Road Accident Analysis: A Case Study of Patna City*

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Abstract

As you would expect, one of India's poorest and densely populated states, Bihar's capital, Patna, is noisy, crowded, polluted, and typically chaotic. The roads in the city are congested and encroached by other activities. Bus services in particular have deteriorated, and their efficiency and quality of service have been declining thus inducing passengers to turn to personalized modes and IPTs. This results not only in restricting the traffic flow, but also putting the road users' life at a great risk. The total number of fatal accidents as well as related fatality in the city is increasing over the years. Persons killed per 100 accidents are alarmingly high, as high as 45 during the year 2000. Pedestrian deaths as a percentage of all road fatalities are also extremely high. During the recent years, they constitute more than 90% of all road fatalities. Also, the adult working age group (18 to 60 years) accounted for more than 80 percent of all casualties. New bypass road on national highway (NH – 38) is the most accidents prone location in the city where around 15% of all accidents occurred during the year 2000. We believe that individual road safety audit for this location should be carried out by a multi-disciplinary team of experts to suggest corrective measures.

Key Words: Road safety

JEL Classification: R49, Z00

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1. Introduction

Urban transport facilities in most of the Indian cities are inadequate and deteriorating over the years. The development of public transport system has not kept pace with the traffic demand both in terms of quality and quantity. As a result, the use of the undesirable modes such as personalized transport, mainly two-wheelers, and intermediate public transport, mainly three-wheelers, is growing at a rapid speed. Roads and footpaths today are heavily encroached by parked vehicles, hawkers, and roadside business forcing pedestrians to walk on the road. This results not only in restricting the traffic flow, but also putting the pedestrians' life at a great risk. Besides encroachment, it is found that road surface in most of the Indian cities is substandard. In addition, lane marking and traffic signs are usually missing and the intersections often require geometric correction. Wholesale goods centers are usually located in center of the city, which attract substantial goods traffic on congested city roads.

As you would expect, one of India's poorest and densely populated states, Bihar's capital, Patna, is noisy, crowded, polluted, and typically chaotic. Patna is located on the east-west corridor of north India in the Indo-Gangetic plain of rich fertile soil. It is well connected with the rest of the country by railways, roadways, and airways. The demographic characteristics of Patna city indicates that it has added around 0.4 million people in last one decade. Current estimate of its population is around 1.3 million. As a result of population growth, the city is expanding. The most important point of its physical expansion is that the city has been growing linearly from east to west due to limiting factor of river Ganga in the north and low lying area of river Poonpoon in the south.

The existing road network in the city is inadequate. Functionally the roads do not have any hierarchy as each individual road changes its characteristics after a short distance. At present around 4.6% of the total developed area is devoted to roads which is much below the desired level. Moreover, the vehicular population growth is quite high, with just 4,384 registered motor vehicles in 1981 to 2,94,164 in 2001, an increase of around 67 fold in the span of two-decades. Furthermore, the lack of effective mass transport system has given rise to a tremendous increase in IPT modes and personalized vehicles.

Most of the Roads in Patna are heavily encroached by parked vehicles, hawkers, and road side business. This results not only in restricting the traffic flow, but also putting the road users' life at a great risk. This paper attempts to analyze the road accidents in Patna using annual data from the year 1996 to 2000. The remainder of the paper is organized as follows: Section 2 provides an overview of road accident scenario in India. Section 3 deals with existing transport system in Patna. In section 4, road accidents in Patna are analyzed in detail. Finally, section 5 summarizes this paper.

2. Road Accident Scenario in India

Many developing countries including India have a serious road accident problem. Fatality rates (defined as, road accidental deaths per 10,000 vehicles) are quite high in comparison to developed countries. While in Europe and North America the situation is generally improving, many developing countries face a worsening situation. Apart from the humanitarian aspects of the problem, road accidents cost countries of developing world at least one percent of their Gross National Product (GNP) each year – sums that those can ill afford to lose. Compared to causes of death more commonly associated with the developing

world, deaths from road accidents are by no means insignificant. The nature of problem in developing countries is in many ways different from that in industrialized world. The proportion of commercial and public service vehicles involved in road accidents are often much greater. Pedestrians and cyclists are often the most vulnerable. Lack of medical facilities in these countries is considered to be an important factor leading to high death rates.

There is an alarming increase in accidental deaths on Indian roads. Table 1 presents the rate of road accidental deaths in India from the year 1991 to 1998. Fatality risk (defined as, road accidental deaths per 1,00,000 population) in India is increasing over the years, from 6.7 in 1991 to 7.9 in 1998. During the period from 1991 to 1998, road accidental deaths have increased at a rate of 4.44 percent per annum while the population of the country has increased by only 1.92 percent per annum.

Table 2 reports road accidental deaths according to type of vehicles for the year 1998. This table reveals that trucks and buses are responsible for highest number of accidental deaths, 25.7 and 17 percent of casualties happened due to trucks and buses, respectively.

It is believed that road accidents are increasing since motor vehicle population is increasing with greater rates than the expansion of road network. Presently, vehicle population in India is over 37 million. During recent years, vehicular population is growing at an annual rate of around 10%. Table 3 presents the growth of vehicular population and road accidents in the country from 1995 to 1998. This table shows that accident and fatality rate in India is quite high, as high as 80 and 20, respectively (last two columns of Table 3).

Table 1. Rate of road accidental deaths during 1991 to 1998

Year	No. of road accidental deaths (in '000')	Estimated mid-year population (in million)	Fatality risk (col.2*100/col.3)
1991	56.6	849.6	6.7
1992	57.2	867.7	6.6
1993	60.6	883.8	6.9
1994	64.0	899.9	7.1
1995	68.4	916.0	7.5
1996	69.8	931.9	7.5
1997	74.2	955.2	7.8
1998	76.7	970.9	7.9

Source: ACCIDENTAL DEATHS & SUICIDES IN INDIA 1996, 1997, and 1998 Published by NATIONAL CRIME RECORDS BUREAU, Ministry of Home Affairs, GOI, New Delhi.

Table 2. Road accidental deaths according to type of vehicles during 1998

Type of vehicles	No. of accidental deaths	Percentage share
Truck/Lorry	19731	25.7
Bus	13007	17.0
Tempo/Van	5429	7.1
Jeep	6890	9.0
Car	4777	6.2
Three-wheeler	2763	3.6
Two-wheeler	8098	10.6
Bicycle	2954	3.8
Pedestrians	7657	10.0
Others	5426	7.1
TOTAL	76732	100.0

Source: ACCIDENTAL DEATHS & SUICIDES IN INDIA 1998 Published by NATIONAL CRIME RECORDS BUREAU, Ministry of Home Affairs, GOI, New Delhi.

Table 3. Growth in motor vehicle population and road accidents in India

Year	Road accidents (in '000')	Persons injured (in '000')	Persons killed (in nos.)	Vehicle population (in '000')	Rate of accidents per ten thousand vehicles	Rate of deaths per ten thousand vehicles
1995	214.4	266.5	68351	30286.9	70.8	22.6
1996	272.1	282.2	69800	33782.7	80.5	20.7
1997	290.9	309.5	74204	37231.5	78.1	19.9
1998	300.0	320.5	76732	37231.5*	80.6 (P)	20.6 (P)

Source: ACCIDENTAL DEATHS & SUICIDES IN INDIA 1997 AND 1998 Published by NATIONAL CRIME RECORDS BUREAU, Ministry of Home Affairs, GOI, New Delhi.
*Figures of 1997 repeated due to non-availability of 1998 statistics.
P - Provisional

3. Transport System in Patna

3.1 Road network

The existing circulation pattern of Patna is of linear type. The most important factor determining the form of road network system is the presence of river Ganga in the north and low lying area of river Poonpoon in the south. This linear type of urbanization coupled with limited number of river crossings has given rise to a dominant east-west orientation of arterial roads. But, unfortunately, the city has no system or hierarchy of roads. The whole road network system is deficient in terms of geometric and traffic management aspects. At present around 4.6% of the total developed area is devoted to roads which is much below the minimum requirement for a city.

3.2 Growth of vehicles

The vehicular population growth is tremendous in Patna, with just 4,384 registered motor vehicles in 1981 to 2,94,164 in 2001, an increase of 67 fold in a span of just two-decades. It is

interesting to note that vehicular growth has slowed down substantially during the 1990s. From 1996 to 2001, vehicular population in Patna grew at an average annual rate of around 6%, whereas if we calculate it from 1981 to 2001, annual growth rate figure goes up to around 23%. It is observed that growth of personalized vehicles such as two-wheelers and cars is very steep due to non-availability of mass transport system. In 1981, cars and two-wheelers population was 409 and 2,534 respectively, which has gone up to 31,290 and 1,97,291 respectively during the year 2001. The population of personalized vehicles has increased by more than 75 fold from 1981 to 2001. At present, around 67% of all vehicles are two-wheelers which were around 57% during the year 1981. The trend in passenger vehicles ownership highlights a gradual shift from slow modes to private fast modes. Particularly the growth of two-wheelers and cars has been much higher than the growth of population as well as other vehicles. It is worth noting that bicycle and cycle-rickshaw still remains an important mode of transportation in the city. This indicates the dominance of low capacity modes operating in the city thus causing distortion in modal mix and resulting in unsafe and uneconomical travel conditions.

Table 4 presents motor vehicle population in Patna for selected years from 1996 to 2001. From 1996 to 2001, bus population has increased by 22%, truck population grew by 28%, car (including jeep and taxi) population experienced highest growth at over 90%, two-wheeler population faced relatively modest growth of around 26%, and total vehicle population has increased by 34%. Besides motor vehicles, there are around 1,25,000 bicycles and 35,000 registered cycle rickshaws in the city. A huge number of cycle rickshaws are operating either with un-authorized registration or without registration. In fact, total population of cycle rickshaw is estimated to be anything between 1.2 to 2.0 lakhs.

Table 4. Motor vehicle population in Patna

Year (as on 31st March)	1996	1998	2000	2001
Bus	2410	2668	2730	2938
Mini-bus	897	1045	1055	1077
Truck	11541	13373	14426	14733
Other goods vehicle	1275	1606	2065	2296
Taxi	2341	2468	2854	2945
Auto-rickshaw	11782	13979	14466	15540
Tractor	5403	6419	6862	7235
Trailer	4691	5595	5968	6213
Car	20818	25548	28670	31290
Jeep	1051	2203	11777	12116
Two-wheeler	156982	180892	189440	197291
Others	715	495	475	490
Total	219906	256291	280788	294164

Source: District Transport Office, Patna.

3.3 Public transport system

Public transport system in Patna primarily relies on its IPT modes. Rail and bus transport plays a negligible role in urban transportation system in Patna. Rail service mainly caters to inter-city movement of passengers. It plays a negligible role in satisfying the intra-city travel demand. The city bus service under Bihar State Road Transport Corporation is virtually perfunctory. For general public, there is no BSRTC bus plying in the city. Only a few private buses are operating under the royalty system of BSRTC. This has led to highly unreliable situation of the city bus transport. The unreliability of bus service and its inefficient operation coupled with deteriorating road network has resulted in high patronage of intermediate public transport. IPT modes mainly auto-rickshaws and cycle-rickshaws play a vital role in meeting

more than 90% of public transport demand. The lack of effective mass transport system has given rise to a tremendous increase in IPT modes and personalized vehicles. The city roads are congested leading to jamming conditions, which has become intolerable disrupting almost every system of the city. Due to high density of cycle-rickshaw on the road, passenger movement is disturbingly slow.

Public transport system in Patna, in general, is inadequate, inefficient, and unplanned and therefore, it is not able to serve the travel demand of the public in the best possible way. Particularly, the city bus system which should play a major role in providing the passenger transport service suffers from many deficiencies. BSRTC does not play any role in satisfying the needs of the urban travel. The unreliability and poor service quality of private bus operators have forced people to opt for IPT and personalized modes of transport. This has resulted into a high degree of congestion in the city besides a huge social, economic, and environmental loss.

4. Road Accidents in Patna

4.1 Type of accidents

Table 5 presents accident scenario in Patna. From the year 1996 to 2000, total number of accidents has decreased from 281 to 241 mainly due to reduction in non-fatal accidents. There were 202 non-fatal accidents during 1996 which has gone down to 133 during 2000, a reduction of around 34%. Although there is a reduction in non-fatal accidents as well as total number of accidents, fatal accidents have been unchecked so far. In quantitative terms, total

number of fatal accidents has increased by around 37% in the span of just four years, from 79 in 1996 to 108 in 2000.[1]

Table 5. Type of accidents in Patna

Year	Fatal	Serious	Minor	Total accidents
1996	79	92	110	281
1997	97	84	117	298
1998	88	83	58	229
1999	107	81	86	274
2000	108	59	74	241

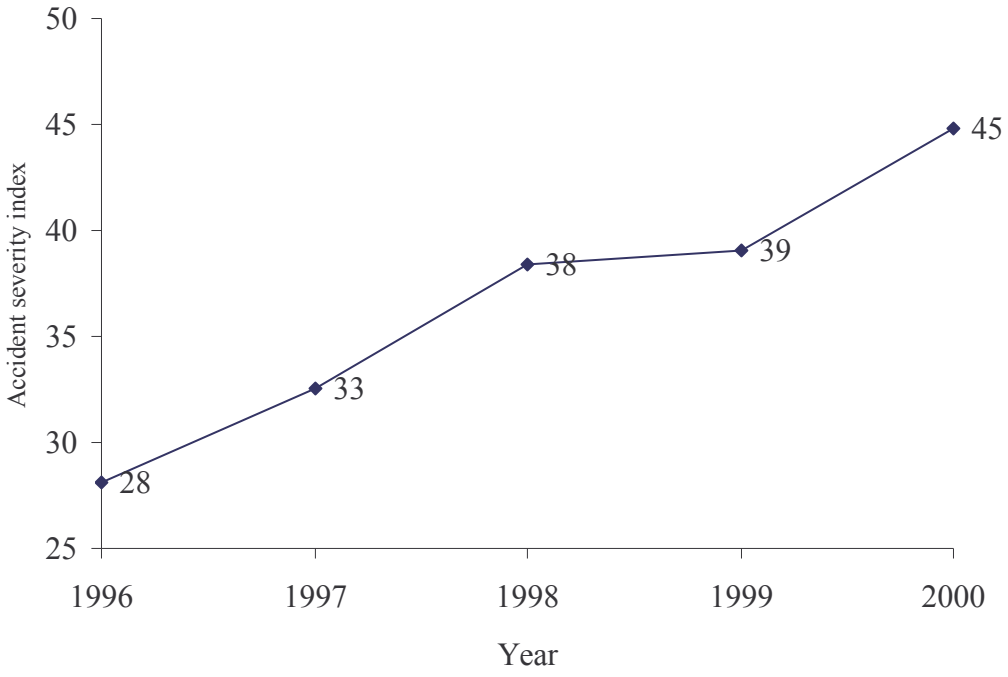
4.2 Accident severity index

The accident severity index measures the seriousness of accidents and availability of medical facilities in the city. Figure 1 presents the accident severity index for Patna which shows that number of deaths per 100 accidents are relatively very high in the city. Furthermore, persons killed per 100 accidents have increased over the years, from 28 in 1996 to 45 in 2000, an increase of around 60% in the span of just four years. When number of serious accidents is decreasing over the years (Table 5), increase in accident severity index seems to be result of reduction in quality of available medical facilities in the city. Moreover, high level of accident severity index may also be a result of poor data collection and its reporting process. Traffic

[1] According to Traffic Police, Patna, number of fatalities is equal to number of fatal accidents in the city. This hypothesis seems to be unrealistic since in general, number of fatalities will always be greater than the number of fatal accidents. The unavailability of other data source force us to rely on the data provided by Traffic Police, Patna. Therefore, for further analysis, we will assume that number of fatalities is equal to number of fatal accidents.

police of Patna may not be recording all the minor accidents and so, accident severity index shows higher level.

Figure 1. Accident severity index (persons killed per 100 accidents)

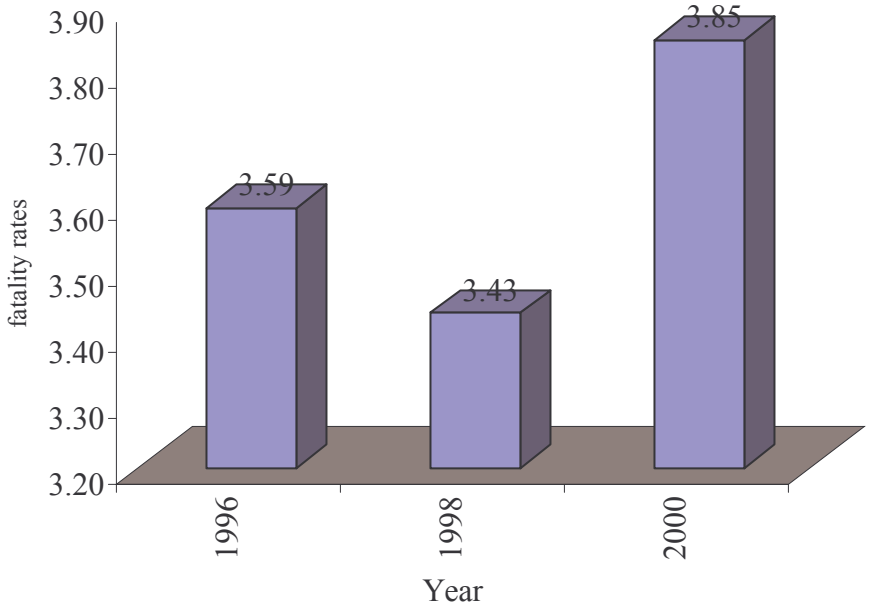


4.3 Fatality rate and risk

Fatality rate is defined as number of deaths per 10,000 vehicles. Figure 2 presents the fatality rates in Patna city for selected years. There is a marginal increase in fatality rates from 3.59 in 1996 to 3.85 in 2000. It should be noted that fatality rate in Patna is well below the fatality rate in India, probably, because there is high density of slow moving vehicles in the city which reduces the average speed of vehicles on road and severity of accident as well.[2]

[2] Fatality rate in India was 20 during the year 1998 (Table 3).

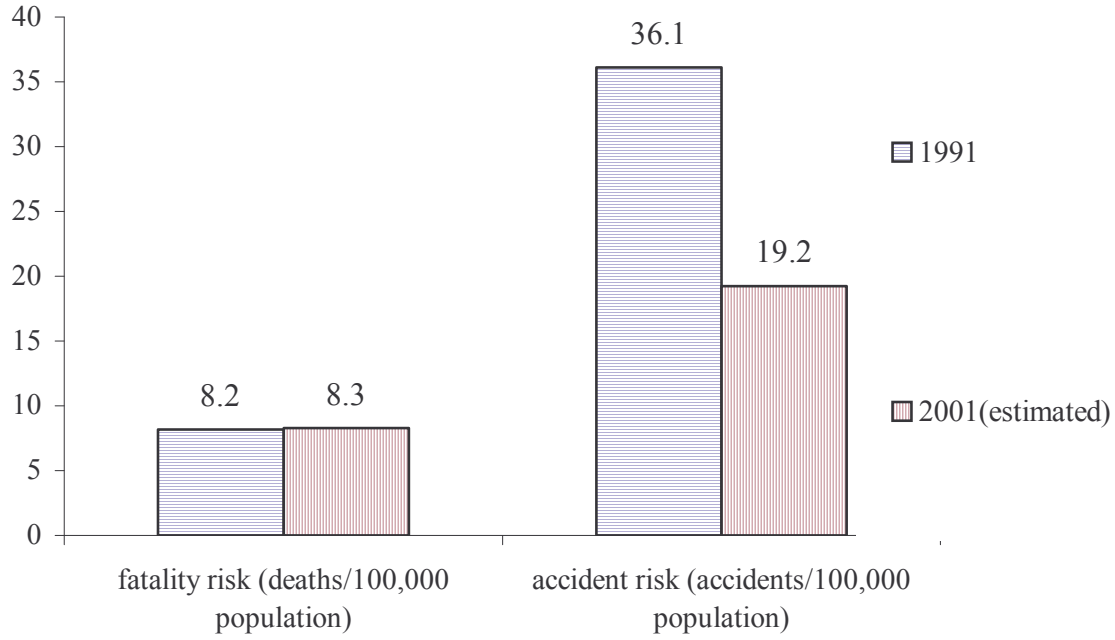
Figure 2. Road accident fatality rates (deaths/10,000 vehicles) in Patna



Although fatality rate in Patna is well below the Indian average, the same thing cannot be said about fatality risk to the people in the city. In fact, fatality risk (defined as number of deaths/100,000 population) in Patna is marginally higher than the average figure for India.[3] Fatality risk in the city has not changed much from the last one decade, its increase is marginal, from 8.2 in 1991 to around 8.3 in 2001 (Figure 3). As far as accident risk (defined as number of accidents/100,000 population) is concerned, it has gone down from 36.1 in 1991 to around 19.2 in 2000. Reduction in accident risk and marginal increase in fatality risk may imply the deterioration in medical facilities in the city. It may also be the result of increase in severity and decrease in frequency of accidents.

[3] Fatality risk in India was 6.7 and 7.9 during the year 1991 and 1998, respectively (Table 1).

Figure 3. Fatality and accident risk in Patna



4.4 Road user type fatalities

Pedestrian deaths as a percentage of all road fatalities are very high in Patna (Figure 4). During recent years, pedestrians constitute more than 90% of all road accident fatalities. Besides pedestrians, in general, cyclists and two-wheeler riders seem to be at higher risk in comparison to car/jeep/taxi occupants, bus passengers, and truck occupants (Table 6). Fatalities related to pedestrians, cyclists, and two-wheeler riders usually account for a very high percentage of all road accident fatalities, more than 98% during the year 1999 and 2000. As they constitute such a large proportion of the accident problem, it is clear that Patna needs to give priority to improving the safety of these particular three groups.

Figure 4. Pedestrian fatalities as a percentage of all road accident fatalities

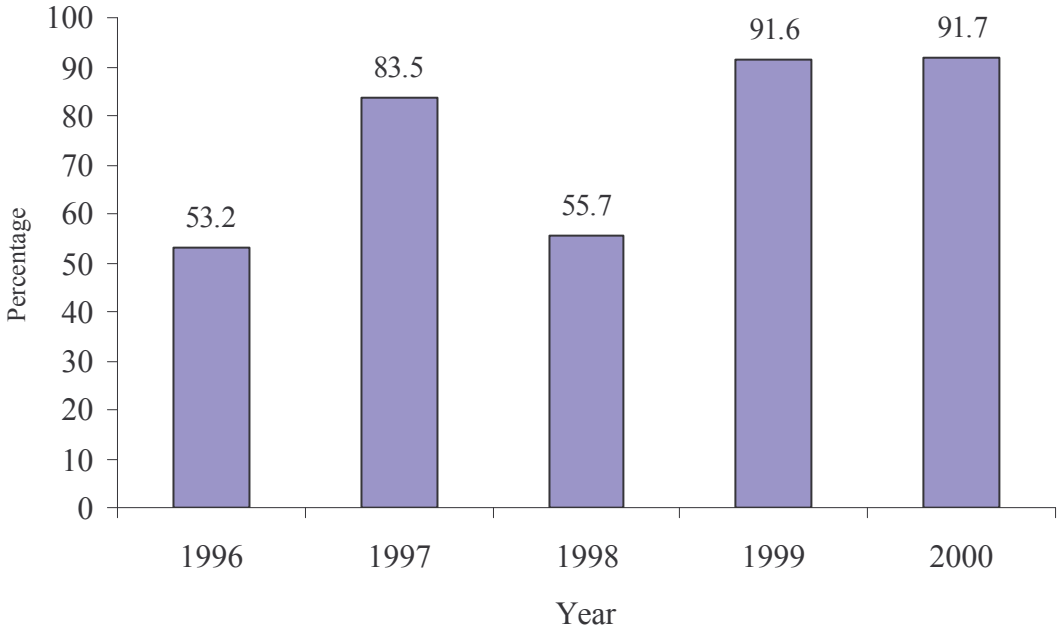


Table 6. Category of fatality

	Pedestrian	Cyclist	2W - rider	Car/jeep/taxi occupant	Bus passenger	Truck occupant	Others
1996	42	10	20	3	2	0	2
1997	81	9	6	0	0	0	1
1998	49	14	18	5	0	0	2
1999	98	5	2	0	0	2	0
2000	99	6	1	1	0	0	1

4.5 Fatality distribution by age

Table 7 presents fatality distribution by age. This table shows that child fatality is relatively low in Patna, varying from 2.5 percent of the total fatality during 1996 to 6.5 percent of the total fatality during 2000. Unfortunately, the most productive age group (31-45 years) is the most prone to road accident fatality. By and large, 40% of casualties fall in the 31-45 age group. The 18 to 45 years age group accounted for over 55 percent of all casualties for every year of the sample period. The adult working age group (18 to 60 years) accounted for more than 80 percent of all casualties over the sample period. Since both adult working age group and pedestrians constitute a large proportion of road accident fatalities, therefore it is believed that the vast majority of pedestrian casualties occur to the economically active cohort (18 to 60 years).

Table 7. Fatality distribution by age

	< 18 years	18 to 30 years	31 to 45 years	46 to 60 years	> 60 years
1996	2	25	31	19	2
1997	6	27	36	23	5
1998	5	29	35	15	4
1999	9	19	58	19	2
2000	7	14	46	29	12
1996	2.5%	31.6%	39.2%	24.1%	2.5%
1997	6.2%	27.8%	37.1%	23.7%	5.2%
1998	5.7%	33.0%	39.8%	17.0%	4.5%
1999	8.4%	17.8%	54.2%	17.8%	1.9%
2000	6.5%	13.0%	42.6%	26.9%	11.1%

4.6 Vehicle-wise accident rates

Table 8 reports the numbers of accidents caused by different categories of vehicles. From the year 1996 to 2000, a total of 1,376 accidents were recorded in the city. On an average, light motor vehicles (e.g., two-wheelers, three-wheelers, cars, jeeps, and taxis) were responsible for marginally less than 50% of all accidents. Buses and trucks were responsible for 22 and 20 percent of all accidents, respectively. Among all major categories of motor vehicles, two-wheelers were responsible for the least number of accidents. In percentage terms, only 9% accidents were caused by two-wheelers which have a population of around 70% of all the vehicles.

Table 8. Vehicle responsible for accidents

	2W	3W	Car/jeep/taxi	Bus	Truck	Others	Total
1996	40	48	77	55	61	19	300
1997	28	46	63	71	68	22	298
1998	20	30	61	60	61	23	255
1999	20	38	66	60	49	40	273
2000	20	40	58	62	43	27	250
Total	128 (9%)	202 (15%)	325 (24%)	308 (22%)	282 (20%)	131 (10%)	1376 (100%)

As far as vehicle-wise accident rates are concerned, buses are the most notorious (Table 9). Not only bus accident rate is very high, around sixteen accidents per thousand buses, but also there is no sign of improvement in its accident rate over the sample period from 1996 to 2000. In general, trucks and three-wheelers are the second and third most risky vehicles, respectively. In terms of accident rates, two-wheelers are the safest vehicle in Patna

city causing just around eleven accidents per lakh of two-wheelers during current years of the sample period.

Table 9. Vehicle-wise accident rates (responsibility of accidents/10,000 vehicles)

	2W	3W	Car/jeep/taxi	Bus	Truck	All vehicles
1996	2.5	40.7	31.8	166.3	47.6	13.6
1998	1.1	21.5	20.2	161.6	40.7	9.9
2000	1.1	27.7	13.4	163.8	26.1	8.9

4.7 Causes of accidents

According to the data furnished by Patna traffic police, all accidents are caused by drivers' fault. From 1996 to 2000, bad weather, bad road, mechanical failure, and pedestrians' fault account zero percent of all road accidents in Patna. These figures are definitely far from the realistic ones. There is no doubt that drivers' fault could be a major cause of road accidents, but above mentioned figures reveal that there is a need for improvement in data collection process to get a more realistic picture of causes of road accidents in Patna.

4.8 Time of accidents

Table 10 reports the percentage of accidents during day as well as night time, separately. This table shows that majority of accidents have occurred during the daytime. On an average, around 70% accidents occurred during daytime in comparison to just 30% during night. One should note that this does not imply that daytime driving for a specified length is more risky than night. If we estimate accident risk per unit of pass.-km during day as well as night time, we may find that driving during night is more risky than daytime. Unavailability of data

restricts us to estimate the probability of accident risk for a specified length of journey during daytime vis-à-vis night.

Table 10. Percentage of accidents during day and night time

	Day	Night
1996	73	27
1997	71	29
1998	78	22
1999	69	31
2000	70	30

4.9 Accident distribution by location

Table 11 presents accident distribution with respect to location of its occurrence. This table shows that around 70% accidents occurred on straight roads. T – Junction seems to be the least prone to accident. The other three junctions, Y – Junction, 4 – Way intersection, and Traffic round about, have almost equal share of accidents of around 8-10%.

Table 11. Accident distribution by location

	Straight road	T – Junction	Y – Junction	4 - Way intersection	Traffic round about
1996	211	10	30	21	21
1997	198	7	39	26	28
1998	195	7	17	19	15
1999	193	6	23	28	24
2000	183	3	25	20	19
1996	72%	3%	10%	7%	7%
1997	66%	2%	13%	9%	9%
1998	77%	3%	7%	8%	6%
1999	70%	2%	8%	10%	9%
2000	73%	1%	10%	8%	8%

4.10 Accident prone spots in Patna city

The Patna traffic police have identified a few accidents prone locations in the city on the basis of the intensity and frequency of accidents. Old bypass was the most accidents prone location in the city till the year 1999. But from the year 2000 onwards, new bypass has become the most accidents prone location. During the year 2000, around 15% of all the accidents in the city occurred on new bypass.

Most of the goods vehicles operate on new bypass road on national highway (NH – 38). There is encroachment on both sides of the road. Most accidents occur to pedestrians while crossing the road. Barricading is one possible solution to check the accidents on new bypass. In fact, individual road safety audit for this location should be carried out by a multi-disciplinary team of experts to suggest corrective measures.

Table 12. Black spots in Patna

	Location	No. of accidents	Persons killed	Seriously injured	Minor injuries
1996	Old bypass	26	8	7	11
1997	Old bypass	37	15	11	11
1998	Old bypass	28	16	6	6
1999	Old bypass	24	11	9	4
2000	New bypass	35	25	7	3

5. Summary

The problem of deaths and injuries as a result of road accidents in Indian cities is serious enough to demand attention of respective administrative authorities. Apart from the humanitarian aspects of reducing road deaths and injuries, a strong case can be made of reducing road crash deaths on economic grounds alone. It is estimated that the total economic loss due to road accidents is of the order of Rs. 60 billion each year in India.

As one would expect, Patna is also suffering from the problem of deaths and injuries on its roads. The total number of fatal accidents as well as related fatality in the city is increasing over the years. Persons killed per 100 accidents are alarmingly high, as high as 45 during the year 2000. Although fatality rate is relatively low in Patna, fatality risk is higher than the Indian average. Pedestrian deaths as a percentage of all road fatalities are extremely high in the city. During the recent years, they constitute more than 90% of all road fatalities. Since both adults working age group and pedestrians constitute a large proportion of road accident fatalities, it is believed that the vast majority of pedestrian casualties occur to the economically active cohort (18 to 60 years). As far as vehicle-wise accident rates are concerned, buses are the most risky. On an average, they are causing around sixteen accidents per thousand buses per annum. In general, trucks and three-wheelers are the second and third most risky vehicles, respectively. Furthermore, the city traffic police have identified few accidents prone locations on the basis of severity and frequency of accidents. From the year 2000 onwards, new bypass road on national highway (NH – 38) is considered to be the most accidents prone location in the city where around 15% of all the accidents occur during recent years.

Appendix

The data

Required primary data are collected from the office of Superintendent of Police (Traffic), Patna. This study is based on the data collected from the 14 police stations in Patna city. Specifically, data are collected from all police stations between Gandhimaidan P.S. in north to Kankadbag P.S. in south and Sultanganj P.S. in east to Shastrinagar P.S. in west. There is one traffic police station in Patna city which is mainly responsible for investigation of traffic related offence including accident related matters and collection and compilation of road accident related data. There are 24 police stations in the city but from the very beginning accident related data are collected from only 14 police stations. This practice is still prevalent.

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