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Research Paper on Factors Influencing Crashes at Signalized Intersection of Delhi

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Abstract: *The main aim of this paper is to analyze the road accidents in India at national, state, and metropolitan city level. Analysis shows that the distribution of road accidental deaths and injuries in India varies according to age, gender, month and time. Age group 30-59 years is the most vulnerable population group, though males face higher level of fatalities and injuries than their female counterparts. Moreover, road accidents are relatively higher in extreme weather and during working hours. Analysis of road accident scenario at state and city level shows that there is a huge variation in fatality risk across states and cities. Fatality risk in 16 out of 35 states and union territories is higher than the all India average. Although, burden of road accidents in India is marginally lower in its metropolitan cities, almost 50% of the cities face higher fatality risk than their offusil counterparts. In general, while in many developed and developing countries including China, road safety situation is generally improving, India faces a worsening situation. Without increased efforts and new initiatives, the total number of road traffic deaths in India is likely to cross the mark of 250,000 by the year 2025. There is thus an urgent need to recognize the worsening situation in road deaths and injuries and to take appropriate action.*

Keywords: *Road safety; public health; fatality rate; fatality risk; India.*

I. INTRODUCTION

Fatalities and injuries resulting from road traffic accidents are a major and growing public health problem in India. Every week nearly 2,650 people get killed and 9,000 get injured due to traffic accidents. In 2013, latest year for which data is available, 137,423 people died and 469,900 people got injured due to road accidents in India. Traffic accidents have now earned India a dubious distinction; with nearly 140,000 deaths annually, the country has overtaken China to top the world in road fatalities. India is the only country in the world which faces more than 15 fatalities and 53 injuries every hour as a consequence of road crashes. While in many developed and developing countries including China, the situation is generally improving, India faces a worsening situation. If the trend continues, the total number of road traffic deaths in India would increase by 100% between 2013 and 2027. Without increased efforts and new initiatives, the total number of road traffic deaths in India is likely to cross the mark of 250,000 by 2025. The main aim of this study is to analyze the road traffic accidents in India at national, state, and metropolitan city level. Focus would be to identify the major road safety issues and discuss countermeasures that would have potential to address the specific road safety problems.

The primary source of data for the study is *Accidental Deaths & Suicides in India, 1970 to 2013* published by the National Crime Records Bureau, Ministry of Home Affairs, Government of India, New Delhi. The analysis shows that during the last ten years, road accidental fatalities in India have increased at the rate of 5% per year while the population of the country has increased only at the rate of 1.4% per year.

Due to this, fatality risk, road accidental deaths per 100,000 people, has increased from 7.9 in 2003 to 11.2 in 2013. Fatality risk in India is not only quadruple than that in some of the developed countries such as United Kingdom and Sweden but also still increasing rapidly. It is also found that the distribution of road accidental deaths and injuries varies according to age, gender, month and time. Among people of all age groups, people of economically active age group of 30-59 years is the most vulnerable. However, if we compare gender-wise fatalities and accidents, we found that the males accounted for 85.2% of all fatalities and 82.1% of all injuries in 2013.

Moreover, road accidents are relatively higher in May-June and December-January which shows that extreme weather influences the occurrence of road accidents.

Accidents remain relatively constant and high during 9 AM - 9 PM and variable but low during mid-night and early hours of the day. However, this does not imply that daytime driving is more risky than nighttime driving. The study also tries to find out cause-wise distribution of road accidents. There are several factors responsible for accidents

1) *Delhi report card*: Delhi ranks the highest in terms of fatal accidents and in number of pedestrians and cyclists falling victim to road crashes. The total number of accidents in 2013 was 9 per cent higher than the 2012 level. The ministry's "Road Accidents in India 2012" report shows that on an average, about five road accident deaths occur every day, which includes two pedestrians and two two-wheeler riders. Every week, two cyclists and one car rider dies in Delhi. In 2014 (till the month of May), road accidents had claimed 325 lives during the night and 332 lives in the day time. Violation of rules is rampant—with 329,000 cases of signal jumps, over 14,000 cases of drunken driving and 45,158 cases of over speeding being reported. Chennai, which follows Delhi in road accident deaths, reports 25 per cent less fatalities.

Scenario of road accidents in India and around the world from which we observe that road accidents are undoubtedly the most frequent and overall the cause of the most damage. The reason behind this scenario is extremely dense road traffic, lack of proper geometric design, environmental conditions and relatively great freedom of movement given to road user. The increasing numbers of road vehicles as well as road accidents had raised the need to improve design and practical approach of various road parameters.

The prevention of road accidents is also extremely important especially at the intersections where there are major conflict points. India is a signatory to Brasilia Declaration and is committed to reduce the number of road accidents and fatalities by 50 per cent by 2020. Hence it is necessary to identify all the major and minor factors which are affecting the road safety. Intersections are among the most dangerous locations of a roadway network. Among deferent types of intersections, signalized intersections are expected to provide efficient traffic movement and to improve traffic safety.

Signalized intersection is the common space of all the crossing roads at an any location which is controlled by providing the electrically operated traffic control devices. The primary purpose of providing signals is to enhance the traffic movement at the junction and to ensure the traffic safety at conflict points over common space by enabling right of way and shared use of road space to all the road users (e.g. Pedestrians, Bicyclists, Motorists and transit users). If this space is left uncontrolled than there is a major chances of conflicting the different traffic streams . Signalization is one of the way to control this space. Figure 1 shows a typical signalized intersection having four legs.



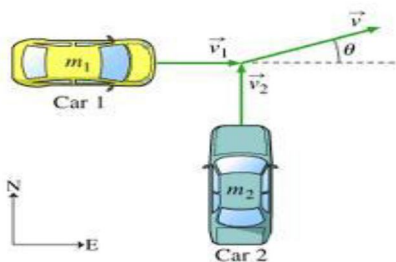
Figure 1.1 .A typical signalized intersection

Signalized intersections are supposed to provide efficient movement of different traffic streams and other road users at the junction by providing right of way and shared use of road space. However many studies have shown that there are many problems related to safety at these locations.

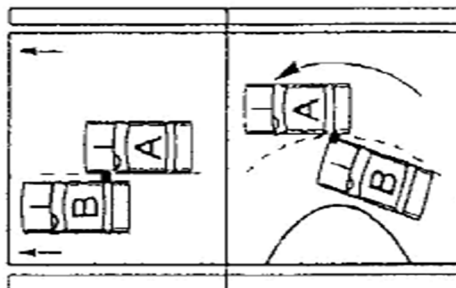
Special types of crashes are one of the problems at these locations as for as the safety concern. Figure 1.2 shows some of special crashes that occur at signalized intersections such as Rare end collision, Right angle collision, right turn collision (in Indian scenario), sideswipe.



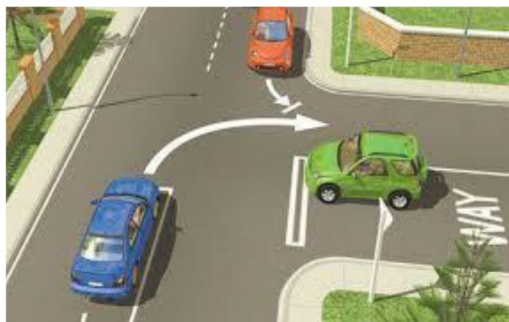
Rare end collision



Right angled collision



Sideswipe collision



Right turn collision

Figure 1.2. Different types of crashes at intersection

In this study focus is given to identifying various factors that affects the safety at signalized intersection. Some of the major factors are as follows:

- a) Geometrical Factors
- b) Traffic volume
- c) Operational control of signals
- d) Environmental Factors
- e) Other miscellaneous factors

Rapid increase in number of vehicles is the primary cause of different traffic movement problems like accidents, congestion, delay etc. In now a days almost every city faces traffic congestion at some locations on their road network. These locations are mostly the intersections. In India 37% of total crashes occurred at the intersections in 2016 (MORTH: A Report on Road Accidents in India-2016).⁸ This signifies that there is still lots of requirement to improve the safety at an intersection. To fulfill this purpose it is mandatory to identify the factors that affects the safety at these locations. This study identifies the factors that affects the safety at signalized intersection. China has first ranked in the world in the number of road accidents and fatalities, in which approximately 30% of accidents occurred at urban intersections. Therefore, measuring intersection safety factors is essential to achieve effective correction countermeasures. It was observed that intersection collision figure in Japan are even more devastating, with more than 58 percent of all traffic crashes reported at intersection. Intersection related fatalities in Japan are approximately 30 percent of all Japanese traffic accidents.

A. *Advantages Of Traffic Signals*

Traffic signals control vehicle and pedestrian traffic by assigning priorities to various traffic movements to influence traffic flow. Properly designed, located and maintained traffic signals have one or more of these advantages:

- 1) Provide for orderly movement of traffic;
- 2) Increase traffic-handling capacity of an intersection;
- 3) Reduce frequency and severity of certain types of crashes, especially right-angle collisions;
- 4) Provide for continuous movement of traffic at a definite speed along a given route;
- 5) Interrupt heavy traffic at intervals to permit other vehicles or pedestrians to cross.

B. *Disadvantages Of Traffic Signals*

Traffic signals are not a solution for all traffic problems at intersections, and unwarranted signals can adversely affect the safety and efficiency of traffic by causing one or more of the following:

- 1) Excessive delay;
- 2) Increased traffic congestion, air pollution and gasoline consumption;
- 3) Disobedience of signals;
- 4) Increased use of less-adequate streets to avoid traffic signals;
- 5) Increased frequency of crashes, especially rear-end collisions.

C. *Objective And Scope Of The Study*

- 1) Selection of study area and the road intersection at which POLS is to be identified.
- 2) Selection and study of the intersection pedestrian delay affect the pedestrian LOS.
- 3) Data collection using video camera kept on road intersection.
- 4) Analysis of data and evaluation of relation between various factor and pedestrian LOS by correlation.
- 5) Summary, conclusion and utilization of data in the future.

D. *Statement Of The Problem*

The purpose of this study on pedestrian need is to provide better facilities to pedestrian in India. Pedestrian level of service is one of the indicative which represents quality of given intersection in terms of perceived safety, convenience and comfort in terms of pedestrian perspective. In India the number of person prone to accidents and deaths are mainly pedestrian. Pedestrian are one of the major commuters on Indian urban streets. In India mostly pedestrian are neglected in transportation planning and management. So as the pedestrian increasing day by day so better facilities need to be provided.

II. LITERATURE REVIEW

Klobucar & Fricker (2007) assumed in his study that bicyclists make decisions on the basis of perceived safety and travel distance. They presented two tools as most commonly used to quantify the perceived safety of a bicycle facility are the bicycle compatibility index (BCI) and the bicycle level of service (BLOS). Each evaluation tool was developed by using stated perceptions of the conditions faced by a bicyclist on various facilities and by using the properties of the facility and its environment to fit a linear regression to predict these perceptions. Based on this safe length have been calculated. It has been concluded that improvement in the total network path safe length indicates an improvement in the perceived safety of the bicyclists.

Parkin, Wardman, & Page (2007) developed two models of perceived risk; based on non-linear least squares, and a model of acceptability, based on the logit model, have been estimated for whole journeys based on responses from a sample of 144 commuters (2002) to video clips of routes and junctions. The risk models quantify the effect of motor traffic volumes, demonstrate that roundabouts add more to perceived risk than traffic signal controlled junctions and show that right turn manoeuvres increase perceived risk. The acceptability model confirms the effect of reduced perceived risk in traffic free conditions and the effects of signal controlled junctions and right turns.

Cho, Rodriguez, & Khattak (2009) examined how perceived and actual crash risks are related with each other and with respect to built environmental characteristics. Perceived risks for pedestrians and bicyclists were measured with a questionnaire including perceived neighborhood safety developed by the Neighborhood Quality of Life Study.

Elvik and Bjornskau (2005) probed the extent to which the public accurately perceived differences in transport risks. Comparisons have been made between estimates of the fatality rate per billion kilometres of travel and four different summary measures of perceived risk. All these comparisons show high correlations between statistically estimated risk and perceived risk.

Finn and Bragg (1986) mentioned in their study that young drivers are significantly overrepresented among all drivers involved in traffic accidents and fatalities. Excessive risk taking by young drivers appears to be largely responsible for this disproportionate involvement. This excessive risk taking could be due to (1) being more willing to take risks than older drivers are, (2) failing to perceive hazardous situations as being as dangerous as older drivers do or (3) both causes. It was also concluded that young male drivers are overrepresented in traffic accidents at least in part because they fail to perceive specific driving situations as being as risky as older drivers perceive them.

Zhao et al. (2014) aimed to develop a pedestrian level of service (LOS) model for unsignalized midblock crossings from the pedestrian’s perception of safety and convenience perspective in China. The potential factors influencing pedestrian LOS at unsignalized midblock crosswalks were summarized from four respects: traffic conflicts, the distance between crosswalks, crossing facilities, and delay. The results revealed that the factors significantly influencing pedestrian LOS of the overall unsignalized midblock crossings of road segments included volume of two-way motor vehicle, the distance between marked midblock crosswalks, and the distance between unmarked crosswalks. Motor vehicle traffic volume was found to have negative effect on pedestrian LOS, and the distance between marked midblock crosswalks and the distance between unmarked midblock crosswalks have differently positive effect on pedestrian LOS [14].

Kadali and Vedagiri (2015) aimed to evaluate the LOS of midblock crossing facilities with respect to different land-use type under mixed traffic conditions. An ordered probit (OP) model was developed by using NLOGIT software package, considering road crossing difficulty as well as safety, number of vehicles encountered, pedestrian individual factors, and roadway geometry and land-use type. The researchers found that perceived safety, crossing difficulty, number of vehicles encountered, land-use condition, number of lanes and median width have significant effect on pedestrian perceived LOS. Increase in vehicle volume results in decrease in pedestrian perceived LOS. The pedestrian safety can be improved by improving crossing facilities such as proper markings, adequate barrier width, lighting and controlling vehicular movement [15].

III. RESULT AND DISCUSSION

A. Overview

Fatalities and injuries resulting from road traffic accidents are a major and growing public health problem in India. Every week nearly 2,650 people get killed and 9,000 get injured due to traffic accidents. In 2018, latest year for which data is available, 137,423 people died and 469,900 people got injured due to road accidents in India. Traffic accidents have now earned India a dubious distinction; with nearly 140,000 deaths annually, the country has overtaken China to top the world in road fatalities

Month- and time-wise distribution of road accidents

Figure 3.1 presents month-wise distribution of road accidents in India. Although monthly variation in road accidents is not substantial, road accidents are relatively higher in May-June and December-January. This shows that extreme weather influences the occurrence of road accidents. Since temperature is fairly high in May-June in India, it might have had its impact on road accidents.

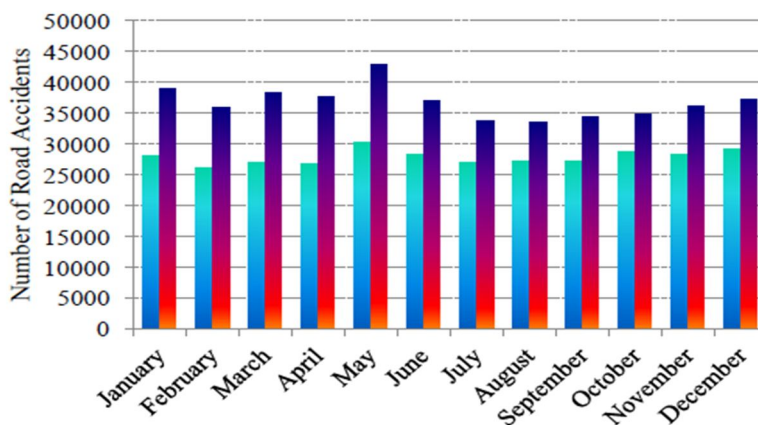


Figure 3.1. Number of Road Accidents by Month of Occurrence in 2008 and 2018

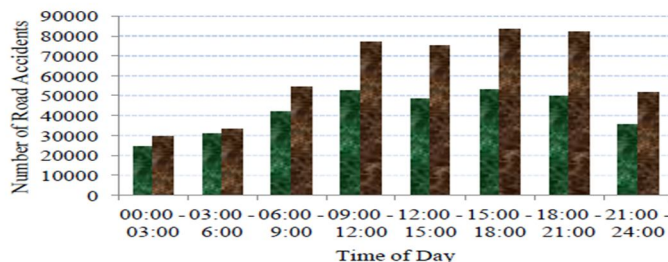


Figure 3.2. Number of Road Accidents by Time of Occurrence in 2008 and 2018

B. Causes of Road Accidents

Figure 3.2 presents cause-wise distribution of road accidents in India in 2018. It clearly shows that drivers' fault is the single most important factor responsible for accidents. Drivers' fault accounted for 78% of total accidents, 76.5% of total injuries and 73.7% of total fatalities in 2018. Within the category of drivers' fault, accidents caused due to exceeding lawful speed accounted for a high share of 55.6%. As a share of total accidents and deaths due to drivers' fault, intake of alcohol and drugs accounted for 5.3% and 6.4%, respectively. As a share of total road accidents and deaths, overloading / overcrowding of vehicles accounted for 19.6% and 22.8%, respectively. The fault of cyclists and pedestrians appears to be marginal; they account only 1.2% and 2.2% of total accidents, respectively. The accidents caused due to defects in motor vehicle condition and road condition is also negligible in comparison to drivers' fault. They accounted only 1.8% and 0.8% of total road accidents, respectively.

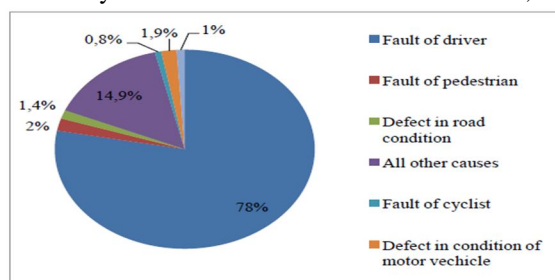


Figure 3.3. Causes of Road Accidents in 2018

C. Analysis Of Road Accident Scenario At State Level

Figure 3.4 presents fatality risk, number of fatalities per 100,000 people, across Indian states and union territories for the year 2008 and 2018. There is a huge variation in fatality risk across states and union territories, ranging from 0 fatality per 100,000 people in Lakshadweep to 22.8 fatalities per 100,000 people in Tamil Nadu in 2018. During the same year, three states, Tamil Nadu (22.8), Haryana (17.2), and Andhra Pradesh (16.9), faced 50% higher fatality risk than all India average (11.2). In 2018, fatality risk in 16 out of 35 states and union territories was higher than the all India average. From 2008 to 2018, fatality risk in 11 states and union territories increased at higher rate than that in the whole country. During the same period, Jharkhand faced the highest increase in fatality risk (1.6 to 8.1) followed by Punjab (6.2 to 16.2), A & N Island (3.2 to 7.5), Bihar (2.5 to 5.0), Assam (4.1 to 7.8), Madhya Pradesh (7.1 to 12.0), Uttar Pradesh (4.6 to 7.5), Orissa (6.1 to 9.8), Tamil Nadu (14.6 to 22.8), Sikkim (7.1 to 10.8), and Chhattisgarh (9.4 to 13.9). However, there are nine states and union territories which experienced decrease in fatality risk from 2008 to 2018. Out of these nine states and union territories, Lakshadweep (1.7 to 0.0), Nagaland (3.1 to 1.5), Chandigarh (14.0 to 7.6), Delhi (12.9 to 9.3), and Punducherry (18.6 to 14.9) experienced sharp decline in their fatality risk. Figure 5 presents fatality rate, number of fatalities per 10,000 vehicles, across Indian states and union territories for the year 2008 and 2018. There is a huge variation in fatality rate across states and union territories, ranging from 0 fatality per 10,000 vehicles in Lakshadweep to 16.0 fatalities per 10,000 vehicles in Bihar in 2018. During the same year, five states, Bihar (16.0), Sikkim (15.8), West Bengal (15.1), Himachal Pradesh (14.3), and Assam (13.5) faced 50% higher fatality rate than all India average (8.6). In 2018, fatality rate in 16 out of 35 states and union territories was higher than the all India average. From 2008 to 2018, fatality rate has decreased in most of the states and union territories; in fact, 24 out of 35 states and union territories experienced higher decline in their fatality rate than that in the whole country. Fatality rate in 8 states and union territories declined by more than 50%. However, two states, Jharkhand (4.1 to 8.4) and Punjab (4.7 to 7.3), and one union territory, A & N Island (4.3 to 5.2), faced increase in their fatality rate.

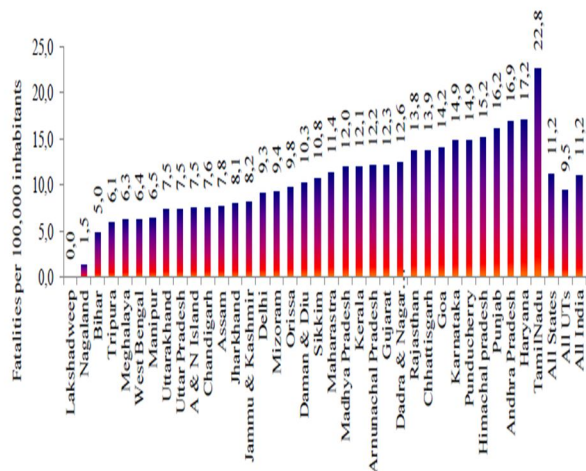


Figure 3.4a. Road Accident Fatality Risk in Indian States and Union Territories in 2018

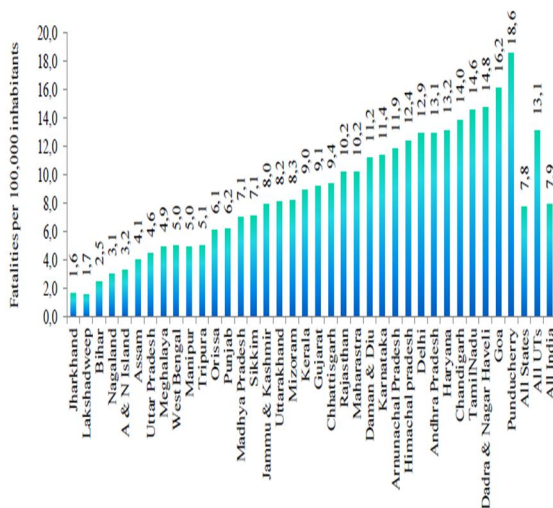


Figure 3.4b. Road Accident Fatality Risk in Indian States and Union Territories in 2008

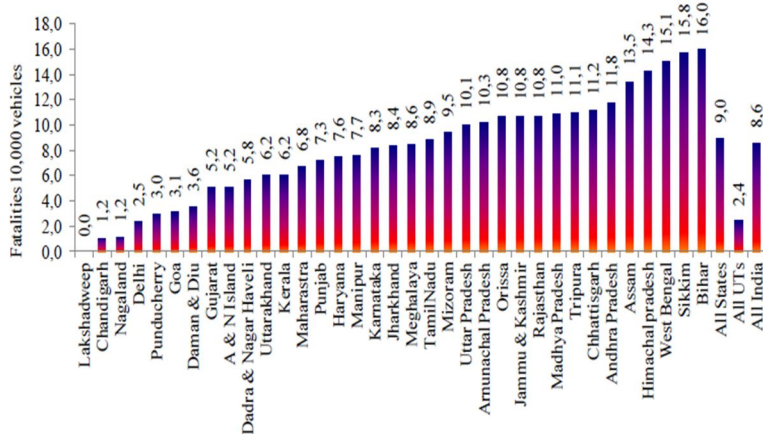


Figure 3.5a. Road Accident Fatality Rate in Indian States and Union Territories in 2018

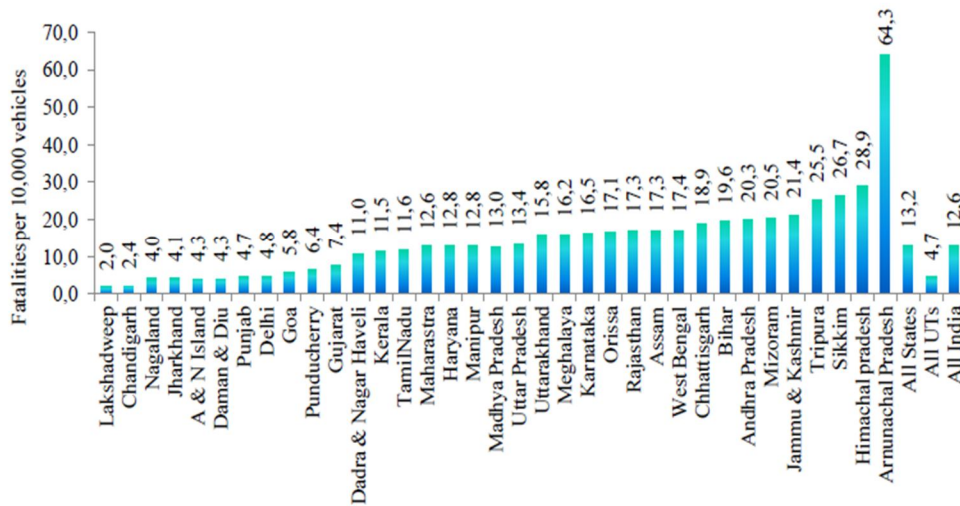


Figure 3.5b. Road Accident Fatality Rate in Indian States and Union Territories in 2008

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

There is clearly a need for road safety education and it should be directed towards road users, who are frequently involved and injured in RTAs (e.g. students). An integrated programme of road safety education is suggested.

- 1) Pre-school children may be introduced to the elementary concepts of road safety through stories involving the animal world.
- 2) Primary school children may be given practice guidance on the use of side walks and road crossing techniques.
- 3) For middle school students - road signs and bicycle riding.
- 4) High school students can be taught about reaction time, braking distance, defensive driving and hazards of alcoholic drinks. Road side random breath testing for alcohol should be done by using breath analyzers, which can be confirmed by blood concentration level of alcohol.

The real pressure and motivation to improve driving skills can come only through licensing authorities by adopting stricter, more comprehensive and scientifically based test laying a stress on road rules, regulations and traffic control devices.

At the time of giving license to the public transport drivers (Bus and Trucks), they can be given training in first-aid skills so that victims are attended immediately in the post accident period.

B. Suggestion

- 1) Introduce high penalty and stringent enforcement of current laws: The Motor Vehicles Act and Rules focus on vehicle safety, seatbelt and helmet requirements, and speeding and drunk-driving laws. This can work effectively only with strong deterrence and stringent penalties. Reform the Motor Vehicles Act and Rules for stringent penalty, reduce speed limit in cities to 30 km/hour and set targets to achieve zero fatalities.
- 2) Improve traffic surveillance and technology aids.
- 3) Introduce a comprehensive road safety act addressing safety of all road users, including vulnerable road users such as pedestrians, cyclists and two-wheeler riders
- 4) Notify street design guidelines under the Delhi Development Act to make it mandatory. For national action, notify under the Central Motor Vehicles Act and Rules.
- 5) Mandate implementation of pedestrian and cycling plans and pre- and post-construction road safety audits of roads. Public transport plans must include pedestrian plans for multimodal integration.
- 6) Make encroachment (parking, gardens etc) on footpaths punishable under law.
- 7) Implement measures to reduce traffic volumes and introduce traffic calming measures – especially on highways/arterials within a city.

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