last two decades. In 2012, RTIs accounted for 139,091 deaths and 469,900 persons were injured as per official reports in India. Further, RTIs contributed to 35% of all unnatural or accidental deaths and increased by 5%−8% annually in the last decade (National Crime Records Bureau [NCRB], 2012).

Nearly 68% of India's population resides in the rural areas (http://censusindia.gov.in). While rural India is witnessing rapid motorisation, urbanisation, globalisation and media impact in recent years, similar changes are seen across other parts of LMICs as well. Official reports (NCRB, 2012), million death study (Hsiao et al., 2013) and independent reviews (Aarti, 2011; Gururaj, 2005, 2011; Mohan, 2004) underscore the huge burden of RTIs in India and need for preventive and care programmes. However, there has been limited research in India on RTIs; the few available are from urban India (Dandona, Kumar, Ameer, Reddy, & Dandona, 2008; Uthkarsh et al., 2012; Verma & Tiwari, 2004). In 2012, only 17.4% of crashes, 11.8% of deaths and 14.7% of injuries occurred in 52 cities of India and the remainder was spread over vast rural India (NCRB, 2012). Few Indian studies indicate the enormity of the RTI problem in rural India (Aeron-Thomas, Jacobs, Sexton, Gururaj, & Rahman, 2004; Cardona et al., 2008; Farooqui et al., 2013; Rajesh et al., 2012; Varghese & Mohan, 1991, pp. 326−329) with little detailed information on the problem, pattern and characteristics of road crashes with its burgeoning motor vehicle population and rapidly expanding road infrastructure including state and national highways (NH).

The objective of the present report is to describe the burden, pattern and outcomes of road crashes, and current status of trauma care for RTIs in a rural district of South India.

Materials and methods

Tumkur, the ninth largest district in Karnataka state, lies 72 km from Bangalore city. It is a rural district with a population of 2.68 million and a literacy rate of 74.32%. The district with 10,597 sq. km area has a total road length of

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4691 km (326 km of NH, 632 km of state highways and 3733 km of major district roads), spread over 10 towns and 2708 villages. As on 31 March 2012, there were a total number of 374,700 registered motor vehicles in the district with 82% being motorised two wheelers. The district has 38 police stations (Government of Karnataka [GoK], 2012) and 2264 police personnel work in traffic, crime and law and order divisions and there is no dedicated traffic and safety wing in the district police (personal communication, Office of the District Superintendent of Police, Tumkur). The district has a 400-bedded general hospital (also a Level 3 trauma care centre), 9 hospitals with 100 beds each, 4 community health centres, 143 primary health centres and an unknown number of private hospitals and general practitioners (GoK, 2012).

The study was undertaken during the period 1 January to 31 December 2011 after an initial review of the situation and discussion with district authorities. The review examined the availability and quality of road safety data, which showed that detailed data was not available for any understanding of road crashes. RTIs and other fatal injuries are categorised as unnatural and medico-legal events in India. Hence, all fatal and some reported non-fatal crashes are reported to police, who collect detailed information as part of their investigation in a specified format. Initial review of sample records revealed that detailed narrative and descriptive information was available on fatal RTIs in police records, while minimal information was available on non-fatal RTIs. Hence, it was decided to undertake a detailed analysis of fatal RTIs from records available with district police authorities.

As police records did not have much information on non-fatal RTIs, we reviewed information availability in the district hospital. The pilot study in the district hospital revealed that the hospital records also did not have detailed information on RTIs with only management details being documented for hospitalised cases. However, it was learnt that it is possible to collect data from those reaching the district hospital for care by directly interviewing the patients or their accompanying family members.

Hence, to develop a comprehensive understanding of RTIs in the district, prospective data collection was undertaken on fatal RTIs from police records and on non-fatal RTIs from the district hospital for a one-year period.

As the characteristics vary significantly between fatal and non-fatal injuries, two separate data collection pro formas were developed based on WHO injury surveillance guidelines (Holder et al., 2001) and Bangalore Road Safety and Injury Prevention Programme (Gururaj et al., 2008) after appropriate modifications. Data collection from police included identification and socio-demographic details along with available details of RTIs (location and time of injury and death, road user category, collision patterns, use of helmets and seat belts, drinking and driving and speeding) and time interval between crash occurrence and death. The hospital data collection focused on the above aspects along with pre-hospital and emergency care details (availability of first-aid, referral patterns, modes of transportation and time interval), severity, mode of management and outcome. Severity of injuries was classified as mild (emergency care and sent home), moderate (requiring care, admission and investigations) and severe (advanced medical or surgical interventions) based on the decision of the managing physician.

The data instruments were pretested and piloted at the beginning of the programme. Approval was obtained from NIMHANS Ethics Committee. After obtaining administrative approvals from district authorities, the police records were reviewed and relevant data was extracted by trained research officers prospectively. Data from the district hospital was collected round the clock for the entire year after obtaining informed consent from individuals or their family members by interviewing them during the course of their hospital stay. Information was also cross-checked with medical records by trained medical interns from the Department of Community Medicine of the local medical college as part of their internship training.

Data collected from both hospital and police sources were checked by the project team for coverage, completeness and quality through fortnightly review of activities. All data was entered into a secure database. Ten per cent of records were cross-checked for any errors and rectified immediately. Data analysis was done using Epi-info version 3.5.1 (Dean et al., 2008) and statistical package for social sciences (SPSS) version 19.

Providing feedback to all stakeholders was a major component of the programme and was undertaken throughout the study period. Three rounds of stakeholder's consultations were held to explore use of data for identifying focussed activities at the district level. Data was used for training and sensitisation of health, police and transport officials, apart from use for campaigns and for improving enforcement (Gururaj, Girish, Ashok, Venkatesh, & Uttkarsh, 2012).

Results

During the period from 1 January to 31 December 2011, 486 road deaths and 2377 injured persons were registered with the police and 1276 (54%) of these injured were also registered in the district hospital. The ratio of fatal to non-fatal RTIs registered in the entire district was 1:5 for the year as per police reports. The annual RTI mortality rate was 18.1/100,000/year for the district and RTIs accounted for 38% of fatal injury deaths and 39% of non-fatal injuries, respectively (Figure 1).

The age−sex distribution of RTIs revealed that nearly 70% of fatal and non-fatal RTIs occurred in the age

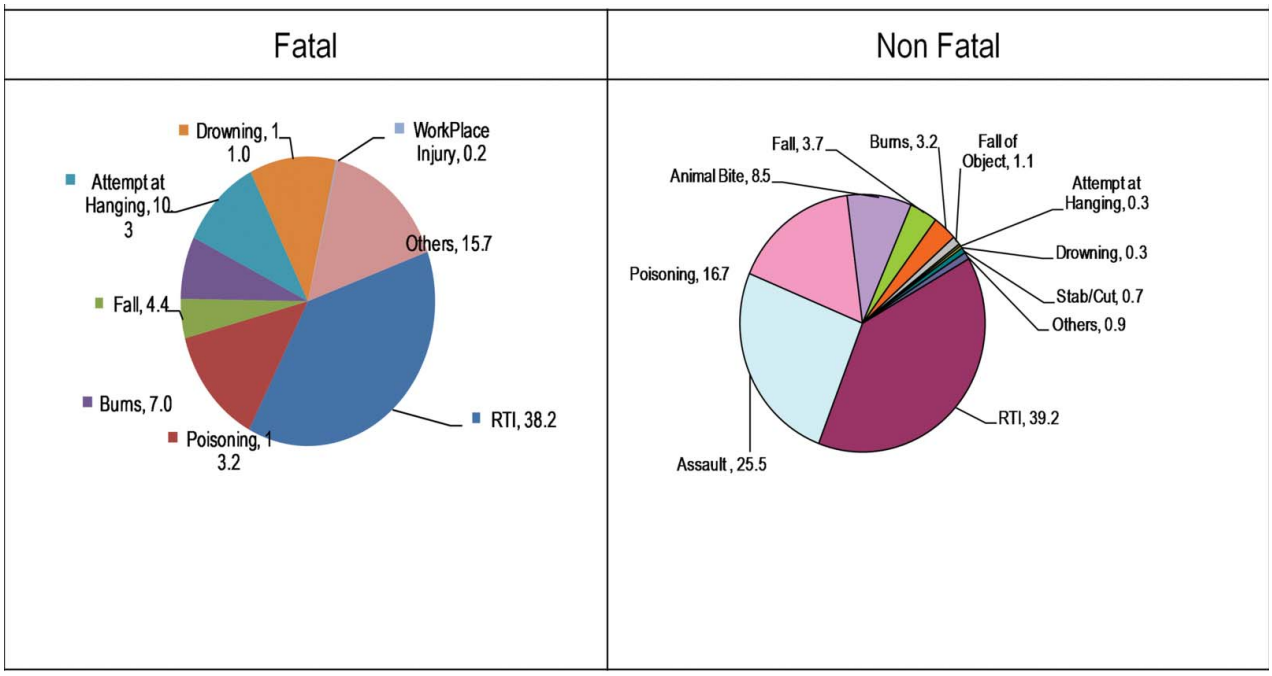

Figure 1. Causes of fatal and non-fatal injuries.

groups of 15–44 years with a male to female ratio of 6:1 (fatal 7:1 and non-fatal 5:1) (Table 1). Age-specific mortality rates in 15–29, 30–44 and 45–59 years age groups were 1.8/100,000, 2.5/100,000 and 2.9/100,000 population, respectively. Children comprised 3.7% and 5.5% of fatal and non-fatal RTIs, respectively, while elderly (60+ age group) accounted for 8% of deaths and injuries. More than two-thirds (65.2%) had completed education up to pre-university levels among the fatalities, while it was 52.2% among those injured. Those completing graduate levels and above comprised 16.1% of the non-fatal injuries.

Vulnerable road users

Motorcyclists (drivers and pillions) comprised the major category of road users injured and killed in road crashes constituting 45% and 34% of fatal and non-fatal crashes, respectively. This was closely followed by pedestrians to the extent of 20% and 29% of fatal and non-fatal crashes, respectively (Figure 2). Passengers and drivers of heavy vehicles (like lorry, buses and trucks) constituted 11% of fatal and 10% of non-fatal injuries. Among fatal crashes, nearly 10% were drivers and occupants of three-wheeled vehicles.

Crash locations

Nearly one-third of crashes had one person dead, while 12% of fatal crashes resulted in death of two persons, and 4% with death of more than 10 persons. Nearly half of the fatal and non-fatal RTIs occurred on NH within the district. The three NH in the district together registered 200 crashes with 248 deaths, while the state highways reported 93 crashes with 88 deaths. The three NH (4, 206 and 48) accounted for 48%, 28% and 24% of fatal crashes, while the state highways contributed to 20% of fatal and 14% of

Table 1. Age, gender and educational status in fatal and non-fatal RTIs.

Age	Fatal ($n = 486$)	%	Non-fatal ($n = 1276$)	%
<5 years	8	1.65	17	1.33
5–14	10	2.06	54	4.23
15–29	125	25.72	486	38.09
30–44	215	44.24	411	32.21
45–59	88	18.11	206	16.14
60+	40	8.23	102	7.99
Gender				
Male	414	85.19	1080	84.64
Female	63	12.96	196	15.36
Education				
Illiterate	0	0.00	188	14.73
Primary school	154	31.69	213	16.69
Middle-school	82	16.87	252	19.75
High-school and PUC	81	16.67	201	15.75
Graduate	12	2.47	116	9.09
Postgraduate	0	0.00	90	7.05
Not known	157	32.30	216	16.93

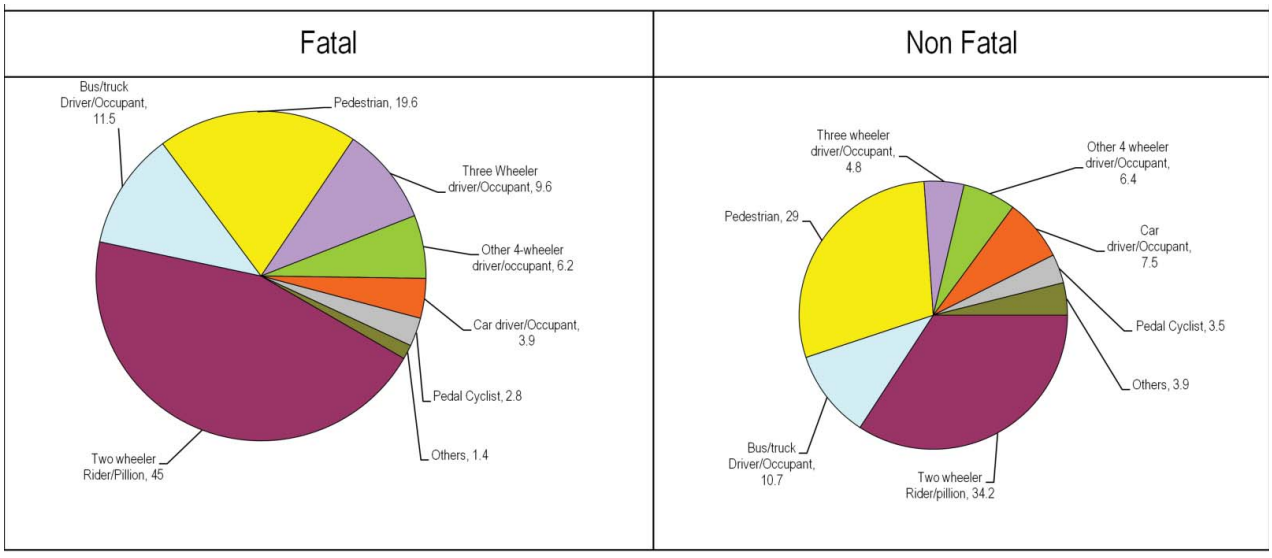

Figure 2. Road user category in non-fatal and fatal crashes.

non-fatal injuries and other district roads resulted in 32% of deaths and 39% of injuries (Figure 3). High-risk crash locations were identified in urban and rural parts of the district and also on highways.

Collision patterns

The collision patterns in rural areas are likely to be different from those in urban areas and are influenced by the heterogeneous traffic environment in the district and on highways. Pedestrians were commonly hit by heavy vehicles like buses, lorries and trucks (61%), followed by motor cars (16%) and two wheelers (14%) in fatal crashes. The absence of traffic separators especially on the highways is a noticeable feature in the district particularly in select stretches. The pattern among non-fatal injuries was primarily collision with a pedestrian (17.3%), rear-end collisions (17.6%), head-on collisions (17%), skid and fall (12%) apart from fall from a moving vehicle (9.7%).

Place of death

Data collected from police sources revealed that 46% of road traffic fatalities died at crash site within minutes after the crash and 17% died on the way to hospital. Nearly one-third died in the hospital, either at first contact hospital or in the definitive hospital. Data on likely

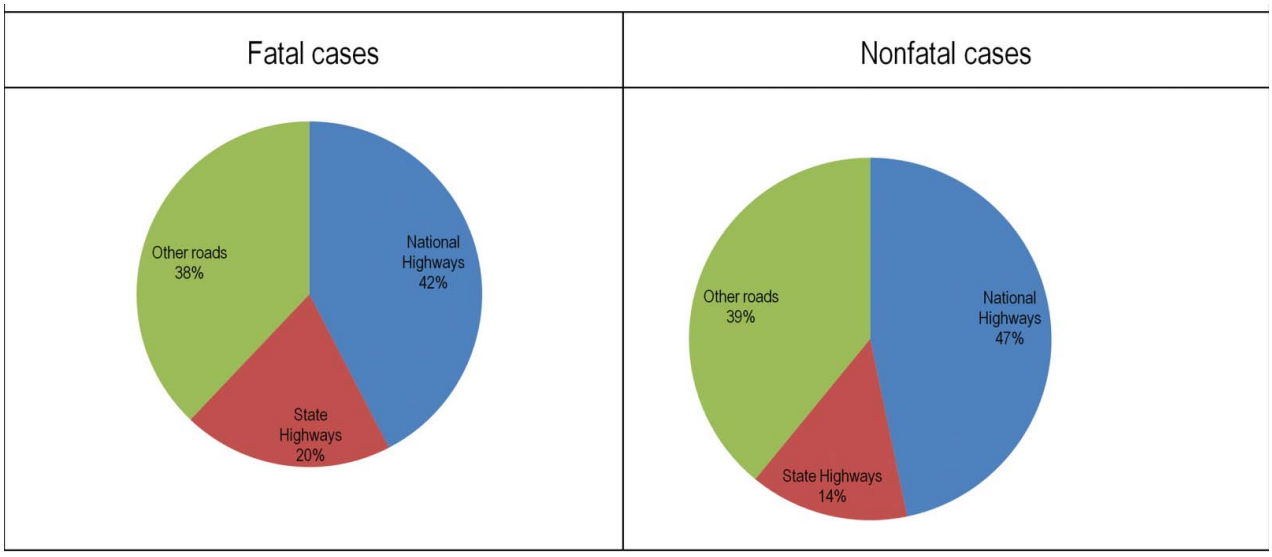

Figure 3. Location of road crashes in the district.

Table 2. Availability of first aid, time interval as per injury severity.

	Injury type							
	Mild		Moderate		Severe		Total	
First aid	*n*	%	*n*	%	*n*	%	*n*	%
Yes	159	37.9	261	48.4	220	69.4	640	50.2
No/do not know	261	62.1	278	51.6	97	30.6	636	49.8
Total	420	100.0	539	100.0	317	100.0	1276	100.0
Time interval								
<3 hours	351	83.4	459	85.2	265	83.9	1075	84.2
3–12 hours	5	1.2	3	0.6	1	0.3	9	0.7
12 hours	65	15.4	77	14.3	50	15.8	192	15.17
Total	421	100.0	539	100.0	316	100.0	1276	100.0

post-hospital deaths was not available and requires long-term follow-up and population-based approaches.

Risk factor information

Data on involvement of alcohol, use of helmets and seat belts in fatal crashes was not available in police records. However, data collected in district hospitals through interviews with the injured revealed that 19% of injured males above the age of 18 years reaching the hospital between 7 pm to 7 am were found to be under the influence of alcohol (assessed by physician certification methods based on person smelling of alcohol and clinical opinion). Helmet and seat belt use was <5% among those reaching a hospital. Analysis of police records, discussions with police officials and interviews with severely injured revealed that speeding was a common and major factor in all fatal crashes.

The timing of fatal road crashes revealed that visibility issues are a major contributor and risk factor, especially for road crashes in rural areas and on highways. Data revealed that 10%, 24%, 38% and 28% of crashes occurred during 12 am–6 am, 6 am–12 noon, 12 noon–6 pm and 6 pm–12 am, respectively. Further analysis of data revealed that 42% of crashes took place between 3 pm–9 pm, 39% of crashes occurred during 6 pm–6 am. Nearly half of the fatal crashes on highways occurred during night-time and visibility and/or speed was a major factor.

Trauma care

Severity of injuries indicated that 33% were mild, 42% moderate and 25% severe in nature. Polytrauma was commonly seen in all severe cases and 11% of moderately injured persons. Fifty-eight per cent of RTI victims sustained a head injury and one-third each had injuries to upper and lower limbs. Nearly 70% of severe and half of moderately injured persons received some first aid at or near to crash site, mainly in nearby government health centres or private hospitals ($p < 001$). Interestingly, 80% of injured had sought care in one other hospital before reaching the district hospital indicating delayed definitive care. The mode of transportation among those reaching the district hospital was predominantly private transport (41%) (three-wheeled motor vehicles or private taxis) or an ambulance (one-third patients). More than 80% of injured had reached the district hospital within 3 hours and the rest beyond, with nearly 12% of severely injured reaching after 12 hours (Table 2). Among non-fatal injured provided care at the district hospital, majority (72%) reached within three hours and nearly two-thirds were hospitalised and provided treatment; rest were referred to nearby higher centres for advanced management.

Discussion

The present study is the first major study comprehensively examining the burden and characteristics of RTIs in rural India. The national data and recent reports reveal that RTIs are increasing at a rapid pace in grade B and C cities and in rural India where motorisation is increasing and infrastructure is under expansion (Gururaj, 2011; Hsiao et al., 2013; Mohan, 2010; Mohan, Tsimhoni, Sivak, & Flannagan, 2009). Karnataka is one of the states with high number of RTIs and contributes to nearly 10% of national road deaths and 12% of non-fatal injuries and an annual mortality rate of 16/100,000 population (NCRB, 2012). Data from the present study clearly shows that RTIs are a major injury cause for both deaths and injuries and accounted for more than one-third of all injuries with a mortality rate of 18.1/100,000/year, much higher than the national and state rate (11.8/100,000/year and 16/100,000/year, respectively) (Ministry of Road Transport and Highways [MoRTH], 2011; NCRB, 2012). Under-reporting of RTI deaths and injuries in India due to various reasons has been acknowledged earlier (Barffour, Gupta, Gururaj, & Hyder, 2012; Dandona et al., 2008; Gururaj, Aeron-Thomas, & Reddi, 2000; Gururaj, Murthy, Girish, & Benegal, 2011; Mohan, 2004). The number of fatal injuries is probably much higher as deaths due to complications of RTIs, and deaths occurring beyond 30 days or outside of the district may be under-reported. Similarly, the number of non-fatal RTIs is likely to be much higher if data is included from all health care institutions within the district (community health centres/taluka hospitals/primary health centres/private hospitals).

RTIs are a leading cause of mortality, morbidity and disability among the young and predominantly males. In this study, nearly 80% of RTIs occurred in the age group of 15–44 years, predominantly among males and those less educated, an observation that is similar to global

findings. RTI results in significant socio-economic losses as the death and hospitalisation of an earning family member can be disastrous leading to fall in income, lower living standards and poor quality of life (Aeron-Thomas et al., 2004).

To design interventions for making people safe on roads, it is crucial to identify the vulnerable groups that can be specifically targeted for interventions. In the present study, two-wheeler riders, pillion riders and pedestrians were the major groups involved and affected in road crashes, a finding similar to other epidemiological studies from India and other LMICs (Barffour et al., 2012; Dandona et al., 2008; Gururaj, 2008; Gururaj, 2011; Gururaj & Bangalore Road Safety and Injury Prevention Program Collaborators Group, 2011; Mohan et al., 2009; Singh, Bhardwaj, Pathak, & Ahluwalia, 2011) but at variance with national and state data (NCRB, 2012). This is primarily because the national reports include the impacting vehicle and driver but not the injured/killed person.

National data indicates that 83.5% of the accidents were due to driver's fault (MoRTH, 2011; NCRB, 2012). Almost all fatal records we analysed showed that 'carelessness, negligence of driver, speeding and driver's fault' as responsible factors documented in police reports without clearly delineating individual risk factors. However, earlier Indian studies have shown that greater involvement of two wheeler riders and pedestrians, higher proportion of deaths on highways, visibility issues, drinking and driving, low prevalence of helmet and seat-belt use, speeding and poor status of trauma care are some of the risk factors that contribute to a higher number of road crashes and deaths in India.

Our study also revealed the absence of reliable data on important behavioural risk factors in both police and hospital records. Among those reaching hospital, nearly one-fifth of injured drivers were under the influence of alcohol at the time of crash based on medical certification. Data from several hospital-based studies in India indicates that nearly one-third of crashes occur during night times and a third of these are linked to alcohol (Arora, Chanana, & Tejpal, 2013; Das, Gjerde, Gopalan, & Normann, 2012; Gururaj, 2004; Gururaj et al., 2011; Jagnoor, 2006). Less than 5% of two-wheeler riders and motor vehicle drivers had worn helmets and seat belts at the time of crash, primarily due to the absence of legislation and enforcement in the district, a scenario similar in other parts of rural India. Few studies have shown the low prevalence of helmet use (Gururaj et al., 2011; Mirkazemi & Kar, 2013; Sreedharan, Muttappillymyalil, Divakaran, & Haran, 2010; Wadhwaniya, Gupta, Tetali, & Hyder, 2012) and seat belts (Chaudhary et al., 2013; Gururaj et al., 2011) even in urban India due to the lack of comprehensive and uniform legislation and enforcement (Gururaj et al., 2011). Police records had a documentation of speeding for the majority of fatal crashes and this was also confirmed by direct interviews with hospitalised subjects; however, speeding details were not available from both sources. The lack of reliable data on modifiable behavioural risk factors indicate the need for establishing good road safety information systems and crash research for designing specific and targeted interventions along with the need for uniform road safety legislation and enforcement across the country.

Indian highways account for 5% (2% national and 3% state highways) of total road network (MoRTH, 2012), carry 40% of total traffic and contribute to nearly two-thirds (63.4%) of total road fatalities (MoRTH, 2011). We observed that nearly half of the total RTI deaths in the district had occurred on the three highways passing through the district. It is well acknowledged that design, operation and safety of highways need the urgent attention of policy-makers and infrastructure development sectors to reduce deaths and injuries (Gururaj, 2011; Gururaj et al., 2008; Mohan, 2004; Mohan et al., 2009). As inappropriate speeding is a major contributor on highways, measures have to be developed to moderate speed while allowing mobility, especially on highways passing through villages of rural India. There is an urgent need for investment in research to clearly delineate the contributory factors for safety in the existing and new highways while promoting transport and mobility.

Trauma care in India is still more of an evolving urban phenomenon. Nearly two out of three deaths in our study occurred during transport of the injured to the hospital or in the hospital indicating the need for organising efficient pre-hospital and acute trauma care in rural areas. The million death study reported that nearly half of deaths occurred in the hospital and others have reported similar findings (Hofman, Primack, Keusch, & Hrynkow, 2005; Hsiao et al., 2013; Subhan & Jain, 2010). Our study showed that nearly one out of four cases reaching the district hospital had polytrauma necessitating the need for appropriate care in district-level hospitals in terms of manpower and facilities. Lack of first aid, delay in transport, late arrivals to a definitive hospital, more number of referrals, absence of triage, deficient human and physical resources and increasing costs of trauma care are some of the known contributing factors for deaths and poor trauma outcomes in India and other LMICs (Gururaj, 2008; Gururaj et al., 2011; Joshipura, 2008; Mock, Lormand, Goosen, Joshipura, & Peden, 2004; Pallavisarji, Gururaj, & Girish, 2013).

The data from the programme was used for sensitisation of stakeholders, training of health professionals and police, conducting campaigns on drinking and driving and for strengthening other ongoing activities at the district level. Along with larger national and state road safety management strategies that are scientific, sustainable and cost effective, a demanding task is implementing co-ordinated programmes at the local level; it is both an opportunity and a challenge. Developing a district road safety and

injury prevention programme covering a population of approximately 1.5−2.5 million can be a possible option in a country like India with a large population, requiring further research. There are several merits in this approach as in all districts − rapid motorisation is in early stages; a decentralised administrative machinery which can implement rules and regulations is already in existence, and programmes can be well monitored and evaluated.

The programme can become sustainable as integrating activities of different sectors and capacity building and strengthening of district officials in transport, police, rural development, municipalities, welfare and others is possible at local levels. It also gives an opportunity to integrate road safety and injury prevention along with activities of different sectors and also integrating with ongoing programmes at the district level (like National Rural Health Mission (http://nrhm.gov.in/) and Urban Renewal Mission (http://jnnurm.nic.in/) and others). The five pillars of road safety recommended by United Nations (http://www.who.int/roadsafety/decade_of_action/en/index.html) should form the basic approach to reduce road crashes in India and other LMICs and implementing sustainable road safety programmes is the need of the hour.

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