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*Original Research*

# Pattern and Distribution of Injuries in Fatal Road Traffic Accident Cases in District Barabanki of Uttar Pradesh, India

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***ABSTRACT*:**
**Background:** Fatal road traffic accidents (RTA) are a major cause of concern all over the world. The outcome of injuries sustained in an RTA depends on various factors including but not limited to: the location of the event, type of vehicle involved, nature of the roads, the time of accident, etc. Present study aimed to elucidate the pattern of fatal injuries in victims of road traffic accidents at District Barabanki. **Method:** This prospective study included all victims of RTA that presented from September 2017 – August 2018 and were either found dead on arrival or died during treatment. The pattern of injuries was studied during the post-mortem examination of the 100 victims presenting to the district mortuary of Barabanki during the study period. **Results**: One hundred RTA victims were studied during the period. The most commonly affected age group was 12 to 82 years. Men died in RTA more than women. Maximum number of accidents took place on state highways than national highway. Most of the accidents were caused by motorized vehicles with collision and hit being the most common type of accident. Head injury, internal organ involvement and multiple injuries were responsible for accidents. **Conclusion**: It is recommended that awareness campaigns against use of alcohol, following safe road practices and use of protective wears should be launched. Moreover, healthcare services should be mobilized in such a way that a victim is attended within 30 minutes of accident to reduce the burden of mortality. This would be extremely helpful in policy making and health management in India.
**Key words**: Road traffic accidents, injuries, vehicles, rural.

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## INTRODUCTION

The earliest records of fatal road traffic accidents due to motor vehicles come from Great Britain where in the year 1896, a total of two deaths were registered. In the United States, first death owing to road traffic accidents was recorded in the year 1899.[1] Today, road traffic accidents continue to be one of the major public health issues throughout the world.[2-6] According to a World Health Organization estimate, a total of 1.25 million deaths were caused by road traffic injuries throughout the world in the year 2010, thus implying that one person was killed every 25 seconds[3]. Although number of mortalities owing to road traffic injuries has shown a downward trend in the recent years. As per Global Burden of Disease (GBD) study, there was a decrease in the rates of death- or disability-adjusted life years (DALYs), between 1990 and 2013, due to injuries from traffic accidents worldwide (-15.7%). However, this reduction occurred mainly in high-income countries, whereas an increase in low- and medium-income countries was observed. 7

During 2008, road traffic injuries (RTIs) ranked 4th among the leading causes of death worldwide[4]. Nearly 1.3 million people die every year globally. RTIs are the leading cause of death among young people aged 15-29 years and cost countries 1-3% of their domestic product (GDP).[5,6] Ninety-one percent of the world's fatalities on the roads occur in low-income and middle-income countries, even though these countries have approximately half of the world's vehicles. Half of those dying in the world's roads are 'vulnerable road users'. If no action is taken, road traffic crashes are predicted to result in deaths of around 1.9 million people annually by 2020.[7]

Globally, more than 50% of road traffic injury-related deaths occur in the age group 15–49 years, an economically productive period.[7, 8] A similar age

distribution has been noted in traffic injury deaths and related hospitalizations in India and other South Asian countries.[12,11, 9] Road traffic injuries can also require expensive hospital-based treatment, including trauma care.[10]

As far as India is concerned, it ranks second after China in terms of total number of deaths owing to road traffic accidents in a year. In the year 2013, China ranked first with a total of 261,367 deaths and India ranked second with a total of 207,551 deaths owing to road traffic accidents.7 The reason for the rising death toll in LMICs such as in South Asia is rapid urbanization and motorization associated with rapid economic growth7. India has one of the highest road accident rates in the world. There has been a steady rise in the casualties in road accidents in the country and their proportions in total deaths due to all accident have also increased considerably in the past. In India, as per a report in 2001, nearly 80,000 get killed and 340,000 are injured every year in about 300,000 accidents on road network of just 22,00,000 $km^2$. There is an accident every minute and death every 8 min. More recently, according to the National Crime Record Bureau (2010), the number of vehicular accidents was 430,600 resulting in 133,938 deaths and 470,600 injuries, thereby accounting for 37.2% of all accidental deaths due to unnatural causes.[11]

In case of road traffic injury cases culminating into mortality, there could be various reasons for death. For the point of view of preparing preventive strategies, it is essential that the pattern of injuries leading to death should first be identified. Moreover, in order to understand the overall burden of these mortalities, it is also essential to study the demographic profile of the patients as well as to study type of vehicle, type of accident, road and traffic conditions, *etc.*

Barabanki district is the neighbouring city to the Lucknow, the capital of Uttar Pradesh and provides passage to almost entire eastern UP to Lucknow and other central and western UP cities. Owing to highly busy national and state highways, it encounters a high number of road traffic injuries ending up in mortality. Hence, in order to understand the fatal injuries and various associated epidemiological factors, the present study was carried out with an aim to study the pattern of injuries in road traffic accidental cases based on an assessment of autopsy records from the District Barabanki.

## MATERIAL AND METHODS:

A prospective study was carried out over the period of one year (September 2017 – August 2018) under the auspices of the Department of Forensic Medicine and Toxicology of Hind Institute of Medical Sciences Barabanki, Lucknow, Uttar Pradesh.

District Barabanki is one of four districts of Faizabad division. Its lies at the very heart of Awadh region of Uttar Pradesh state of India, and acts as a centre from which no less than seven other districts radiate. The district has an area of 4,402.00 $km^2$ and has a population of 3,260,699. Nearly 10% of the population lives in urban areas. The district has six tehsils, *viz.* Nawabganj, Fatehpur, Ramsanehi Ghat, Haidergarh, Ram Nagar and Sirauli Ghauspur. Two national highways (NH-27 and NH-28B) pass through the district. It is well connected to other cities by means of roadways. The district has two major hospitals namely Rafi Ahmad Kidwai Memorial General Hospital and Barabanki Government Ladies Hospital. Apart from these there is a large network of private and government primary and secondary health care facilities. The district also has two private medical colleges (Hind Institute of Medical Sciences, Lucknow Road and Mayo Institute of Medical Sciences, Gadia, Faizabad Road). There are other paramedical and dental colleges too within the district limits of Barabanki.

The study was approved by Institutional Ethical Committee. Permission for collection of data was obtained from Chief Medical Officer (CMO) of District Hospital, Barabanki.

The pattern of injuries was studied during the post-mortem examination of the 100 victims presenting to the district mortuary of Barabanki during the study period.

All the data was then entered in MS Excel spreadsheet and analyzed using Statistical Package for Social Sciences (SPSS) version 21.0. Chi-square test. A 'p' value less than 0.05 was considered as statistically significant.

## RESULTS

The results showed that maximum number of accidents took place between 6 a.m. and 12 Noon (44%) followed by 6 p.m. and 12 midnight (42%), 12 Noon and 6 p.m. (11%) and 12 midnight and 6 a.m. (3%)

Maximum accidents took place in winter (32%) followed by summer (26%), rains (24%) and Autumn (18%) respectively.

Maximum accidents in a month occurred in March (11%). In months February, May, June and October 10 accidents took place. In months of January, November and December, a total of 9 accident each took place. In month of April, 8 accidents took place and 6 accidents took place in September. A total of 5 accidents took place in the month of August and 3 accidents took place in the month of July.

Age of victims ranged from 12 to 82 years. Maximum number of victims were aged 21-30 years (27%) followed by 41-50 (19%), 31-40 years (16%), 51-60 years (14%), 61-70 years (11%), $\leq$20 years (9%), 71-80 years (3%) and >80 years (1%) respectively. Age group 21 to 50 years together comprised majority (62%) of cases. Mean age of victims was 41.52$\pm$17.46 years. Majority of victims were males (77%). There were 23 (23%) females.

All the three cases who met with accident between 00:00-06:00 Hrs were males. Among 44 cases who met with accident between 06:00-12:00 Hrs, 31 (70.5%) were males and 13 (29.5%) were females. Among 11 cases who met with accident between 12:00-18:00 Hrs, 9 (81.8%) were males and 2 (18.2%) were females. Among 42 cases who met with accident between 18:00-24:00 Hrs, 34 (81%) were males and 8 (19%) were females. Thus, irrespective of the time of accident, there was a male dominance, thus statistically, no significant change in gender of victims was observed for different times of accident (p=0.480).

Maximum number of accidents took place on state highways (46%) followed by national highway (36%). Only 18% accidents took place at other roads.

In majority of cases (57%), the nature of accident was collision and hit followed by collision (39%). In 3% cases it was hit and in 1% case it was fall.

**Table 1:** Vehicles involved in accidents

| SN | Vehicle responsible | Mode of transport used by Victim | | | | | |
|---|---|---|---|---|---|---|---|
| | | Bullock cart (n=5) | Bicycle/ Rickshaw (n=25) | Motor cycle (n=19) | Pedestrian (n=48) | Car (n=1) | Tempo (n=2) |
| 1. | Auto rickshaw (n=2) | 1 (20%) | 1 (4%) | 0 | 0 | 0 | 0 |
| 2. | Bus (n=12) | 0 | 4 (16%) | 3 (15.8%) | 4 (8.3%) | 0 | 1 (50%) |
| 3. | Car (n=10) | 0 | 3 (12%) | 1 (5.3%) | 6 (12.5%) | 0 | 0 |
| 4. | JCB Machine (n=1) | 0 | 1 (4%) | 0 | 0 | 0 | 0 |
| 5. | Jeep (n=8) | 0 | 1 (4%) | 2 (10.6%) | 5 (10.4%) | 0 | 0 |
| 6. | Mini Bus (n=6) | 0 | 0 | 3 (15.8%) | 3 (6.3%) | 0 | 0 |
| 7. | Motor cycle (n=3) | 0 | 1 (4%) | 0 | 2 (4.2%) | 0 | 0 |
| 8. | Tempo (n=1) | 0 | 1 (4%) | 0 | 0 | 0 | 0 |
| 9. | Tractor (n=15) | 0 | 2 (8%) | 2 (10.6%) | 10 (20.8%) | 0 | 1 (50%) |
| 10. | Truck (n=42) | 4 (80%) | 11 (44%) | 8 (42.1%) | 18 (37.5%) | 1 (100%) | 0 |

$\chi^2$=37.93 (df=45); p=0.763

In majority of cases, the victim was pedestrian (48%) followed by bicycle/rickshaw (25%), motor-cycle (16%), bullock cart (5%), motor cycle (3%) and car (1%) respectively.

Among vehicles responsible for the accident, truck (42%) was most common followed by tractor (15%), bus (12%), car (10% each), jeep (8%), mini bus (6%), motor cycle (3%), auto-rickshaw (2%), JCB machine and tempo (1% each).

Most common victim / offending vehicle combination was pedestrian-truck (18%), followed by bicycle/rickshaw-truck (11%) pedestrian-tractor (10%) combination. On evaluating the association between mode of transport of victim and vehicle responsible for accident, it was not found to be significant statistically (p=0.763). None of the victims were using any protective measures. A total of 48 (48%) cases were pedestrians. There were 38 (38%) who were drivers/riders and 14 (14%) were passengers. Driver/victim alcoholic intoxication could be established in 39 cases. Influence of alcohol was most common in age group 31-40 years (68.8%) followed by 21-30 years (44.4%), 41-50 years (36.8%), $\leq$20 years (33.3%), 51-60 years (28.6%) and 61-70 years (18.2%). Out of 39 alcohol users, 26 (66.7%) were $\leq$40 years of age. Statistically, there was a significant association between age and influence of alcohol (p=0.010).

**Table 2:** Thoraco-Abdominal and Extremities involvement

| SN | Category | No. & % |
|---|---|---|
| 1. | Thoraco-abdominal involvement | 66 |
| | Thoracic | 36 |
| | Abdomen | 8 |
| | Both thorax & abdomen | 22 |
| 2. | Upper limb involvement | 37 |
| 3. | Lower limb involvement | 58 |

Thoraco-abdominal involvement was seen in 66% cases (36% thorax only, 8% abdomen only, 22% both thorax and abdomen). Upper limb was involved in 37 cases and lower limb was involvement in 58 cases.

**Table 3: Types of External injuries**

| SN | Type | No. & % |
|---|---|---|
| 1. | Abrasions | 70 |
| 2. | Contusions | 72 |
| 3. | Lacerations | 55 |
| 4. | Incised /punctured / perforated wounds | 30 |
| 5. | Crush wounds | 35 |
| 6. | Fractures and dislocations | 20 |

Among external injuries, contusions (72%) and abrasions (70%) were most common followed by lacerations (55%), crush wounds (35%), incised/ punctured/ perforated wounds (30%), fractures and dislocations (20%). Most of the injuries were secondary injuries (187/282; 66.3%) produced by secondary impact. Only 95/282 (34.7%) injuries were caused by primary impact.

**Table 4: Type of Internal Injuries**

| SN | Organ involved | Type of Injury | No. & % |
|---|---|---|---|
| 1. | Lungs | Lacerated 28, C&F Blood in pleural cavity 11 | 28 |
| 2. | Heart | Lacerated | 12 |
| 3. | Liver | Lacerated 6, C&F Blood 21 | 21 |
| 4. | Spleen | Ruptured | 15 |
| 5. | Kidney | - | 0 |
| 6. | Stomach | Ruptured | 10 |
| 7. | Intestine | Ruptured | 15 |
| 8. | Urinary bladder | - | 0 |
| 9. | Rib fractures | 52 | 52 |
| 10. | Others (Uterus, etc.) | 0 | 0 |

Most common internal injuries (except for head injury) were rib fractures (52%) followed by lungs (28%), liver (21%), spleen and intestine (15% each), heart (12%) and stomach (10%) respectively. There was no case showing involvement of kidneys, urinary bladder or other internal organs. On an average each case had 1.52 internal organs involved. A total of 63 victims had head injury. Intracranial haemorrhage was seen in 50 cases – among these 32 (64%) had subdural haemorrhage, 8 (16%) had Intracerebral haemorrhage, 4 (8%) each had extradural and Intrathecal haemorrhage while remaining 2 (4%) had Subarachnoid haemorrhage. Skull fracture was observed in 60 cases – among these linear fractures (40%) were most common followed by depressed (28.3%), communited (25%) and compound fractures (6.7%) respectively.

Coma due to head injury was the cause of death in 44% cases whereas in remaining 56% shock and haemorrhage was the cause of death.

**Table 5: Pattern of Head Injuries**

| SN | Type | No. & % |
|---|---|---|
| 1. | Head injury | 63 |
| 2. | Intracranial haemorrhage | 50 |
| | Subdural | 32 |
| | Intracerebral | 8 |
| | Extradural | 4 |
| | Intrathecal | 4 |
| | Subarachnoid | 2 |
| 3. | Skull fracture | 60 |
| 4. | Type of skull fracture | (n=60) |
| | Communited | 15 (25.0%) |
| | Linear | 24 (40.0%) |
| | Depressed | 17 (28.3%) |
| | Compound | 4 (6.7%) |

**Table 6: Time between accident and death**

| SN | Time between Accident and Death | No. & % |
|---|---|---|
| 1. | Instant | 25 |
| 2. | ≤30 minutes | 46 |
| 3. | 31-60 minutes | 12 |
| 4. | >60 minutes | 17 |
| Mean survival time±SD (Range) in minutes | | 57.44±112.37 (0-600) |

Survival time ranged from 0 min to 10 hrs. In 25% cases, the death was instant on the spot. In a total of 46 cases, death occurred within 30 minutes of accident. There were 12 cases in whom death occurred within 31 to 60 minutes and in remaining 17 cases death occurred after 60 minutes. Mean survival time was 57.44±112.37 minutes.

**Table 7: Association between survival time and different study factors**

| SN | Factor | ≤30 minutes (n=71) | | >30 minutes (n=29) | | Statistical significance | |
|---|---|---|---|---|---|---|---|
| | | No. | % | No. | % | $\chi^2$ | 'p' |
| 1. | Age >40 years | 34 | 47.9 | 14 | 48.3 | 0.001 | 0.972 |
| 2. | Male sex | 56 | 78.9 | 21 | 72.4 | 0.485 | 0.486 |
| 3. | Time of accident | | | | | | |
| | 00:00-06:00 Hrs | 2 | 2.8 | 1 | 3.4 | 0.374 | 0.946 |
| | 06:00-12:00 Hrs | 30 | 42.3 | 14 | 48.3 | | |
| | 12:00-18:00 Hrs | 8 | 11.3 | 3 | 10.3 | | |
| | 18:00-24:00 Hrs | 31 | 43.7 | 11 | 37.9 | | |
| 4. | Weather | | | | | | |
| | Autumn | 13 | 18.3 | 5 | 17.2 | 2.575 | 0.462 |
| | Summer | 20 | 28.2 | 6 | 20.7 | | |
| | Rain | 14 | 19.7 | 10 | 34.6 | | |
| | Winter | 24 | 33.8 | 8 | 27.6 | | |
| 5. | Alcohol influence | 34 | 47.9 | 5 | 17.2 | 8.13 | 0.004 |
| 6. | Accident caused by vehicle other than bus, truck and tractor | 19 | 26.8 | 12 | 41.4 | 2.06 | 0.151 |
| 7. | Pedestrian victim | 41 | 57.7 | 7 | 24.1 | 9.32 | <0.002 |
| 8. | Type of roads | | | | | | |
| | National Highway | 30 | 42.3 | 6 | 20.7 | 15.6 | <0.001 |
| | State highways | 35 | 49.3 | 11 | 37.9 | | |
| | Other roads | 6 | 8.5 | 12 | 41.4 | | |
| 9. | Lung involvement | 31 | 43.7 | 8 | 27.6 | 2.24 | 0.135 |
| 10. | Liver involvement | 7 | 9.9 | 0 | 0 | 3.07 | 0.080 |
| 11. | Thoraco-abdominal involvement | 44 | 62.0 | 20 | 75.9 | 0.437 | 0.509 |
| 12. | Upper limb involve. | 26 | 36.6 | 11 | 37.9 | 0.152 | 0.902 |
| 13. | Lower limb involve. | 45 | 63.4 | 14 | 48.3 | 1.94 | 0.163 |
| 14. | Collision and hit | 26 | 36.6 | 13 | 44.8 | 0.583 | 0.445 |
| 15. | Head injury | 50 | 70.4 | 13 | 44.8 | 5.79 | 0.016 |

On evaluating the association of different factors with time between accident and death, alcoholic influence, pedestrians, national and state highways and head injury were found to be significantly associated with instant or early death (≤30 minutes after accident) ($p<0.05$). [Table 7]

**Table D1:** Demographic profile of victim and associated conditions of fatal road accidents in different contemporary studies from India (2012 onwards) and their comparison with present study

| SN | Author (Year) | Place of study | No. of victims | Dominant | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Age profile | Gender profile | Victim type | Time & Season | Road type | Alcohol influence |
| 1. | Kuchewar *et al.* (2012)[33] | Auranga-bad (Mah.) | 216 | 20-40 Yrs (50%) | 87% Males | Two-wheeler (40%) | - | Good/ Straight roads (91%) | - |
| 2. | Manish *et al.* (2012)[13] | Davan-gere (Kar.) | 408 | 21-30 Yrs | 81.6% Males | Motor-cyclists (38.9%) | 6am-12 noon (38.41) | - | - |
| 3. | Farooqui *et al.* (2013)[30] | Ahmed-nagar (Mah.) | 98 | 20-30 Yrs | Males | Pedestrians/ two wheeler | - | Secondary roads | - |
| 4. | Kumar *et al.* (2013)[14] | Central India | 224 | 21-40 Yrs (52.7%) | - | Motor-cycle (47.8%) | 6pm-12 midnight | - | - |
| 5. | Gouda *et al.* (2014)[27] | Manga-lore (Kar.) | 111 | 21-30 Yrs (21.6%) | Males (82.9%) | Motor-cycle (38.7%) | - | - | - |
| 6. | Kulkarni *et al.* (2014)[20] | Akola (Mah.) | 270 | 21-40 Yrs (53.7%) | Males (84.8%) | - | - | - | - |
| 7. | Angam *et al.* (2014)[34] | Imphal (Manipur) | 178 | 21-30 Yrs | Males (82%) | - | - | - | - |
| 8. | Sonawane and Jambure (2015)[31] | Auranga-bad (Mah.) | 100 | 20-60 Yrs (83%) | Males (89%) | Pedestrians (28%) | - | - | 31% |
| 9. | Katageri *et al.* (2015)[21] | Chitradurga (Kar.) | 52 | 31-40 Yrs (25%) | 88.2% Males | Motor-cycle (28.8%) & Pedestrians (25%) | - | NH (75%) | - |
| 10. | Arora and Khajuria (2016)[22] | J&K | 422 | 21-40 Yrs | Males (85.5%) | - | - | - | - |
| 11. | Guntheti and Singh (2016)[17] | Khammam (Telangana) | 108 | 21-40 Yrs (56.5%) | Males (97%) | Two- wheeler & Pedes-trians | Day time; Winter (55.6%) | NH (55.6%) | - |
| 12. | Marak *et al.* (2016)[16] | Puducherry | 140 | 51-60 Yrs (22.9%) | Male (85.7%) | Pedestrians (46.4%) | Evening hours (42.86%); October (13.6%) | - | - |
| 13. | Nair and Lakshmanan (2017)[35] | | 106 | ≤40 Yrs (64.8%) | Males (92.5%) | - | - | - | - |
| 14. | Ranjan *et al.* (2017)[26] | - | 500 | 15-44 Yrs (56%) | Males (64.3%) | Pedestrians (36%); Two-wheeler (31%) | - | High-way (83.15%) | - |
| 15. | Vyawahare and Giri (2017)[15] | Central India | 129 | 21-30 Yrs (31.5%) | Males (88.4%) | Motor- cycle (51.2%), Pedestrian (24.5%) | 6:01 pm – 12 midnight (48.9%) | - | - |
| 16. | Raza *et al.* (2018)[18] | Varanasi, UP | 150 | 21-30 Yrs | Males (85%) | Two wheeler, Pedes-trians | 4pm-8pm | - | - |
| 17. | Present study (2018) | Barabanki, UP | 100 | ≤40 Years (52%) | Males (77%) | Pedestrians (54%), Bicycle/ Rickshaw (25%) | 6am-12 noon (44%), 6pm-12 midnight (42%), Winter (32%) | SH (46%), NH (36%) | 28% |

## DISCUSSION

In the present study, we have made an attempt to understand the nature and type of fatal injuries and their associated factors in district Barabanki, which is one of the largest districts of Uttar Pradesh and is a neighbour to the state capital, Lucknow. A record of a total of 100 fatal accidents that took place during the last one year was accessed from the district mortuary, Barabanki. The age of the victims ranged from 12 to 82 years. The majority of victims (62%) were in the age ranging from 21 to 50

years. Most of the victims were males (77%). Hours between 6 a.m. to 12 noon and 6 p.m. to 12 midnight was the time range when maximum (86%) accident occurred and commonest season was winters (32%) while minimum accidents took place in autumn (18%). Pedestrians were the most commonly affected victims (54%). Influence of alcohol was noted in 28% cases. State highways (46%) were most common place of accident.

The demographic profile and associated conditions of fatal road accidents in different parts of India has shown slight variability. Table D1 shows the demographic profile of victims and associated conditions of fatal road accidents in different studies from India and compares it with the present study.

**Time and Season**: In the present study, we found early morning hours (6:00 am to 12 noon) and late evening (6 pm to 12 midnight) hours to be the most common timings responsible for 84% of the accidents. As far as the season is concerned, in the present study, the winter season was the most common (32%) for RTAs (fatal). March (11%), February (10%), May (10%), June (10%) and October (10%) were most affected months of a year while July (3%) and August (5%) were least commonly affected months of a year. There is limited data regarding the time and season in different studies done earlier, despite the fact that it is an important issue. Similar to the present study, Manish *et al.*[13] also showed 6 am-12 noon timing to be commonest for most of the accidents (38.4%) in their study while Kumar *et al.*[14] and Vyawahare and Giri[15] reported 6pm to 12 midnight as the most common time-range for occurrence of fatal road accidents. Marak *et al.*[16] also reported evening but Guntheti and Singh[17] in their study reported day-time as the most common time for occurrence of fatal road traffic accidents. Raza *et al*[18] in their study highlighted 4pm-8pm as the most vulnerable timings for such accidents. The high dominance of 6am-12 noon and 6pm to 12 midnight in the present study could be owing to the fact that these are the usual timings for commutation for most of the people, particularly those plying from Barabanki to Lucknow city and vice versa in order to earn their livelihood. Secondly, these are the time-ranges during which the speed of traffic is fast and there is change in visibility conditions as well. Similar could be said to be the reason for high dominance of RTAs in winter season as also observed by Singh *et al.*[19] and Guntheti and Singh[17] in their studies. In the present study, we also made an attempt to find out any association between the time of accident and gender, in order to assess the relatedness of movement pattern of different genders in association with time of accident. However, it failed to find out any significant association. The reason for this could have been the broad categorization of time-frames. Moreover, fewer number of female victims also ruled out deep exploration into this finding. Another aspect of the problem was that most of the female victims were accompanied by male members and hence assessment of this problem from the gender perspective was not possible.

**Age**: As far as the age of affected victims is concerned, the present study showed a dominance of those aged $\leq$40 years (52%). Those aged 21-40 years comprised 43% of the sampled population, thus showing that younger individuals in the productive phase of their life were affected by road traffic accidents. This implies a huge social and economic burden owing to road traffic fatalities. Dominance of those in 21-40 years range has been reported in a number of other studies too, *viz.* Kulkarni *et al.*[20], Katageri *et al.*[21], Arora and Khajuria[22]and Guntheti and Singh[17] which is similar to the present study. There could be various reasons for this. Young age, leading to more outdoor responsibilities owing to personal and occupational commitments, the need to travel in early morning/late night and the experimentation with alcohol (28%) could be the reasons that most of the accidents in present study took place between 6 a.m. to 12 noon and between 6 p.m. to 12 midnight (84%). Moreover, the present study also found influence of alcohol in a sizeable proportion of affected victims (28%) and that too was associated with the young age. The present study also found that precautionary measures such as use of helmets or Personal Protective Equipment (PPE) and compliance to safety measures was altogether absent, thus implying that young age could be a reason to show reluctance to follow road safety measures and a higher tendency to experiment with alcohol. The trend seems to have a global similarity. Not only from India but contemporary studies from abroad too have shown a dominance of those aged 40 years or less to be most commonly affected in fatal road traffic accidents. Khadim *et al.*[23] (Pakistan) in their study found all the affected victims within 19 to 51 years age range and 50% of death in 4$^{th}$ decade (31-40 years) of life. Mirza *et al.*[17] (Pakistan) too reported 55.8% of their victims in 19 to 40 years age range. Mandal and Yadav[24] (Nepal) found 40% of their victims in 31 to 50 years age range. Kalouglvaki and Goundar[25] (Fiji) reported 29.4% of victims in 30 to 44 years age group. A comparative analysis thus shows that the age profile of victims in Barabanki district was similar to that reported in various studies from India.

**Sex:** In the present study, most of the victims (77%) were males. A dominance of males among victims has been reported in various studies from India and abroad. Among studies from abroad, the proportion of males has been reported to vary from 64.3% to 88.5% [17-25] Among different studies from India too, a male dominance has been reported with proportion of males ranging from 64.3%[26] to 97%.[17] Manish *et al.*[26] reported the proportion of male victims to be 81.6% in their study which is quite similar to this study report. In fact, most of the studies from India have reported a high proportion of males (above 80%).[26-28] A relatively, higher proportion of female victims in this study could be incidental, nevertheless, despite a slightly higher prevalence of female victims there is an obvious male dominance. This is attributable to the stereotypic gender roles in the society where males are considered to be involved in earning the livelihood and outdoor tasks requiring travel. However, an increased proportion of females in the present study could possibly be a reflexion of the changing societal trends and shifting of gender-based role. Another reason for higher proportion of females in the present study could be a high prevalence of

pedestrians among the victims as against automobile drivers/riders in other studies as illustrated in the subsequent paragraph on Nature of Victim.

**Vehicles Responsible for Accident**: In the current study, all the accidents were caused by automobiles and amongst these, heavy vehicles (truck, tractor, bus, JCB machine) accounted for the majority (70%) of the accidents. The dominance of heavy vehicles in the causation of fatal road traffic accidents has been reported in other studies too.[29,19] The passage of National Highway across the district accounts for the large nos. of heavy vehicles passing through it, thus becoming a prevalent factor for the occurrence of a large no. of RTAs.

**Type of Roads:** In the present study, maximum accidents took place on the State highways (46%) followed by the national highways (36%) and other roads (18%) respectively. This is similar to the observation made by Farooqui *et al.*[30] who also found secondary roads to be most commonly affected types of roads in their study. However, some other researchers like Katageri *et al.*[21] and Guntheti and Singh[17] reported National highways to be the most common road type. In Barabanki district, in the last few years, the National highways have shown considerable improvement, however, the condition of State highways and other roads has not improved to that extent thus making such places more prone to accidents in general, and fatal accidents in particular. The findings of this study thus suggest the need to improvise the conditions of the State highways and other such roads. The high prevalence of accidents on the highways (National / State) in the present study and in other studies too[16-21] could be owing to plying of heavy traffic and high speed vehicles. Keeping in view the fact that highways are generally meant for heavy traffic and also the fact that such highways passed through the districts, where most of the victims were pedestrians, the findings of the present study also indicate the need to launch mass media campaigns for awareness on road safety measures.

**Type of Accident**: The present study found (collision and hit) (57%) as the most common cause of accidents followed by collision (39%) alone. Road traffic accidents are often a result of collisions[15], especially when heavy vehicles are the offenders. Accident by hitting only are generally caused by light automobiles such as motor cycle or a result of self-hit and fall[26] In the present study, most of the injuries were caused by heavy vehicles and occurred as a result of accident by collision. However, in cases involving light vehicles or those where no pedestrians were involved, self-hit following collision was also present, making collision and hit all the more the most common accident.

**Nature of Victim**: In the present study, pedestrians comprised the majority of victims (54%) followed by bicycle riders/rickshaw pullers (25%), thus showing that the role of driving motorized vehicles among victims was less common. A number of studies done earlier show two-wheeler riders to be most commonly affected.[19-26] However, pedestrians have been shown to be affected in major proportion in a number of other studies.[26-28] One of the reasons for the high proportion of pedestrian victims in the present study could be the presence of agricultural land in the vicinity of the national and state highways where a number of agriculturists and farm labourers have to move about in early morning or late evening hours. Moreover, in view of its vicinity to the state capital, a number of high-rise buildings and colonies have developed alongside the national/state highways, where despite the high density of population, no adequate arrangements such as speed breakers or radium road indicators have been made. Unfortunately, on these highways, the density of traffic is quite high, owing to their connectivity with the state capital, Lucknow. Moreover, these highways do not have appropriate pavements for pedestrians. Although, there are tracks marked for bicycle / non-motorized vehicle users on some of the roads, yet these are often encroached in highly populated areas where people have to move on the road in the absence of adequate pavements for pedestrians. The high proportion of pedestrians as commonly affected victims, is thus an indication for town-planners to make adequate arrangements to make the state and national highways safe for them.

**Alcohol Influence**: In the present study, a total of 39% of the victims were under the influence of alcohol. Although, alcohol is considered to be one of the most common causes for road traffic accidents, however, it is often viewed as the factor associated with the "accident-causing" part rather than "victim" part but findings of present study show that alcohol influence could not only affect the decision making of the drivers of the vehicles responsible for the accident but could also be responsible for mistakes in decision making while using the roads by the victims. The careless attitude due to the inebriated condition under the influence of alcohol is equally responsible for accident causation and victimization. On reviewing contemporary literature, we found that similar observation has also been made by Sonawane and Jambure[31] who reported 31% of their victims under alcohol influence. These findings thus suggest that nearly one-quarter of the victims were under the influence of alcohol, moreover, the fact that alcohol influence was commoner in the younger age group. Thus, it can be identified as one of the reasons for the high prevalence of young-age victims of fatal road traffic accidents.

**Pattern of Injuries:** In the present study, multiple external injuries were quite prevalent. The type of external injuries included Abrasions (70%), Contusions (72%), Lacerations (55%), Incised/Punctured/Perforated wounds (30%), Crush wounds (35%), Fractures and Dislocations (20%). Internal organ injuries were also observed in 76% cases. Injuries of Lung (38%), Heart (12%), Liver (21%), Spleen (15%), Stomach (10%), Intestine (15%) and Rib fractures (52%) were the other most common internal organ injuries other than head injury. A total of 66% patients also had thoraco-abdominal injuries while upper and lower limbs were involved in 37% and 58% cases respectively. Head injury and skull fracture were observed in 63% and 60% cases and intracranial haemorrhage was seen in 50% cases.

Table D2 below summarizes the findings of some of the contemporary studies highlighting the nature and type of fatal injuries among road traffic victims and compares it with that of present study:

**Table D2:** Nature and type of injuries sustained in fatal road traffic accidents in different studies from India and their comparison with present study (2012 onwards)

| SN | Author (Year) | Place | No. of victims | External injuries | Internal organ involvement | Upper & Lower limbs | Head Injury | Intracranial haemorrhage | Others |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Farooqui *et al.* (2013)[30] | Ahmed-nagar (Mah.) | 98 | - | Av. 2.06 organs | - | 46.9% | - | Skeletal injuries Av. 2 |
| 2. | Gouda *et al.* (2014)[27] | Manga-lore (Kar.) | 111 | | | | 68.5% | 90.7% (Subarachnoid 78.3%), Skull fracture (78.9%) | |
| 3. | Kulkarni *et al.* (2014)[20] | Akola (Mah.) | 270 | - | Lung (51.7%), Rib fracture (76.6%), Liver (59.5%), Spleen (28.9%), Kidney (23.1%) | Lower limb 34.9% | 61.1% | 66.7%; Fracture skull (63.6%) | Thoracic 53.7%, Abd. 44.8% |
| 4. | Angam *et al.* (2014)[34] | Imphal (Manipur) | 178 | - | - | - | - | 43.4%; Skull fracture 74.1% | - |
| 5. | Sonawane and Jambure (2015)[31] | Auranga-bad (Mah.) | 100 | Abrasion+ Contusion+ Laceration+ Crush 37%, Crush+ Contusion + Laceration (33%) | Lung (22.5%), Heart (3.15%), Fracture ribs (12.6%) | 45% Upper limbs | 86% | 98%; Fracture skull 99% | Abd. 43^ |
| 6. | Katageri *et al.* (2015)[21] | Chitra-durga (Kar.) | 52 | Laceration (94.2%), Abrasion (82.7%), contusion (76.9%) | - | - | - | - | Frac-tures (98%) |
| 7. | Arora and Khajuria (2016)[22] | J&K | 422 | - | - | - | - | Subdural haemorrhage (64%); Brain contusion (63.9%) | - |
| 8. | Marak *et al.* (2016)[16] | Puducherry | 140 | Abrasion (44.3%), Laceration (30.7%), Contusion (20%) | - | - | - | 33.6% | - |
| 9. | Ranjan *et al.* (2017)[26] | - | 500 | - | - | Lower extre. 65% | 85% | - | - |
| 10. | Vyawahare and Giri (2017)[15] | Central India | 129 | - | - | - | 65.1% | - | - |
| 11. | Raza *et al.* (2018)[18] | Varanasi, UP | 150 | - | - | - | - | 63%; 62% Skull fracture | - |
| 12. | Present study (2018) | Barabanki, UP | 100 | Abrasions (70%), contusions (72%) lacerations (55%), Incised/punc-tured/perfo- rated wounds (30%), crush wounds (35%), fractures and dislocations (20%), | Lung 28%; Heart 12%, Liver 21%, Spleen 15%, Stomach 10%, Intestine 15%, Rib fractures 52% | Upper 37%, Lower 58% | 63% | 50%: 32% Subdural haemorrhage; Skull fracture 60% | Thoraco-abd. 66% |

**Upper and Lower Extremities Involvement**: The involvement of upper and lower limbs was found to be present in 37% and 58% cases respectively in the present study. There is a limited account of upper and lower extremity involvement in different studies on fatal road accidents. Kulkarni *et al.*[20] in their study highlighted the lower extremity involvement in 34.9% cases while Sonawane and Jambure[31] reported the involvement of upper limbs in 45% cases. In another study, Ranjan *et al.*[26] reported lower extremity involvement in 65% cases. One of the reasons for fewer studies reporting upper and lower limb involvement could be owing to the fact, that most studies did not consider them to be fatal injuries and described only the injuries that could be considered as fatal. As far as involvement of upper and lower extremity in the present study is concerned, it is probably owing to the fact that most of the cases met with accidents that were those of collision and hit and hence the impact of the accident was of higher magnitude affecting both skeletal as well as other organ involvement. There are some studies like Farooqui *et al.*[30] and Katageri *et al.*[21] who have covered some injuries in a wider domain of skeletal injuries or fractures, however, they did not specify whether these included upper and lower limb injuries too. Nevertheless, despite the non-fatal nature of upper and lower limb injuries, their study helps to

understand the overall impact of the road traffic accidents leading to fatal injuries and could help in the strategic planning from the point of view of prevention, treatment and rehabilitation of the affected victims.

**Nature and Type of External Injuries:** The present study found Abrasions (70%), Contusions (72%), Lacerations (55%), Incised/Punctured/Perforated wounds (30%), Crush wounds (35%), Fractures and Dislocations (20%) as the common external injuries, thus indicating presence of multiple injuries. Sonawane and Jambure[42] too in their study reported presence of multiple external injuries with combinations Abrasion+ Contusion+ Laceration+ Crush seen in 37% and Crush+ Contusion + Laceration in 33% cases. Katageri *et al.*[21] also described multiple external injuries with Laceration (94.2%), Abrasion (82.7%) and contusion (76.9%) as the types of injury. Marak *et al.*[16] also reported abrasion (44.3%) as the most common type followed by Laceration (30.7%) and Contusion (20%). The type of external injury is generally dependent on the impact, nature and type of collision, time of contact between victim and offending vehicle as well as on a host of other factors such as object from which the victim was hit, secondary injury after fall on road and injuries as a result of friction or penetration by secondary objects. In the present study, most of the offending vehicles were heavy duty vehicles and that too in high speed that is why the pattern of external injuries included a wide variation including all the possible combinations *i.e.* penetrating, frictional, contact and pressure as the causative factor for injury resulting in a wider profile of injuries.

**Internal Organ Involvement**: In the present study, while injury to lung and liver was studied separately and was found to be most common internal organ injuries affecting 28% and 21% patients respectively, overall prevalence of internal organ injuries was 76%, and prevalence of thoraco-abdominal injuries in 66% cases. In general, there were multiple internal organ injuries. Multiplicity of internal organ injuries has also been reported in other studies too. Farooqui *et al.*[30] reported an average of 2.06 internal organs being involved. Among internal organs, similar to present study involvement of lung and liver has as the dominant internal organs has also been reported by Kulkarni *et al.*[20] in their study. Similarly, involvement of thoracic and abdominal organs in majority of cases has also been reported by Kulkarni *et al.*[38]. The incidence and pattern of internal organ involvement in different studies might be dependent on the nature of victim, type of offending vehicle and type of accident. In present study, collision and hit was the most dominant type of accident and victims were mainly pedestrians while offending vehicle was generally heavy vehicle and that is why the profile of internal organ injuries indicated a dominance of multiple organ involvement.

**Head Injury/Intracranial Haemorrhage and Skull Fractures**: These are probably the most widely covered injuries in various studies on fatal road accidents as head injury *per se* is considered to have the most deterministic impact on the survival of a road traffic victim. Almost all the contemporary studies have dealt with these injuries in detail. In present study, head injuries were seen in 63% cases, skull fractures in 60% and intracranial haemorrhage in 50% cases (with dominance of subdural haemorrhage). Prevalence of head injury has been reported to vary from 46.9%[34] to 86%[42] in different studies highlighted in Table D2 above. Head injury rate in 60-70% range has been reported by a number of studies including Gouda *et al.*[27] (68.5%), Kulkarni *et al.*[20] (61.1%) and Vyawahare and Giri[15] (65.1%). As far as skull fractures are concerned, in present study, they were seen in 60% of cases. However, this factor has been reported to be as high as 90.7% by Gouda *et al.*[27] and 98% by Sonawane and Jambure.[31] However, these studies specifically focussed on the pattern of cranio-cerebral and head injuries and hence these results could be slightly overestimated. Angam *et al.*[34], in their study however reported a skull fracture rate of 74.1% and intracranial haemorrhage rate of 43.4% which is similar to the present study. Although dominance of type of haemorrhage also showed a variability in different studies with Gouda *et al.*[27] reporting Subarachnoid haemorrhage to be most common while Arora and Kahjuria[22] similar to our study reported subdural haemorrhage to be most common type of intracranial haemorrhage.

**Time Between Accident and Death / Cause of Death**

In the present study, the survival time after the accident ranged from 0 to 10 hrs. In majority of cases (71%) deaths took place within 30 minutes of accident. The mean survival time was 57.44±112.37 minutes. With respect to the cause of death, coma due to head injury was the cause of death in 44% cases whereas in remaining 56% it was shock and haemorrhage. Instant/on the spot death occurred in 25% cases. The survival time between accident and death has varied significantly in different studies. While in the present study, the majority of deaths (71%) took place either instantly or within 30 minutes of accident. In some studies, death has been reported after 24 hour of hospitalization in majority of cases.[28] One of the reasons for this could be the poor healthcare infrastructure and inability to provide instant first aid facility leading to on-the-spot death of the patients. Similar to findings of present study, Khadim *et al.*[23] who conducted their study in Rawalpindi (Pakistan) reported on the spot death in 70.1% cases, thus indicating that most of the patients died even before receiving any primary healthcare. In the present study, the maximum survival time was 10 hrs which is relatively much lower than that reported in some other studies from India[25-28] which reported survival upto and beyond 24 hours in a sizeable proportion of their study population. Farooqui *et al.*[30] too found that majority of the victims (64.3%) either died on the spot or during transportation. These findings in effect show that there is a need to strengthen the healthcare facilities in order to provide the same within this crucial half a hour where most of the fatalities took place in our setup so this can be quite distressing and painful. As far as cause of death is concerned, the findings in the present study are similar to the other studies that are indicating of head injury, shock and

haemorrhage as the cause of death among road traffic accident victims.[31-35]

In the present study, we found that the rate of death during the first 30 minutes was most common, affecting 71% of victims, and hence we tried to explore the factors that influence a higher fatality rate during this period. We found a strong association between al influence, deaths of pedestrians, use of national ar 56 highways and occurrence of head injury with instant or early death (≤30 minutes after accident). Emergence of these factors, provides the basis for strategic planning for conducting mass awareness, campaign, improvement of road conditions and healthcare infrastructure development, in order to prevent the burden of such fatal accidents.

The findings of the present study showed that most of the victims were pedestrians while the offending vehicles were heavy vehicles, most probably high speed vehicles that led to the occurrence of collision and hit as the major type of accident and multiple injuries along with head injuries that led to the fatal outcome of the accidents. The short time span between the accident and death in most of the cases, is indicative of the need to upgrade the ambulatory healthcare services on the State and National highways along with safer pavements for the pedestrians. It is also recommended that safe speed limits in densely populated areas or where new residential, commercial establishments are coming up at national and state highways should also be imposed.

The findings of present study provided some insight regarding the injury pattern and epidemiology of the fatal road accidents in Barabanki district. It gave specific information, mainly regarding the time span between accident and death, thus providing the basis for strategic planning for prevention and recurrence of fatal RTAs. Keeping in view the fact that local factors play an important role in causation of road traffic accidents, it is essential that such studies should also be carried out in other different parts of Uttar Pradesh, more so, in view of the fact that with the changing demographics, there are limited studies available from this part of our country.

## CONCLUSION

The present study thus shows that fatal accidents in Barabanki district mainly affected the young adults in productive age groups and pedestrians. State highways were most commonly affected locations and alcoholic influence was a conspicuous finding affecting a sizeable proportion of victims. Most of the accidents were caused by motorized vehicles with collision and hit being the most common type of accident. Head injury, internal organ involvement and multiple injuries were responsible for accidents. As most of the fatalities took place within 30 minutes of accident which was affected by alcoholic influence, pedestrian nature, national and state highways and head injury, hence it recommended that awareness campaigns against use of alcohol, following safe road practices and use of protective wears should be launched. Moreover, healthcare services should be mobilized in such a way that a victim is attended within 30 minutes of accident to reduce the burden of mortality.

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