

Alcohol, drugs and road traffic crashes in India: a systematic review

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Abstract

Objective: India reported the highest number of road traffic crashes, related injuries and deaths of all countries in the world with 105,725 road traffic fatalities and 452,922 non-fatal road traffic injuries in 2007. In this report we present a systematic review of available literature on the use of psychoactive substances (alcohol and drugs) among road users, particularly those involved in road traffic crashes (RTC).

Methods: MEDLINE, EMBASE, INDMEDICA and several other databases were searched for published reports between 1980 and 2011 that present data on prevalence or extent of substance use among road users in India.

Results: Among the 23 studies eligible for the review, alcohol was reported by all, but only two mentioned use of drugs. Most of the studies were hospital based, included injured or killed road users and belonged to southern parts of India. Seven studies did not report any method for detecting alcohol use, whereas seven used analytical testing, seven studies used self-reporting and two used observation. Utilizing the various means of verification, the studies reported that 2-33% of injured and 6-48% of killed RTC victims had consumed alcohol or drugs; only two mentioned drugs without specifying which types. Most studies did not distinguish between drivers, passengers, bicyclists and pedestrians, and none investigated alcohol or drug use among those responsible for the accident.

Conclusion: A significant proportion of injured or killed road users in India had used alcohol before the accident. The existing studies cannot be used to estimate the risk of accident involvement among drunk drivers.

Key words: road traffic crashes, drunk driving, alcohol, substance use, developing countries, India

Introduction

Road traffic crashes: a global challenge

Road traffic crashes (RTC) have emerged as a major public health threat across the globe.

According to the estimates of the World Health Organization (WHO), RTCs will be the fifth leading cause of global deaths by 2030 (WHO 2009a). Globally, more than 1.2 million individuals die per year on roads and around 50 million are injured, causing an economic loss of US\$518 million annually. Low- and middle-income countries (LMIC) show an increasing trend for RTC compared to the high-income countries (HIC) and constitute over 90% of the global RTC with only 48% share of global vehicles. The social gradient is more unfavorable for the LMICs as the majority of victims are ‘vulnerable road users’ like pedestrians, cyclists or motorized two-wheeler riders (Dharmaratne and Stevenson 2006, Odero 1995). RTCs pose considerable public health challenges as they demand substantial skilled human resources, infrastructure, trauma, death investigations and related healthcare (Department for International Development 2003). Dealing with the mental health of the victims and family members also demands huge preparations from the health systems (WHO 2009a).

The adverse social impacts of RTCs are well-established as they lead to significant increase in burden of disease and thereby indirectly to poverty. RTCs are even reported to curtail the progress towards Millennium Development Goal 1 on reducing poverty as young populations

and breadwinners of the households are predominantly affected by RTCs (Shah and Menon 2006, Paulozzi et al. 2009).

Burden and impact of road traffic crashes in India

LMICs contribute to 62% global burden of RTCs and India tops among such countries in this regard (WHO 2004). In total, 105,725 road traffic fatalities and 452,922 non-fatal road traffic injuries were reported in 2007 (WHO 2009b). The traffic fatality risk (fatalities per 100 000 inhabitants) in India is 16.8 (less than six in some HIC), while the fatality rate (fatalities per 10 000 vehicles) is 14.5, while it is less than one in some HIC (WHO 2009b). The burden and impact of RTCs in the country vary across the states depending on the infrastructural capacity, law enforcement, and the preparedness of the health system to meet the increasing demand for trauma care (National Crime Records Bureau 2007). During the past four years, RTCs contributed to 78% of deaths due to injury, major cause of mortality for young adults under 45 years, disability to two million people, and economic loss of INR 550 billion (US\$ 12.1348 billion) (WHO 2009b). The RTC related fatalities per 1000 persons increased from 82 to 92 during 2002-2004 (National Crime Records Bureau 2007). As per the estimates, the burden due to RTC in India is expected to rise to 154,600 fatalities, about three million serious injuries and ten million minor injuries by 2015 (WHO 2008). Reportedly, lower socio-economic groups are more at risk of RTCs than their affluent counter parts. A study in Bangalore observed 13.1% mortality among rural economically worse-off groups (48.1% in urban counter parts) compared to 7.8% among rural well-off (26.1% in urban counter parts) (Gururaj 2008).

Nexus between substance use and road traffic crashes: what is known?

Among all the determinants of RTCs, the use of psychoactive substances, particularly alcohol but also drugs, is established as a crucial risk factor globally. The use of such substances can impair judgment and increase the possibility of other high risk behaviors like speeding, risk taking, and violating traffic rules, and thereby contribute to the involvement in RTC (Blomberg et al. 2009, Gjerde et al. 2011, Gururaj 2004a, Penning et al. 2010, Ramaekers et al. 2004, Walsh et al. 2004, Zhao et al. 2010). The South East Asia Region (SEAR) has the largest burden of RTCs and related injuries in the world. It has been estimated that SEAR has about 30% and 50% of all RTCs contributed by alcohol and drugs respectively (WHO 2009b, Gururaj 2004a, Dhawan and Mohan 1999). However, many LMICs have not studied the prevalence of substance use among RTC victims, and its impact on RTCs may therefore not be widely acknowledged (Mohan 2002, Gururaj and Benegal 2002). A comprehensive understanding on various dimensions of substance use such as timing, profile of users, geographical distribution and its impact is essential for an informed policy approach on law enforcements.

Objectives of the review

This review was undertaken to synthesize the evidence on the prevalence of substance use among road users and its impact on RTCs in India from the existing literature. The review intended for assessing; 1) prevalence of substance use among road users, 2) impact of substance use on road traffic crashes. Such a review can highlight the strengths and gaps in the current evidence base for a policy guide in India and similar global settings. The review can explore the regional variations in the prevalence of substance use in the country. The study outcomes would be relevant for policies, law enforcements and future research in this regard.

Methods

This systematic review was performed according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al. 2009).

Criteria for considering studies

Types of studies

The studies meeting the following criteria were included; (i) conducted in India after 1980, (ii) included road users of any kind, (iii) reported substance use, and (iv) presented quantitative information. The decision to include studies only after 1980 was based on a preliminary search. Studies without describing the methodology, not published in English and of qualitative nature (without reporting any quantitative data) were excluded apart from the review articles. The presence of ‘substance use’ among road users was recognized if the drivers of vehicles (motorized or non-motorized) or pedestrians were under the influence of any psychotropic substance (alcohol or drugs), which could impair their motor skills, reaction time and judgment, or whether any such substance could be detected in blood or breath samples.

Types of participants

The participants were all kinds of road users, i.e. pedestrians, bicyclists and drivers of all motor vehicles.

Type of outcome measure:

The four major outcome measures were; 1) prevalence of substance use among different kinds of road users, 2) type of substance in the body fluids, e.g. blood, serum, saliva or urine 3) level of substance in the body fluids, and 4) impact of substance use on RTCs and related burden (i.e. number of accidents, fatalities, injuries, socio-economic burden etc.) Given the dearth of literature in this regard, studies applying any means of verification for substance use such as self-reporting, observation, breathalyzer, or any analytical test method were included.

Search strategy for identification of studies

The electronic database searches included MEDLINE, EMBASE, Web of Science, Google Scholar, Elsevier, Science Direct, INDMEDICA, Transport Research Information Services (TRIS), the Cochrane Central Register of Controlled Trials (CENTRAL) and Campbell Collaboration, British Library of Development Studies (BLDS), the World Health Organization, the World Bank, Transport Research Board, National Institute of Mental Health and Neuro Sciences (Bangalore, India), Indian Institute of Technology (New Delhi, India), and Ministry of Shipping and Road Transport (New Delhi, India), and National Crime Records Bureau (NCRB), IDEAS (Repec) for economic working papers, Journal Storage (Jstor), and Inter-Science (Wiley). A hand search enabled to look through the bibliography of the retrieved articles. In addition, experts, researchers, officials, and organizations known to be involved in road traffic injuries or substance use research were contacted to obtain unpublished or upcoming research in India. The search screened published and un-published articles, working papers, dissertations, reports and other gray literature documented or published between 1980 and 2011.

Search algorithms

The search terms were entered in all searchable, subject-specific fields (title, keyword, and abstract), medical subject heading (MeSH) and free text terms, different for various search engines. A pilot search prompted us to modify the algorithm and exclude some of the MeSH terms to limit the inclusion of irrelevant papers. The following key words were used to locate studies: '*road traffic injury*', '*road traffic accidents*', '*road traffic crash*', '*road traffic trauma*' all separately combined with: '*psychotropic substance*', '*substance use*', '*substance abuse*' '*alcohol*', '*drugs*', '*drug use*', '*drug abuse*'; and '*India*'.

Data collection and synthesis

The papers stored in the EndNote software (Thomson Reuters, Carlsbad, CA) were screened and assessed independently by three of the authors (AD, HG and SSG) and were included in the final review through discussions. The data extraction, which was designed after initial search collected information on (i) general study characteristics such as year, site (hospital or road side), geographical distribution, population, and sample size (ii) study objectives, (iii) prevalence or incidence of substance use among road users, and (iv) means of verification. Data were reviewed for duplication after the extraction was completed and entered in Microsoft Excel. The quality of the selected studies was assessed independently by three of the authors (AD, HG and SSG), based on how they presented population level disaggregated data (age and gender), 24 hours collection of sample during the study period, means of verification and blood alcohol concentrations, and differentiation between types of road users. An in-depth statistical analysis was impossible as the studies were heterogeneous in terms of their objectives, samples, and study design. Rather, a descriptive analysis of extracted data was performed. The proportion of road

users under the influence of any substance from each study was retrieved and calculated. The proportion among each group of road users was assessed wherever such information was available. Data analysis was done with Microsoft Excel software.

Appraising methodological and reporting quality of studies

Quality evaluation was conducted by assessing seven parameters. (i) gender disaggregated data on substance use (score 0 or 1); (ii) age-specific data on substance use (0 or 1); (iii) collection of study participants 24/7 (0 or 1); (iv) detection of alcohol or drugs (no information: 0, self-reported/observation: 1, analytical method: 2); (v) reporting of blood alcohol limit (0 or 1); (vi) differentiation between different types of road users when presenting results (0 or 1); (vii) peer reviewed paper (0 or 1). The studies were classified as having low (1-3 score), medium (4-5 score), or high (6-8 score) quality based on the sum of scores for all parameters.

Results

Literature search

Our database search produced a total of 390 papers and an additional 32 records were obtained through websites and individual contact with researchers (Figure 1). After checking for duplicates, there were 181 papers for title and abstract screening, of which 29 were included for the full screening of the paper. The reasons for the exclusion of 152 papers at this stage were that studies were not conducted in India (n=52), not related to RTC (n=71), and only reported substance use (n=29). A further 11 records were added after hand searching of the references. Forty full text records were assessed for their eligibility and 18 were excluded as they were not primary studies (n=7), review articles and commentaries (n=5), did not report substance use

(n=4), and only reported qualitative data (n=2). Finally, a total of 22 papers met the inclusion criteria and were included in this review. One of the papers (Gururaj and Benegal 2002) presented a roadside survey along with a hospital based study. Those two studies were independent, thereby increasing the number of records to 23. All these studies reported alcohol use among various categories of road users. Two studies reported the use of ‘alcohol or drugs’ without specifying which types of drugs.

Quality of the included studies

Mean quality score was 4 with studies ranging from 1 (lowest) to 7 (highest). Only two studies were of high quality (scores 6-7) (Tabin et al. 2007, Millo et al. 2008), whereas 14 had moderate quality (scores 4-5) and seven had low scores (<4).

Characteristics of included studies

Study populations and settings

Most of the studies (n=16) were conducted after the year 2000 (Table I). Though the studies were carried out across India, a large proportion (43%) were conducted in the southern region of the country. However, Delhi topped the list with nine studies as a single state followed by Karnataka with seven. The study populations constituted diverse groups and most included injured (n=15) or killed (n=4) road users or both (n=1), while a few focused on community members (n=1), students (n=1) and random road users (n=1). The community members consisted of general population and adolescents, while random road users constituted drivers, pedestrians and passengers. The majority were two-wheel drivers. The most common study setting was hospital (n=19), whereas only one was a roadside survey.

Study objectives and design

There were only a few studies (n=4), which intended primarily to investigate the prevalence of alcohol among road traffic injury cases (Tabin et al. 2007, Millo et al. 2008, Kochar et al. 2002, Gururaj and Benegal 2002) and one explored it among general road users (Gururaj and Benegal 2002). The relative focus of the studies was more on exploring epidemiological, socio-demographic and contextual factors related to road traffic injuries; such as type, incidence, prevalence, mode and pattern of injury, road safety behavior among injured, killed and healthy road users. All of them were observational and none had a comparison group.

Means of verification of substance use

Six studies did not report any method for detecting alcohol or drug use, whereas ten assessed it through self-reporting by the respondents or observation by their attendants. Four studies analyzed the alcohol content in body fluids through gas liquid chromatography (GLC) method (Tabin et al. 2007, Millo et al. 2008, Biswas et al. 2003, Behera et al. 2009), breath analyzer was used only in the roadside study (Gururaj and Benegal 2002), one study used an alcohol estimation kit (Kochar et al. 2002). One study reported the analysis of 'alcohol or drugs' without specifying which types of analytical methods and which types of drugs (Singh et al. 2005). Results for drugs alone were not reported.

Outcome of interest

Two studies were excluded from the presentation of alcohol and drug use in Figures 2 and 3 and in the discussion below because only small fractions of the road users were assessed regarding substance use (Biswas et al. 2003, Fitzharris et al. 2009).

Utilizing various means of verification, the studies reported that a median of 15% of the road users had consumed alcohol or drugs (Table II and Figure 2); 15% among injured and 23% among killed victims. The only road side study reported that alcohol was detected in 42% of the population (Gururaj and Benegal 2002). The results of breath testing indicated that 35% had alcohol concentrations above the legal limit of 0.03g/dL blood (Gururaj and Benegal 2002). That study was performed at night (between 8 or 9 pm and midnight) during a 15-day period at selected sites in Bangalore and does therefore not reflect the general prevalence of alcohol in breath samples from road users in that city. All types of road users were included in the study, and the majority of the alcohol-positive road users were two-wheel drivers.

Four studies found more prevalence of drink driving among 20-30 years age group in comparison to older (>30 years) age groups (Tabin et al. 2007, Millo et al. 2008 and the two studies presented in Gururaj and Benegal 2002). Four studies reported gender disaggregated data on the presence of alcohol among road users (Gururaj 2004b, Kiran et al. 2004, Gururaj and Benegal 2002, Millikarjuna and Krishnappa 2009). One of the community based studies found relative risk of road traffic injuries among adult males reporting daily alcohol consumption was 2.26 (Sathiyasekaran 1996).

Despite diverse populations, study settings and methodology, the use of analytical tests seemed to give higher prevalences of alcohol or drugs than self-reported or observed data (see Figure 3). This might be related to the fact that analytical tests were primarily used in studies of killed drivers.

With respect to the regional distribution of the prevalence of alcohol use among the study population, irrespective of the means of verification, Delhi reported a higher proportion of alcohol used (median 26%) than rest of the country (median 15%).

Three hospital based studies and one roadside study reported blood alcohol concentration (BAC) levels among the study population (Tabin et al. 2007, Millo et al. 2008, Kochar et al. 2002, Gururaj and Benegal 2002). The BAC among the injured road users was above the legal limit of 0.03 g/dL or over 0.05 g/dL in 16 to 33% of the patients (Tabin et al. 2007, Kochar et al. 2002), whereas it was 30 to 46.7% in killed RTC victims (Kochar et al. 2002, Millo et al. 2008). In all these studies conducted in Delhi, the 20-30 years age group had the highest prevalence of alcohol.

Discussion

This paper is an attempt to explore the current evidences on substance use among road users and its impact on road traffic crashes in India through the existing literature. The review outcomes have relevance for settings where the influence of substance use on RTCs has not been widely explored.

Very few studies on road traffic crashes in India have been performed compared to the extent of their burden on health consequences and household economy (WHO 2004). Many developed country settings have widely investigated road traffic crashes and their determinants (WHO 2009a). Further, among the determinants of road traffic crashes in India, the influence of substance use has been grossly under-investigated. Many countries of Asia, Europe, Africa and America have studied the impact of substance use on road traffic crashes (WHO 2004).

The geographical distribution of studies in India was skewed with the gross neglect of regions with more use of alcohol (e.g. Kerala) or psychotic drugs (north-eastern states) than the average of the country. Further, many studies confined to metro cities and capital cities of states and neglected national highways and rural regions. This under-investigation along with the inappropriate method of assessing the alcohol content (as discussed further) and no drug testing might have led to an under-reporting of alcohol or drug influence in RTCs.

Despite the heterogeneity of the extracted studies, a significant proportion of random, injured and killed road users were found to have consumed alcohol. The observed alcohol use (42%) among road users in Bangalore at night-time was unexpectedly high. Usually, roadside surveys in other countries study alcohol and sometimes drug use among motor vehicle drivers only, not among pedestrians, passengers and bicyclists. Studies at sobriety checkpoints in Brazil found that 22-38% of the motor vehicle drivers at night-time in weekends had been drinking (Campos et al. 2008, Duailibi et al. 2007). An American study found that about 12% of the drivers at night-time during weekends had positive blood alcohol concentration (Lacey et al. 2009). The recent DRUID project in Europe found large variations between countries, the prevalence of blood

alcohol concentrations of 0.01 g/dL or higher was between 0% and about 17% for the 13 participating countries (Houwing et al. 2011). The results of the one roadside survey in Bangalore have not been confirmed by others, so it is not known whether it reflects the situation at certain sites and time points in Bangalore, whether there was a significant selection bias, or whether it reflects the general situation in India.

Due to various design flaws it is difficult to establish that consumption of alcohol alone would have led to road traffic crashes resulting in injuries and deaths apart from other human, vehicle, road and environmental factors. In other words, it is difficult to establish the magnitude of the impact of the use of alcohol or other substances on road traffic crashes in India through the current literature. Nonetheless, millions of rupees are being invested on sensitization and law enforcement targeted towards drink driving without much funding on its research (Ministry of Shipping, Road Transport and Highways 2007, Patel et al. 2011).

Since the majority of the studies did not mention the method of alcohol estimation and many studies used self-reported information, it is difficult to arrive at a conclusion on the prevalence of alcohol use among different categories of road users. Mere presence of alcohol in breath or self reporting cannot give an idea about the concentration of alcohol in the bloodstream, which would result in impaired judgment during driving.

In general, most of the studies showed selection bias as they were hospital based. Thus, only the most seriously injured road users were included.

Underreporting alcohol use may be a concern in many of the RTC studies (Dharmaratne and Stevenson 2006). Relying on hospital based studies will give a false account of the denominator as the studies would be missing the injuries and deaths that would not have been reported to that particular hospital or any hospital. There is also a likelihood of missing less severe cases in hospital based studies.

Many of the studies did not look into the pattern of alcohol use or drink driving. For instance, there are many studies in other countries showing that the incidence of drink driving is more during weekends than weekdays (Derriks and Mak 2006). There is only one published roadside study from India looking at the aspects of alcohol use among random road users. More random road-side surveys would have given more data on the prevalence, extent and distribution of alcohol consumption among different types of road users. Many developed and developing countries have demonstrated the role of road side surveys to determine the extent of alcohol and drug use among road users in addition to consumption pattern (Odero et al. 1997, WHO 2004).

Strengths and limitations

This is, as far as we know, the first comprehensive review of studies in India on the use of alcohol or drugs among random road users and victims of traffic accidents. This review has employed widely established and utilized systematic review techniques to identify and extract data in an unbiased manner. The general search engines and websites of Indian journals were explored to include more number of relevant studies, which might not have been indexed elsewhere. The hand-searching through the references of the selected articles enabled to further broaden the search base.

This review has incorporated gray literature (non-peer-reviewed publications) such as reports, working papers and dissertations apart from peer-reviewed publications. There is definitely a concern on the quality of research and publication for some of the gray literature. However, considering the paucity of literature on substance use and road traffic crashes in the specific field in the Indian context, we decided to have a broad-based approach so that a rich evidence base could be created. Despite the best of our efforts, we might not have identified all relevant literature. Due to the heterogeneity of literature it was not possible to perform any in-depth statistical calculations so that some quantitative evidence could be derived. However, the focus of the review is more on conceptual generalizability than evidences on statistical comprehensiveness. None of the studies had a comparison group, without which it is difficult to arrive at a conclusion on the impact of alcohol use on road traffic crashes. Similarly the studies did not adjust for any socio-demographic, road, climatic, seasonal or vehicle factor which could have introduced confounding in the studies. The vast majority of the studies did not distinguish between motor vehicle drivers, passengers, pedestrians, bicyclists or other road users.

Implications for policy

The results of this review are significant for public health planners and policy makers working on road safety. The review outcomes call for adequate policy level attention and funding for research on substance use and road traffic crashes in the country. There is an inevitable need for a country-level nodal agency to cater to the research, sensitization, and capacity development of human resources in this regard. Such an apex entity could further develop regional centers on research and training and technical support for policy makers in this regard. Such invasive efforts

are likely to fill the current gaps on the scientific appropriateness in conducting research and infrastructural facilities of laboratories. External collaborations with various governments in other countries, policy makers, development agencies and civil society organizations would be a definite need. This exchange of resources augments streamlining the efforts on research, capacity development, sensitization and behavioral change (Wang et al. 2010). More number of reference laboratories can be set up in India along with skilled human resources to estimate substance use among road users and provide evidences for policy making.

Implications for future research

Additional directions for future research might include the following.

- Conduct more rigorous research on impact of substance use on road traffic crashes
- Distinguish between different groups of road users like motor vehicle drivers versus pedestrians, and also between road users who can be blamed for the accident versus innocent victims
- Include other contributing factors, like vehicle, road and climatic conditions in addition to speed and risk-taking behavior
- Include important socioeconomic factors
- Study under-explored regions in India such as north-eastern states which have higher prevalence of psychotropic drug use
- Employ evidences from other settings of the country and rest of the world for further exploration and evidenced-based policy suggestions

Conclusion

India lacks considerable evidences on the influence of psychoactive substance use on road traffic crashes. Among the various substances practically only alcohol has been explored. Studies reported that a large proportion of RTC victims had used alcohol; but the lack of use of analytical methods led probably to some under-reporting, thus restricting appropriate law enforcements. One single roadside study had been performed; that study found that an unexpectedly large proportion of road users had drunk alcohol. Most studies did not distinguish between different types of road users, and none investigated alcohol use among those responsible for the accidents. The research findings on substance use and traffic safety performed so far in India cannot be used to estimate the relative risks for involvement in RTCs after using alcohol or drugs due to poor study design. The accumulated research portfolio can neither be used to document differences between different road user groups nor between regions. India needs policy prioritization on research to generate relevant evidences on substance use vis-à-vis road traffic crashes.

Authors' contributions:

AD, SSG and HG conceptualized the review, designed the data extraction form, extracted the data and assessed the quality of the papers. PTN was part of conceptualization and design of the manuscript. AD designed the first manuscript and all the authors revised and finally approved.

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Table I Basic characteristics of the study: a descriptive comparative assessment

Characteristics	N
<i>Year of study</i>	
1980-90	2
1991-2000	5
2001-2010	16
Total	23
<i>Site</i>	
Hospital	19
Community	3
Roadside	1
<i>Region</i>	
South	10
North	10
East	2
West	1
<i>Study population</i>	
Random community members	1
Random road users	1
Students	1
Injured RTI victims	15
Killed RTI victims	4
Injured or killed RTI victims	1
<i>Alcohol or drug exposure assessment</i>	
Not mentioned	6
Self reported	7
Analytical testing	7
Observation	3

Table II Study characteristics and summary of findings

Study location and year	Study site	Sample size (RTC)	Population	Means of verification	Alcohol Use	Quality score ^b	Indexed in Pubmed	Reference
Delhi, 1980-81	Hospital	87	Injured riders of motorized two-wheelers	Self-reported	29%	4	No	Mishra et al. (1984)
Delhi, 1985	Hospital	302	Injured motorised two-wheel crash victims. 66.6% drivers, 33.3% pas.	Self-reported	8%	4	Yes	Sood (1988)
Chennai, 1993-4	Community	4333	Random families	Not mentioned	Relative risk 2.26 for RTIs in adult males consuming alcohol daily	3	Yes	Sathiyasekaran (1996)
Pondicherry, 1994	Hospital	726	Injured crash victims. 16% drivers, 43% pas., 13% bikers, 22% ped. 6% bullock drivers	Not mentioned	Among drivers, bullock drivers and bicyclists 14.9%	2	No	Jha et al. (2003)
Delhi, 1997-8	Hospital	500	Injured crash victims. 49.8% drivers, 29.8% ped., 20.4% unknown	Analytical test (GLC of blood)	In total: 22% 16% >0.05 g/dL Drivers 22%, pas. 20%, ped. 22%	7	No	Tabin et al. (2007)
Delhi, 1997-8	Hospital	500	Killed crash victims 51% drivers, 10% pas., 39% ped.	Analytical test (GLC of blood)	34% 30% >0.05 g/dL Drivers: 20%	7	No	Millo et al. (2008)
Delhi, 1999-2000	Hospital	110	Killed crash victims 20.0% drivers, 12.7% bikers, 25.7% pas., 44.5% ped.	Analytical test (GLC of urine)	7 out of 11 ^c	2	No	Biswas et al. (2003)
Assam, 1999-2003	Hospital	1872	Killed crash victims. 14.2% drivers, 27.6% pas., 10.5% bikers, 47.0% ped.	Analytical tests (not specified)	Alcohol or drugs: In total 11.3%, drivers 33.1%, ped. 7.4%, pas. 8.3% bikers 7.7%	5	No	Singh et al. (2005)
Karnataka, 2002	Hospital	161	Injured crash victims. 39.8% drivers, 60.2% ped.,	Self-reported	In total: 13% Males 15%, females 0%	4	No	Kiran et al. (2004)
Delhi, 2002 ^a	Hospital	160	Injured and killed crash victims. 36.9% 3/4-wheel drivers/pas., 18.8% 2-wheel drivers/pas., 6.8% bikes, 37.5% ped.	Analytical test (alcohol estimation kit for blood)	Injured 33.0% >0.03 g/dL, Killed 46.7% > 0.03 g/dL	5	No	Kochar et al. (2002)
Karnataka, 2002	Hospital	1605	Injured crash victims. 43.3% drivers, 23.9% pas., 3.7% bikers, 25.3% ped.,	Observation	11%	5	No	Gururaj and Benegal (2002)

3.9% others								
Karnataka , 2002	Roadside	480 (random)	Random road users (between 8 or 9 pm and midnight). 75.4% riders/pillion, 24.2% 3-4 wheel drivers, 0.4% ped.	Breathalyzer	42% 35% >0.03 g/dL 2-wheeler drivers/pas: 44% 3/4-wheeler drivers/pas: 34%	5	No	Gururaj and Benegal (2002)
Delhi, 2002	Community	680	Injured crash victims. 57.7% drivers/pas., 14.1% bikers, 24.9% ped., 4.1% others.	Self-reported	Alcohol or drug use: 1.9%	3	No	Verma and Tewari (2004)
Maharashtra, 2003-4	Hospital	350	Injured crash victims. 28.9% drivers, 49.7% pas, 7.4% bikers, 13.4% ped, 0.6% bullocks.	Observation	Drivers: 29.5%	4	Yes	Patil et al. (2008)
Karnataka, 2004 ^a	Hospital	1553	Male trauma patients . 42% motorcycle occupants, 18% pas., 20% ped.	Self-reported	16%	5	Yes	Gururaj (2004b)
Madhya Pradesh, 2004-5	Hospital	164	Injured crash victims	Not mentioned	11.58	2	No	Swarnkar 2010
Hyderabad, 2005-6	Hospital	378	Injured motorised two-wheel crash victims. 66.7% drivers, 33.3% pas.	Not mentioned	35 out of 58 riders ^c 13 out of 24 pillons ^c	4	Yes	Fitzharris et al. (2009)
Karnataka, 2006-7	Hospital	540	Injured crash victims. Drivers 30.5%, pas. 42.6%, ped. 26.8%	Observed	12.1%	2	No	Gudadinni (2007)
Karnataka, 2006-7	Hospital	144	Injured motorized two-wheeler crash victims. 75.7% drivers, 24.3% pas.	Not mentioned	22.9%, all males Drivers 24.1%, pas. 20.0%	5	Yes	Mallikarjuna and Krishnappa (2009)
Delhi, 2007 ^a	Community	550	Adolescent students	Self-reported	20% had been passengers of drunk driver during last month	4	Yes	Sharma et al. (2007)
Delhi, 2007-8	Hospital	94	Killed motorcycle crash victims	Analytical test (GLC of blood)	6.38%	4	No	Behera et al. (2009)
Orissa, 2008	Hospital	40	Injured crash victims. 37.5% drivers, 47.5% pas., 15% ped.	Not mentioned	15%	2	No	Sarangi et al. (2009)
Karnataka, 2008-9	Hospital	251	Injured crash victims 82.9% vehicle users, 17.1% pas.	Self-reported	14.1%	4	Yes	Utharsh et al. (2011)

^aIndicates year of publication

^bQuality score takes into account: age and gender disaggregated information presented; 24 hours collection; means of verification, BAC cut-off and types of road users mentioned, and peer reviewed (Maximum score – 7, minimum score – 0)

^cNot included in calculations or Figures 2 and 3 due to small fraction analyzed or questioned about alcohol or drug use.

Drivers = drivers of two-wheel, three-wheel or four-wheel motor vehicle of any type; pas.= passengers or pillon riders; ped.= pedestrians; bikers= bicycle riders

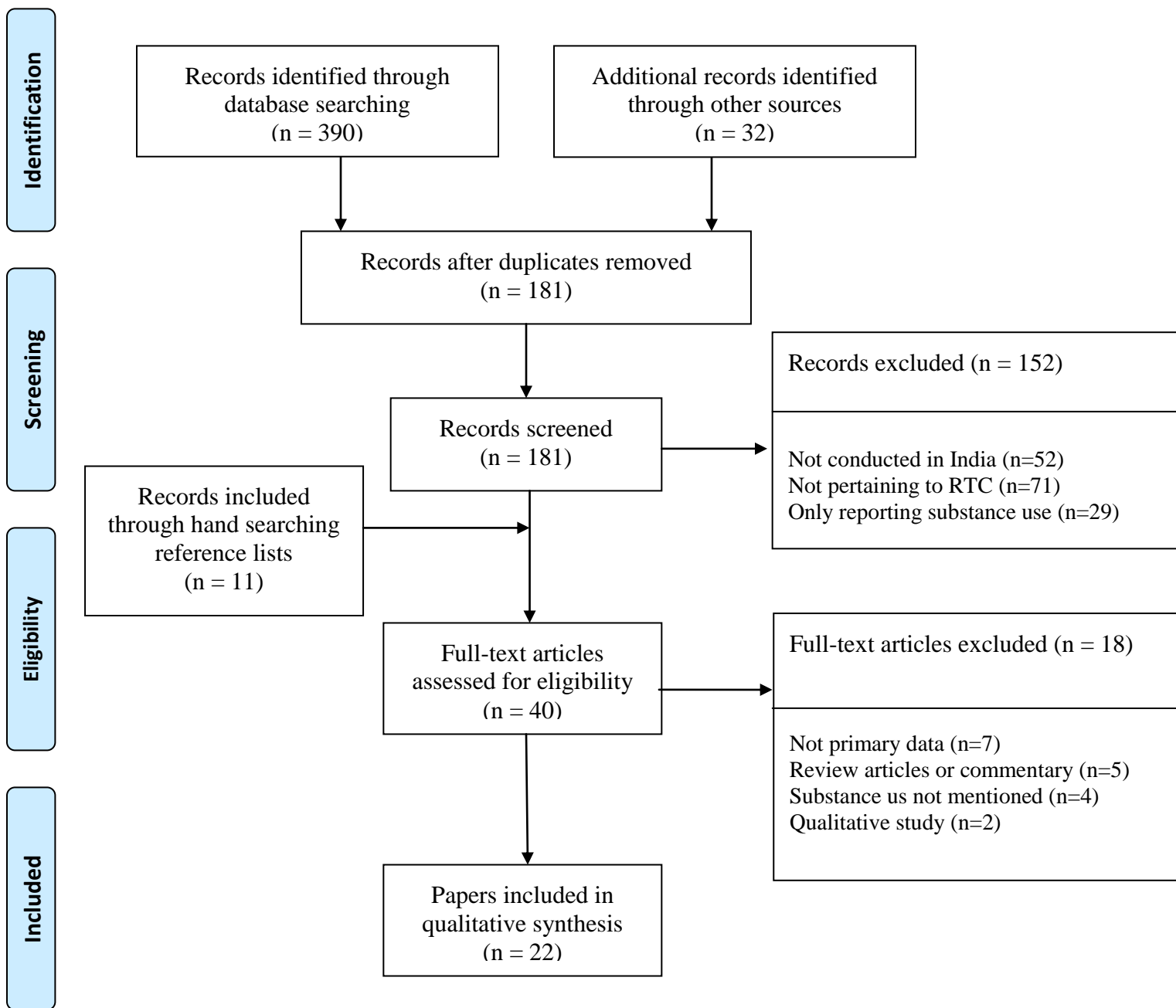


Figure 1 PRISMA 2009 flow diagram for selection of papers

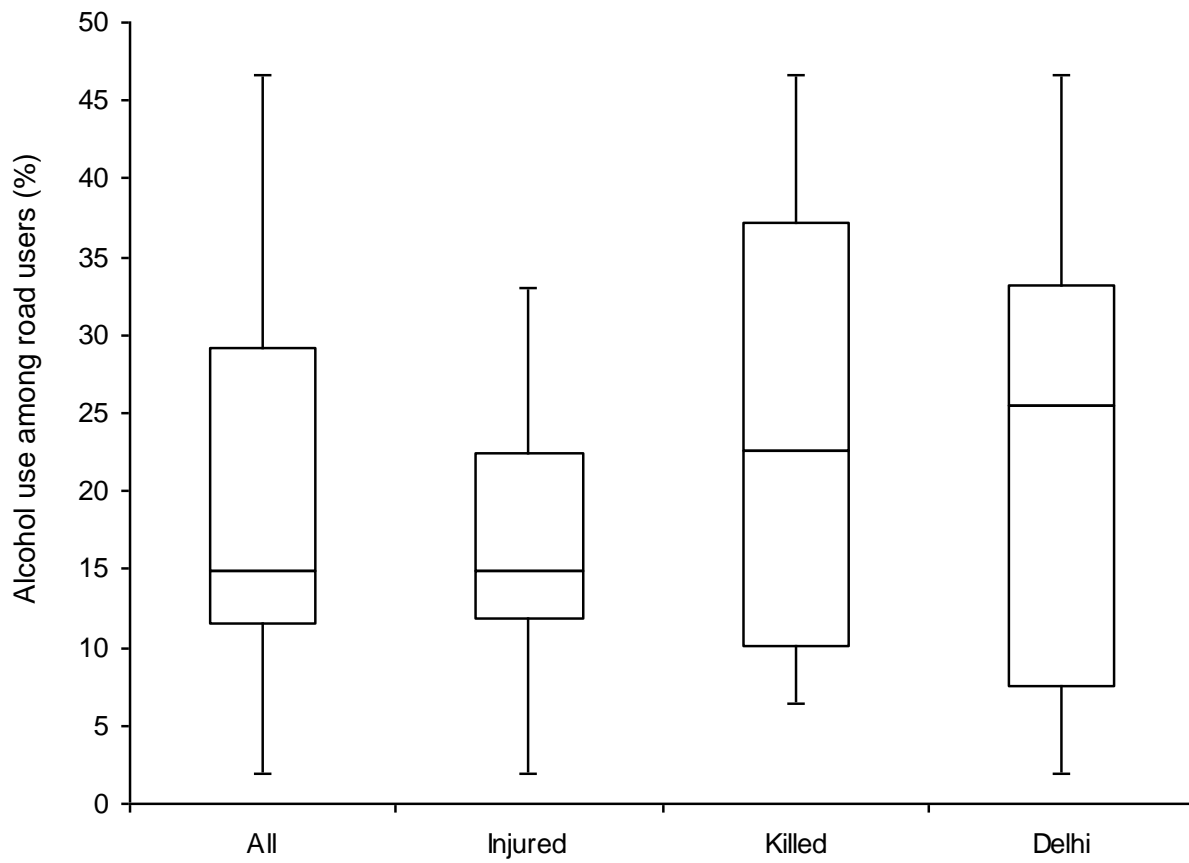


Figure 2 Proportion of road users having used alcohol or drugs

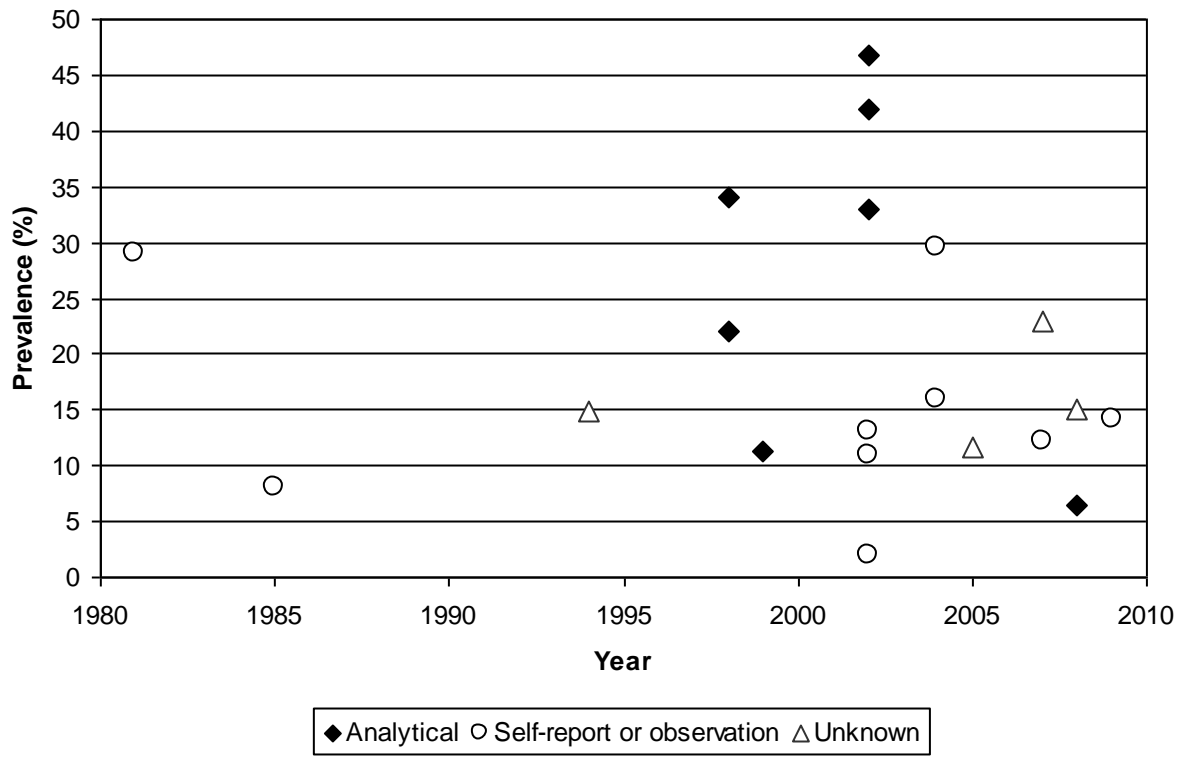


Figure 3 Prevalence of alcohol or drug use in relation to year of study and type of alcohol and drug determination.