GEOGRAPHICAL ANALYSIS

ORIGINAL ARTICLE

Spatio-Temporal Analysis of Road Accident Patterns in Karnataka: Causes, Risk Dimensions, and Policy Implications

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Abstract

This study presents a comprehensive macro-level epidemiological and spatial-temporal analysis of road traffic accidents in Karnataka for the calendar year 2023, contextualized within a five-year longitudinal framework (2019–2023) to evaluate regional traffic safety dynamics. Drawing on empirical data from the official registries of the Karnataka State Police and the State Crime Records Bureau (SCRB), the research evaluates a dataset of 43,440 discrete vehicular crashes, representing an acute 9.25% year-over-year escalation in traffic incidents that culminated in 12,321 fatalities and 52,547 non-fatal injuries. By stratifying these incidents across roadway classifications, vehicular typologies, kinematic collision mechanics, victim demographics, and behavioral infractions, the analysis reveals a concerning post-pandemic resurgence in crash metrics. The findings indicate that National and State Highways exhibit disproportionately high fatality rates relative to their linear mileage, with Vulnerable Road Users (VRUs)—predominantly motorized two-wheeler operators and pedestrians within the active 18–35 age cohort—bearing the primary mortality burden. Furthermore, the data isolates speeding, non-compliance with passive safety systems (helmets and seatbelts), and hazardous overtaking as the primary proximal drivers of fatal outcomes, exacerbated by distinct temporal high-frequency crash vectors linked to peak transit hours. Ultimately, this widening divergence between expanding road infrastructure and regional safety enforcement metrics underscores the critical need for a pivot toward predictive, evidence-based interventions. To mitigate this systemic public health crisis, the study concludes with targeted policy frameworks, advocating for automated speed-enforcement corridors, stricter legislative mandates for protective gear, geometric remediation of infrastructure blackspots, and optimized trauma-care distribution along high-speed corridors.

Keywords: Road accidents, Karnataka, Traffic fatalities, Over-speeding, Two-wheelers, Road safety policy, SCRB

1 Introduction

Road traffic accidents constitute one of the leading causes of unnatural deaths and disability in India. Karnataka, as one of India's major states with a rapidly expanding road network and motor vehicle fleet, faces a significant road safety challenge. The State Crime Records Bureau (SCRB) of Karnataka, in coordination with the Ministry of Road Transport and Highways (MoRTH)[35], compiles annual road accident data to inform policy. The 2023 edition covers data across 38 police units, 43 statistical annexures, and six analytical sections.

A growing body of international and national research underscores the multidimensional nature of road traffic accidents. Studies by Hammoudi *et al.* (2014)[1] in Abu Dhabi and Hussain *et al.* (2011)[2] in Pakistan emphasised the critical role of public awareness, road safety education, proper use of seat belts and helmets, and broad stakeholder participation in reducing accident rates. Shruthi *et al.*

(2013)[3] highlighted the high proportion of fatal injuries among accident victims in South Indian metropolitan cities and recommended stricter enforcement against drunken driving alongside improved safety measures at accident-prone locations. Abojaradeh (2015)[4] developed accident prediction models in Jordan and found that driver behaviour errors — speeding, lane violations, and close following — are the dominant causes of accidents and fatalities. Geospatial approaches have also proven effective: researchers including Vyas *et al.* (2014)[5], Sorate *et al.* (2015)[6], Subbareddy and Prasad (2015)[7], Bobade *et al.* (2015)[8], Gupta and Singh (2014)[9], Jayan and Ganeshkumar (2010)[10], and Saleh (2014)[11] demonstrated the power of GIS-based techniques, weighted severity indices, and kernel density analysis in identifying accident black spots and planning targeted mitigation measures. At the macro level, studies by Zhao and Deng (2012)[12] in China, Augustus (2012)[13] in Nigeria, and Zhou *et al.* (2007)[14] in Southwest China revealed increasing trends in road traffic fatalities — particularly on expressways and in mountainous terrain — attributing them to poor road design, inadequate traffic management, and rapid transportation development. Collectively, the literature confirms that road traffic accidents are shaped by a complex interplay of human, vehicular, infrastructural, environmental, and management-related factors, and underscores the need for effective road safety policies, GIS-based accident analysis, public awareness programmes, and strict law enforcement. This paper situates the Karnataka 2023 data within that broader framework.

This paper uses the official SCRB dataset as its primary source. It aims to: (1) document the macro-level trends in accident incidence, fatality, and injury rates; (2) systematically analyse the risk profile of road accidents by multiple dimensions; (3) identify causal factors with the greatest explanatory weight; and (4) propose targeted, data-grounded interventions. Karnataka's record of 33 deaths and 119 accidents every day in 2023 underscores the urgency of this analysis.

2. Review of Literature

The review of literature on road traffic accidents draws on studies from multiple countries and disciplinary perspectives, collectively illuminating the human, infrastructural, vehicular, environmental, and policy dimensions of accident causation, severity, and prevention.

- **Human and Behavioural Factors**

Driver behaviour and public awareness consistently emerge as central risk factors. Hussain *et al.* (2011)[2] conducted a questionnaire-based survey in Islamabad, Pakistan, revealing that approximately 27% of respondents lacked awareness of road safety measures, 21% misused seat belts and helmets, and a significant proportion were underage licence holders. Rahman *et al.* (2005)[15] surveyed 618 adolescent school students in Malaysia and found students operating vehicles without proper licences and without wearing seat belts, emphasising parental responsibility. Lalitha and Ruther (2014)[16] found that around 70% of college students in Andhra Pradesh had limited awareness of traffic regulations, highlighting the importance of safety education for younger road users.

Hammoudi *et al.* (2014)[1] examined accident scenarios among 291 respondents in Abu Dhabi, identifying a range of causal factors and recommending sustained stakeholder engagement for accident reduction. Abojaradeh (2015)[4] developed statistical regression models using 394,188 accident records from Jordan (2000–2010). The models showed that close following and lane violations are the leading causes of total accidents, while speed limit violations are the primary cause of fatalities — a finding directly echoed in Karnataka's 2023 data, where over-speeding accounted for 91.75% of all accidents.

- **Fatal Injury Patterns and Medical Perspectives**

Shruthi *et al.* (2013)[3] analysed autopsy records from South Indian metropolitan cities (2010–2012) and found that accident cases constituted 55% of all forensic cases, of which 78% were male victims and 30.22% involved fatal head, abdominal, and limb injuries, with peak incidence during morning hours (6 AM–12 PM). Chinnaswamy *et al.* (2007)[17] assessed flat-fronted commercial vehicle accidents using an 'Aggressivity Index' and found child pedestrians significantly more vulnerable than adults — a concern mirrored in Karnataka's 15.94% rise in deaths among minors (under 18) in 2023.

- **Road Infrastructure, Geometry, and Environment**

Zhao and Deng (2012)[12] analysed expressway accident data in China (1995–2010) and found expressway deaths increased 10.2-fold, with a lethality rate 1.33 times higher than general highways, calling for speed monitoring and emergency rescue infrastructure. Zhou *et al.* (2007)[14] documented serious traffic safety conditions in mountainous Southwest China attributable to imperfect road design, deficient law enforcement, and adverse environmental factors. Augustus (2012)[13] identified an upward trend in road accidents in Warri, Nigeria over ten years, with projections of continued increase. Pandi *et al.* (2016)[18] reported that improper road maintenance — potholes and unmarked humps — contributed significantly to nighttime accidents in Tamil Nadu, resonating with Karnataka's 330.91% surge in pothole-related accidents in 2023. Islam and Kanitpong (2008)[19] highlighted that absence of street lighting, inadequate lane marking, and late evasive action are major severity-amplifying factors in developing Asian road contexts.

- **GIS-Based Black Spot Identification**

Geographic Information Systems have become the dominant tool for identifying accident-prone zones. Jayan and Ganeshkumar (2010)[10] used kernel density estimation on three years of data from Kannur District, Kerala, to map accident-prone roads. Saleh (2014)[11] developed a GIS-based accident database for Nigeria's Federal Capital Territory (2010) to enable black spot identification. Gupta and Singh (2014)[9] employed ArcGIS spatial autocorrelation tools to validate black spots in Chandigarh. Vyas *et al.* (2014)[5] applied Weighted Severity Index and GIS on State Highway 85 in Karnataka; Sorate *et al.* (2015)[6] used similar methods on National Highway 4 in Pune; Subbareddy and Prasad (2015)[7] extended this to mixed-traffic urban streets; and Bobade *et al.* (2015)[8] applied a 10-parameter ranking method to NHs 9 and the Mumbai–Pune Expressway. Apparao *et al.* (2013)[20] demonstrated GIS and GPS integration on NH-58. At the international level, Oulha *et al.* (2013)[21] applied kernel estimation in Algeria, Molla *et al.* (2014)[22] used ordinary kriging in North Dakota across 37 years of data, and Kundakci (2014)[23] employed Near Neighbourhood Hierarchical clustering in Ankara.

- **Temporal and Spatio-Temporal Patterns**

Svetlana (2013)[24] conducted temporal analysis of road accidents in Vojvodina (2001–2009), demonstrating that time mapping is valuable for identifying critical periods for drink-driving controls and pedestrian safety. Ivan and Haidu (2012)[25] found peak accident incidence during daytime rush hours in spring and autumn in Cluj-Napoca (2010–2012). Soltani and Askari (2014)[26] used kernel density estimation in metropolitan Shiraz, Iran, and found the highest accident concentrations on high-volume arterial roads — consistent with Karnataka's findings on National and State Highways.

- **Vehicle-Specific Studies**

Jain *et al.* (2009)[27] analysed five years of two-wheeler accident data from Mangalore, Karnataka (2000–2004), finding 77% of victims were aged 18–44, 83% were male, and most accidents occurred during evening peak hours — findings that anticipate Karnataka's 2023 state-wide pattern in which two-wheelers account for over 53% of accidents and 54% of deaths. Rodriguez *et al.* (2015)[28] conducted time series analysis of injuries in Colombia (2008–2012), finding 82% male involvement and a significant seasonal pattern. Amarasingha (2015)[29] studied three-wheeler crashes in Sri Lanka (2004–2013), finding predominantly male drivers aged 21–40 and daytime/clear weather predominance. Misra and Singh (2004)[30] documented a more than doubling of fatal accidents in Patna city from 2000 to 2004.

- **Policy and Management Interventions**

Yang and Kim (2010)[31] reviewed accident trends and policy outcomes in Korea from 1970 to 2000, showing a near eightfold increase in crashes followed by measurable improvement after policy interventions implemented in 2000. Ndung'u *et al.* (2015)[32] analysed response strategies in Kenya, recommending new policies suited to the country's terrain constraints. Kharola *et al.* (2010)[33] documented an 80% rise in fatal accidents in Bengaluru (2003–2007) and recommended low-floor buses, mechanical doors, and segregated cycling and pedestrian infrastructure. Collectively, the literature consistently demonstrates that sustainable road safety improvement requires an integrated approach combining data analytics, geospatial tools, behavioural interventions, engineering improvements, and coordinated policy — all of which anchor the analytical framework of the present paper.

3 Methodology and Data Sources

The research adopts a descriptive-analytical methodology, primarily using secondary data from the official report 'Road Accidents in Karnataka – 2023' published by the Government of Karnataka Police Department[34] and the SCRB, Bengaluru. Data were extracted across six thematic sections and 43 annexures. Longitudinal comparisons were made over the five-year period from 2019 to 2023, and decade-long trend analyses were applied where available (2013–2023).

Quantitative analysis includes percentage change calculations, share decompositions, and cross-tabulations by road type, vehicle type, collision type, age-gender profiles, district, time of day, month, and weather condition. The analysis acknowledges the inherent limitations of police-reported accident data, including possible under-reporting, classification inconsistencies across districts, and survivorship bias in injury recording.

Study Area: Karnataka

Karnataka is one of the largest states in Peninsular India, situated between latitudes 11°31'N to 18°45'N and longitudes 74°07'E to 78°33'E. Covering an area of 191,791 km², it is the sixth-largest state in India by area and ranks among the top five most motorised states. Karnataka is bounded to the north by Maharashtra and Goa, to the northeast by Telangana, to the east by Andhra Pradesh, to the south by Tamil Nadu and Kerala, and to the west by the Arabian Sea. This strategic geographic position, combined with the state's role as a major economic and IT hub, generates exceptionally high volumes of inter-state and intra-state road traffic.

- **Administrative and Road Network Profile**

For administrative and policing purposes, Karnataka is divided into 38 units — comprising districts and police commissionerates — all of which contribute accident data to the State Crime Records Bureau (SCRB). The state's road network spans all categories: National Highways (NHs), State Highways (SHs), Major District Roads (MDRs), and Other District Roads (ODRs). Key highway corridors include NH-44 (Bengaluru–Hyderabad), NH-48 (Bengaluru–Mumbai), NH-75 (Mangaluru–Bengaluru), and NH-67 (connecting central districts), all of which cut through the state's most accident-prone zones.

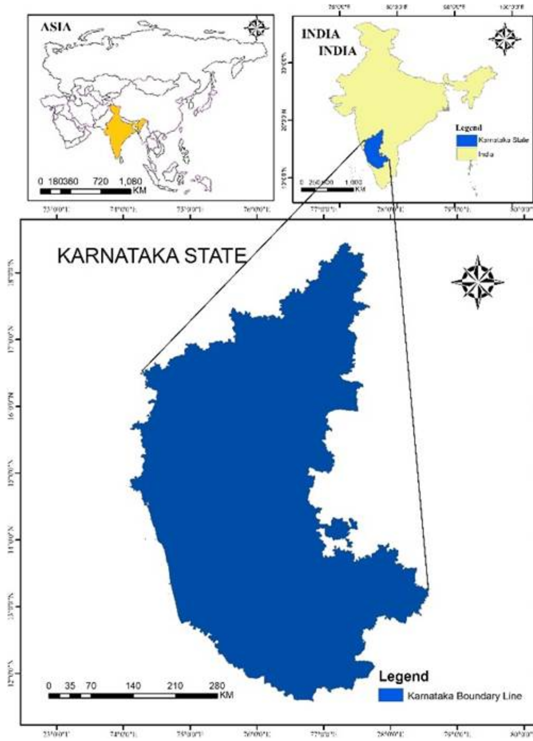

Fig. 1: Karnataka State — Study Area Map

The state capital, Bengaluru, situated at approximately 12°58'N, 77°35'E, is India's third-largest metropolitan area and the single largest contributor to road accidents in Karnataka (11.45% of state total in 2023). Other major urban centres include Mysuru (12°18'N, 76°38'E), Hubballi-Dharwad (15°21'N, 75°07'E), Mangaluru (12°52'N, 74°51'E), Belagavi (15°51'N, 74°29'E), and Kalaburagi (17°19'N, 76°49'E). These cities serve as significant traffic generation and distribution points along both north–south and east–west highway corridors.

- **Physiographic and Climatic Context**

Karnataka's terrain falls into three broad physiographic zones: the Western Ghats (Sahyadri) along the western fringe, characterised by steep gradients, sharp curves, and heavy rainfall that significantly increase accident risk; the Coastal Lowlands (Karavali) along the Arabian Sea shoreline, with dense urban traffic in Mangaluru and Udupi; and the Deccan Plateau, covering the vast interior, where long open stretches of National and State Highways favour high-speed driving and account for the majority of over-speeding-related fatalities. The plateau region encompasses most of the state's high-accident districts — Bengaluru, Tumakuru, Bengaluru Rural, Hassan, Mandya, Chitradurga, and Ramanagara — all of which feature in Karnataka's top-10 accident districts for 2023.

The state experiences a tropical and semi-arid climate over much of its interior, with the Southwest Monsoon (June–September) affecting road surface conditions along the Western Ghats and coastal belt. The post-monsoon period (October–December) corresponds to high festival traffic and elevated accident incidence on inter-city highways.

Macro-Level Trends: 2019–2023

1) Overall Accident Incidence

[Table. 1] summarises the five-year trend. After a sharp COVID-affected decline in 2020 (−15.93%), accidents rebounded steadily, with 2023 setting an absolute five-year record at 43,440 accidents, 12,321 deaths and 52,547 injuries.

Table 1: Road Accidents, Persons Killed and Injured in Karnataka (2019–2023)

Year	Accidents	% Change	Killed	% Change	Injured
2019	40,658	−2.51	10,958	−0.29	50,447
2020	34,178	−15.93	9,760	−10.93	39,492
2021	34,647	+1.37	10,038	+2.84	40,754
2022	39,762	+14.76	11,702	+16.57	48,154
2023	43,440	+9.25	12,321	+5.29	52,547

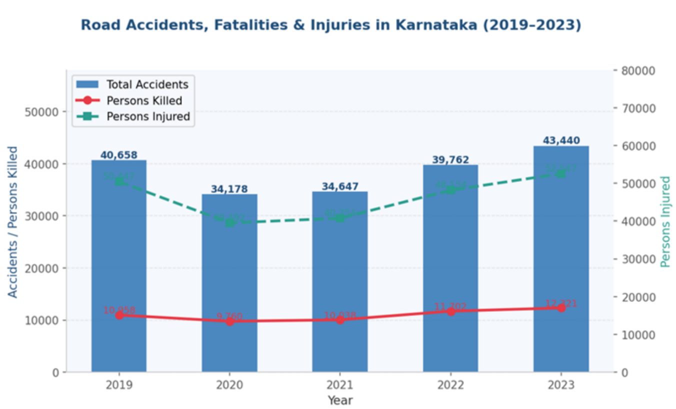

Fig. 2: Five-Year Trend — Accidents, Fatalities and Injuries (2019–2023)

The 2023 figure translates to an average of 119 accidents, 33 deaths, and 144 injuries per day — approximately one accident every 12 minutes. The mortality rate (deaths per 100 accidents) stood at 28.4.

2) Accident Type Distribution

In 2023, grievous injury accidents were the dominant category (46.49%), followed by fatal accidents (26.71%), minor injury (19.27%), and non-injury (7.53%). Fatal accidents increased 6.9% and grievous injury accidents rose 17.76% over 2022.

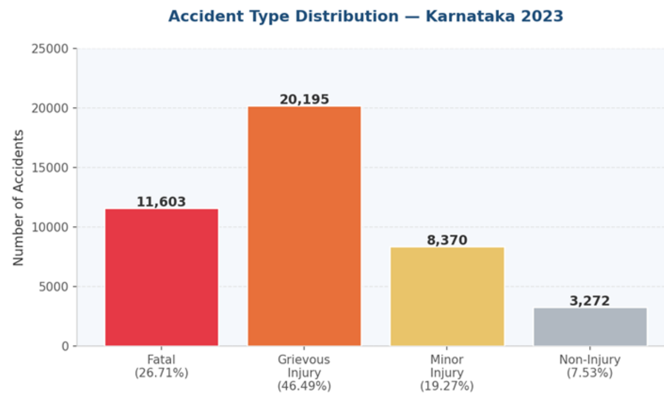

Fig. 3: Accident Type Distribution — Karnataka 2023

3) Accidents by Road Category

National and State Highways together accounted for 56.87% of accidents and 61.88% of deaths in 2023, despite representing a smaller fraction of total road length. This disproportionate share reflects higher vehicle speeds and greater traffic volumes.

Table 2: Accidents, Fatalities and Injuries by Road Category (2023)

Road Category	Accidents	% Share	Killed	% Share	Injured	% Share
Expressways	521	1.20%	188	1.53%	540	1.03%
National Highways	13,749	31.65%	4,177	33.90%	16,820	32.01%
State Highways	10,956	25.22%	3,448	27.98%	14,685	27.95%
Other Roads	18,214	41.93%	4,508	36.59%	20,502	39.02%
Total	43,440	100%	12,321	100%	52,547	100%

The decade-long trend (2013–2023) shows the NH share oscillating between 28–34% of accidents but 33–40% of deaths, confirming that highways are structurally over-represented in fatalities. The elevated fatality rate on NHs reflects higher impact velocities and remoteness from trauma care centres.

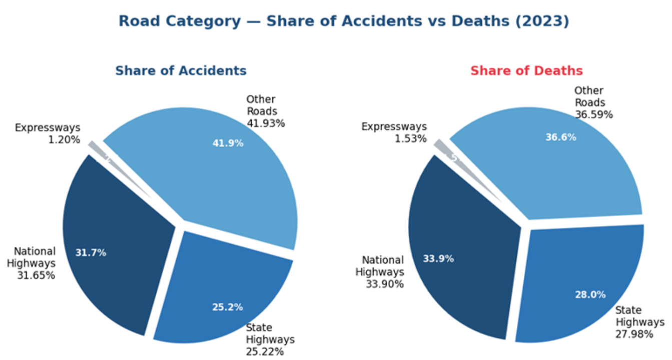

Fig. 4: Road Category Share of Accidents vs Deaths (2023)

4) Accidents by Vehicle Type

Table 3: Accidents and Fatalities by Vehicle Type — 2022 vs 2023

Vehicle Type	Accidents	% Share	Killed	% Share	% Chg (Acc.)	% Chg (Killed)
Two-Wheelers	18,914	53.62%	5,389	54.61%	+5.47%	−5.22%
Car/Jeep/Van/Taxi	7,260	20.58%	1,733	17.56%	+6.97%	+12.83%
Auto Rickshaw	1,743	4.94%	371	3.76%	+4.00%	−6.55%
Truck/Lorry	2,050	5.81%	497	5.04%	−20.33%	−29.30%
Bus	1,069	3.03%	258	2.61%	−6.64%	−10.42%
Others	3,927	11.13%	1,549	15.70%	+59.38%	+71.35%

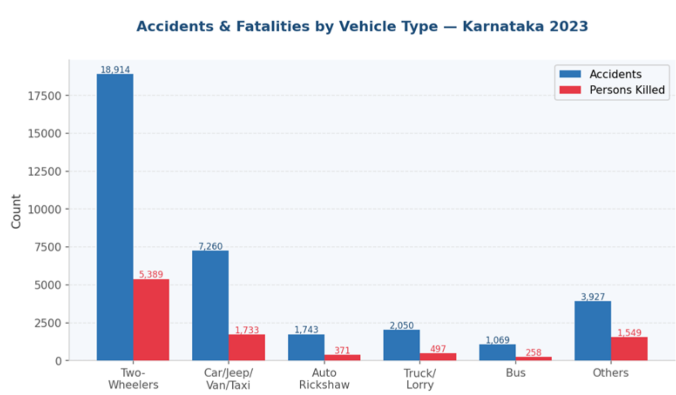

Fig. 5: Accidents & Fatalities by Vehicle Type — Karnataka 2023

Motorised two-wheelers dominated the accident landscape in 2023, accounting for 53.62% of all accidents and 54.61% of all fatalities — figures consistently above 50% for multiple consecutive years.

The 'Others' category registered the largest percentage increase in accidents (+59.38%) and fatalities (+71.35%). Trucks and lorries recorded significant declines (−20.33% accidents; −29.30% deaths), possibly reflecting stricter enforcement of overloading regulations.

5) Accidents by Type of Collision

'Hit from Back' (25.91% of deaths) and 'Head-on Collision' (20.90%) together account for nearly half of all road fatalities in 2023. Vehicle-to-vehicle collisions dominated at 76.23% of accident deaths, while vehicle-to-pedestrian collisions accounted for 22.35%.

Table 4: Accidents by Collision Type — 2022 vs 2023

Collision Type	Acc. 2022	Acc. 2023	% Chg	Killed 2022	Killed 2023	% Deaths
Hit from Back	9,808	11,483	+17.08%	2,653	3,192	25.91%
Head-on Collision	8,411	9,223	+9.65%	2,180	2,575	20.90%
Hit from Side	6,833	7,274	+6.45%	1,642	1,590	12.90%
Hit & Run	3,017	2,737	−9.28%	1,176	1,117	9.07%
Fixed Object	1,286	1,591	+23.72%	394	461	3.74%
Run Off Road	2,069	1,802	−12.90%	670	530	4.30%
Vehicle Overturn	1,478	1,310	−11.37%	371	363	2.95%

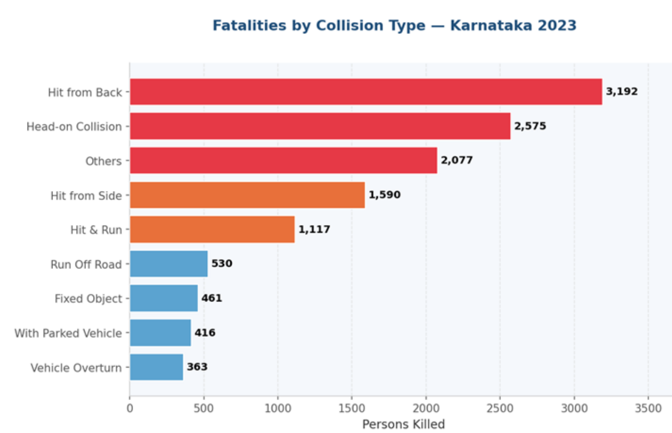

Fig. 6: Fatalities by Collision Type — Karnataka 2023

The rise in 'Fixed Object' collisions (+23.72%) and 'Hit from Back' (+17.08%) suggests a confluence of distracted driving, inadequate roadside hazard delineation, and failure to maintain safe following distances.

6) Demographic Profile of Victims

Age Distribution: The working-age group of 18–60 years accounted for 83.35% of all deaths. Young adults aged 18–45 collectively accounted for 63.31% of fatalities. Deaths among the 60+ cohort surged 88.67% (from 821 in 2022 to 1,549 in 2023), now representing 12.57% of all accident deaths.

Table 5: Age Profile of Road Accident Deaths (2021–2023)

Age Group	Killed 2021	% Share	Killed 2022	% Share	Killed 2023
< 18	376	3.75%	433	3.70%	502
18–25	2,157	21.49%	2,267	19.37%	2,261
25–35	2,740	27.30%	3,346	28.59%	2,825
35–45	2,250	22.41%	2,687	22.96%	2,714
45–60	1,760	17.53%	2,148	18.36%	2,470
60+	755	7.52%	821	7.02%	1,549
Total	10,038	100%	11,702	100%	12,321

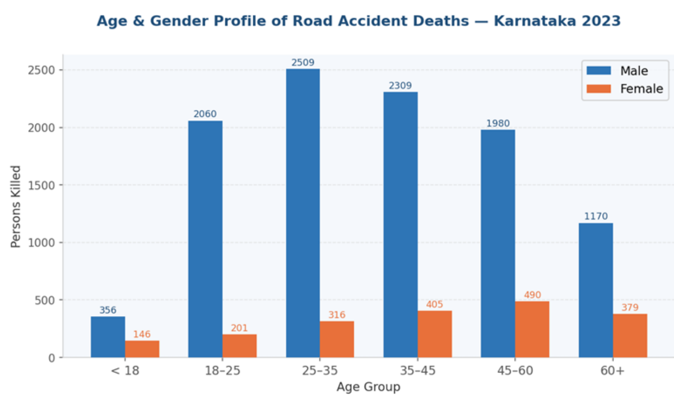

Fig. 7: Age & Gender Profile of Road Accident Deaths — Karnataka 2023

Gender Distribution: Males constituted 84.28% (10,384) of all road accident deaths in 2023, against 15.72% (1,937) for females. The female share has been growing gradually — from 12.19% in 2021 to 15.72% in 2023 — potentially reflecting increasing female participation in motorised mobility.

Road User Category: Two-wheeler riders account for 43.74% of road deaths, followed by pedestrians (19.63%), car/taxi/LMV occupants (14.07%), and truck/lorry occupants (4.03%). The pedestrian toll rose 14.86% — from 2,105 in 2022 to 2,418 in 2023.

7) Causes of Road Accidents

Table 6: Accidents by Traffic Violation Type — 2022 vs 2023

Violation Type	Acc. 2022	Acc. 2023	% Chg	Kill. 2022	Kill. 2023	% Chg Killed
Over-speeding	35,550	39,857	+12.12%	10,723	11,523	+7.46%
Wrong Side/Lane	1,059	1,070	+1.04%	195	213	+9.23%
Drunken Driving	178	407	+128.65%	82	180	+119.51%
Red Light Jumping	17	49	+188.24%	4	6	+50.00%
Mobile Phone Use	13	141	+984.62%	5	32	+540.00%
Others	2,945	1,916	−34.94%	693	367	−47.04%

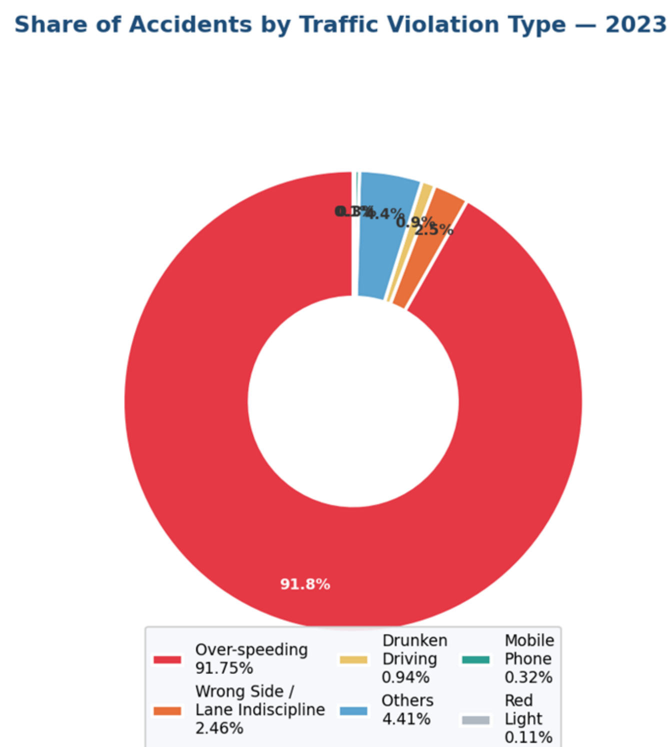

Fig. 8: Share of Accidents by Traffic Violation Type — 2023

Traffic Violations: Over-speeding is overwhelmingly the primary cause. In 2023, speeding was associated with 91.75% of accidents, 93.52% of deaths, and 91.37% of injuries. Drunken driving more than doubled (+128.65%), and mobile phone use surged nearly tenfold (+984.62% in accidents).

Safety Device Non-Compliance: Non-wearing of helmets was responsible for 3,347 deaths (27.16% of total) in 2023 — a 14.5% increase over 2022. Non-use of seat belts was associated with 980 deaths (7.95% of total). The helmet non-compliance toll alone exceeds one in four accident-related deaths.

Table 7: Deaths Due to Non-Use of Safety Devices — 2022 vs 2023

Year	Helmet Drivers	Helmet Passengers	Total Helmet Deaths	Seatbelt Drivers	Seatbelt Passengers	Total Seatbelt Deaths
2022	2,067	856	2,923 (24.97%)	476	638	1,114 (9.51%)
2023	2,340	1,007	3,347 (27.16%)	506	474	980 (7.95%)
% Change	—	—	+14.50%	—	—	−12.02%

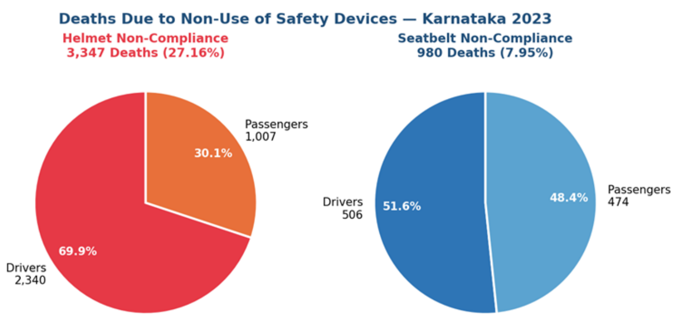

Fig. 9: Breakdown of Deaths by Safety Device Non-Compliance — 2023

Driver Licence Status: Notably, 80.92% of accidents involved drivers with valid licences, with only 10.98% involving unlicensed drivers. This challenges assumptions about unlicensed driving dominance and instead points to inadequacy in the licensing system's ability to promote safe driving behaviour.

Road Infrastructure: Straight roads accounted for 81.54% of accidents and 83.39% of deaths — consistent with the over-speeding dominance. Pothole-related accidents surged from 55 to 237 (+330.91%). Open areas were the setting for 64.77% of accidents and 72.62% of deaths, reflecting lower enforcement presence. Uncontrolled junctions accounted for 77.01% of junction-related accidents.

8) Geographic Distribution

Bengaluru City recorded the highest number of accidents (4,974) in 2023 — a 30.14% increase over 2022 — accounting for 11.45% of the state total. The top 15 districts together represented 65.63% of all accidents in 2023.

Table 8: Top 10 Districts by Road Accidents — 2022 vs 2023

Rank	Unit	Accidents 2022	Accidents 2023	Change	% Change
1	Bengaluru City	3,822	4,974	+1,152	+30.14%
2	Tumakuru	2,257	2,601	+344	+15.24%
3	Bengaluru Rural	2,129	2,451	+322	+15.12%
4	Mandya	1,978	2,160	+182	+9.20%
5	Hassan	1,975	2,138	+163	+8.25%
6	Belagavi District	1,935	2,086	+151	+7.80%
7	Chitradurga	1,722	1,750	+28	+1.63%
8	Mysuru District	1,599	1,736	+137	+8.57%
9	Ramanagara	1,410	1,627	+217	+15.39%
10	Shivamogga	1,395	1,483	+88	+6.31%

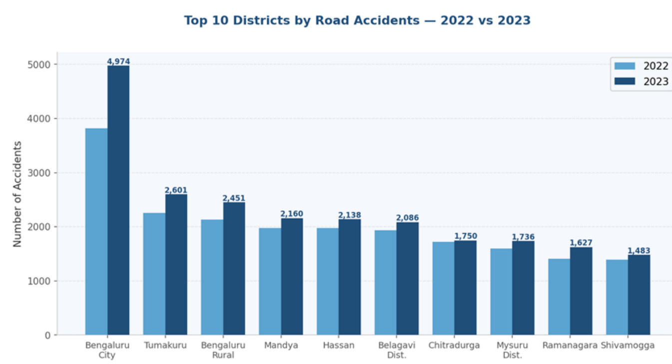

Fig. 10: Top 10 Districts by Road Accidents — 2022 vs 2023

Other notable high-growth districts include K.G.F. (+31.82%), Chickballapura (+22.40%), and Mysuru City (+22.81%). Districts recording declines include Dakshina Kannada (−4.88%), Bagalkot (−4.22%), and Raichur (−4.26%).

9) Temporal Patterns

Road accidents exhibit pronounced temporal clustering. Post-monsoon and festival months (October–December) and summer holiday months (April–June) tend to see higher accident rates. Nighttime hours and early mornings are associated with disproportionate fatality rates, likely reflecting reduced visibility and fatigue-related driving. These temporal concentrations should inform targeted patrol deployment and speed enforcement scheduling.

10) Policy Recommendations

Based on the foregoing analysis, the following targeted interventions are recommended:

1. Speed Management Infrastructure: A systematic roll-out of speed cameras, automated enforcement, variable speed limits, and speed-activated warning signs on National and State Highways — particularly in straight-road, open-area corridors.
2. Mandatory Helmet Enforcement: With 27.16% of all road deaths linked to helmet non-compliance, a state-wide zero-tolerance helmet enforcement drive could save thousands of lives annually.
3. Two-Wheeler Safety Programme: Dedicated rider training, ABS/CBS mandates for new vehicles, lane safety infrastructure, and road marking improvements targeting the 53%+ accident share of two-wheelers.
4. Pedestrian Safety Infrastructure: Investment in pedestrian crossings, footpaths, grade-separated crosswalks on highways, and safe-street design in Bengaluru, Tumakuru, and other high-accident cities.
5. Golden Hour Emergency Response: GPS-tracked trauma response network including highway patrol medical units and pre-designated trauma centres at highway intervals, backed by strong Good Samaritan legal protections.
6. Anti-Drunk Driving Operations: Intensified late-night and weekend breathalyser checkpoints, given the 128.65% surge in drunk-driving accidents.
7. Driver Licence Reform: Incorporate hazard perception tests, defensive driving training, and periodic renewals with skill reassessment, as 80.92% of accidents involve validly licensed drivers.
8. Road Maintenance and Pothole Rectification: Real-time pothole reporting, rapid repair protocols, and accountability mechanisms for road agencies — pothole accidents surged 330.91% in 2023.
9. Junction Safety: Priority traffic signal installation programme at uncontrolled intersections, which account for 77% of junction accidents.
10. Mobile Phone Distraction Enforcement: Dedicated distracted-driving operations; hands-free technology mandates for vehicles, given the near-tenfold increase in mobile-phone-related accidents.

4 Conclusion

Karnataka's road accident data for 2023 presents a stark picture: an absolute record of 43,440 accidents, 12,321 deaths, and 52,547 injuries — all above pre-pandemic levels and trending upward. The data reveals a concentrated risk profile: two-wheelers, National and State Highways, over-speeding, open-area straight roads, and working-age males in the 18–45 bracket are the dominant dimensions of risk.

The finding that the vast majority of fatal accidents involve validly licensed drivers speeding on clear days on straight roads fundamentally reframes the problem: it is not primarily one of illegal behaviour, but of tolerated norm violations and structural incentives that make high-speed driving commonplace.

The upward trajectories of drunken driving, mobile phone use, pothole-related crashes, and pedestrian fatalities represent emerging threat vectors that, if unaddressed, will compound the baseline problem. Conversely, declines in truck/lorry fatalities and hit-and-run incidents demonstrate that targeted enforcement can yield measurable results.

Karnataka has the data, the institutional capacity through the SCRB, and a policy framework aligned with MoRTH national guidelines to act decisively. Every percentage point reduction in the fatality rate translates into hundreds of lives saved, billions of rupees in economic productivity preserved, and immeasurable human suffering prevented.

References

1. Hammoudi A, Karani G, Littlewood JR. Road Traffic Accidents Among Drivers in Abu Dhabi, United Arab Emirates. *Journal of Traffic and Logistics Engineering*. 2014;2(1):7-12.10.12720/jtle.2.1.7-12
2. Hussain T, Shu LY, Sosorburam T, Adji AS, Khan AH, Farooq A. Road Traffic Accidents; An Observational and Analytical Study Exploring the Hidden Truths in Pakistan and South East-Asian Countries. *Healthline*. 2011;2(1):52-57.https://www.healthlinejournal.org/index_pdf/33.pdf

3. Shruthi P, Venkatesh VT, Viswakanth B, Ramesh C, Sujatha PL, Dominic IR. Analysis of Fatal Road Traffic Accidents in a Metropolitan City of South India. *Journal of Indian Academy of Forensic Medicine*. 2013;35(4):317-320.10.1177/0971097320130406
4. Abojaradeh M. Development of Traffic Accident Prediction Models to Improve Traffic Safety and to Reduce Traffic Accident Severity and Rate in Jordan. *IISTE, Journal of Biology, Agriculture and Healthcare*. 2015;5(2):42-54.https://www.iiste.org/Journals/index.php/JBAH/article/view/19533
5. Vyas PR, Honnappanavar ML, Balakrishna HB. (2014). Identification of Black Spots for Safe Commuting Using Weighted Severity Index and GIS. 3rd World Conference on Applied Sciences, Engineering & Technology.
6. Sorate RR, Kulkarni RP, Bobade SU, Patil MS, Talathi AM, Sayyad IY, Apte SV. Identification of Accident Black Spots on National Highway 4 (New Katraj Tunnel to Chandani Chowk). *IOSR Journal of Mechanical and Civil Engineering*. 2015;12(3).10.6084/M9.FIGSHARE.1415742.V1
7. Subbareddy M, Prasad KSB. Identification and Improvement of Accidents black Spots for Mixed Traffic Streets in Developed Cities-A Case Study. *International Journal of Engineering Research*. 2015;4(10):527-533.10.17950/ijer/v4s10/1003
8. Bobade SU, Patil JP, Sorate RR. Black Spot Analysis on National Highway - 4. *International Journal of Engineering Research and*. 2016;V5(03).10.17577/ijertv5is030842
9. Gupta R, Singh M. Accident Black-Spot Validation Using GIS. *15th Esri India User Conference*. 2014;.https://www.researchgate.net/publication/313858691_Accident_Black-Spot_Validation_using_GIS
10. Jayan DK, Ganeshkumar B. (2010). Identification of Accident Hot Spots: A GIS-Based Implementation for Kannur District, Kerala. International Journal of Geomatics and Geosciences, 1.
11. Saleh S. Geographical Information System (GIS)-Based Analysis of Road Traffic Accident Blackspots in Federal Capital Territory (F.C.T). *Journal of Traffic and Logistics Engineering*. 2014;2(2):108-112.10.12720/jtle.2.2.108-112
12. Zhao J, Deng W. Traffic Accidents on Expressways: New Threat to China. *Traffic Injury Prevention*. 2012;13(3):230-238.10.1080/15389588.2011.645959
13. Atubi AO. Road Traffic Accidents in Warri and Environs: A Ten-Year Survey. *AFRREV IJAH*. 2012;1(2):195-210.https://scispace.com/pdf/road-traffic-accidents-in-warri-and-environs-a-ten-year-57ysa6lsk2.pdf
14. Zhou J, Zhao X, Jiang Z, Zhu S, Zhaou J. Investigation on Road Traffic Safety of the Mountain Areas in Southwest China Based on Wulong County, Chongqing Municipality. *Traffic Injury Prevention*. 2005;6(2):193-196.10.1080/15389580590931707
15. Rahman HA, Zulkifli NAM, Subramaniam K, Hua LT. Car Occupants Accidents and Injuries among Adolescents in Malaysia. *Proceedings of the Eastern Asia Society for Transportation Studies*. 2005;5:1867-1874.https://easts.info/on-line/proceedings_05/1867.pdf
16. Lalitha K, Ruther GK. (2014). Road Traffic Accident Awareness among College Students in Guntur, Andhra Pradesh. *IMPACT: International Journal of Research in Humanities, Arts and Literature*, 2(3). 83-86
17. Chinnaswamy GK, Chirwa EC, Nammi S, Nowpada S, Chen T, Mao N. Benchmarking and accident characteristics of flat-fronted commercial vehicles with respect to pedestrian safety. *International Journal of Crashworthiness*. 2007;12(3):279-291.10.1080/13588260701441365
18. Pandi DG, *et al.* (2016). Road Maintenance and Nighttime Accident Prevention in Tamil Nadu. *IJARIIE*, 2.
19. Islam MB, Kanitpong K.). Identification of Factors in Road Accidents Through In-Depth Accident Analysis. *IATSS Research*. 2008;32(2):58-67.10.1016/s0386-1112(14)60209-0
20. Apparao G, Mallikarjunareddy P, Raju SVG. (2013). Identification of Accident Black Spots for National Highway Using GIS. International *International Journal of Scientific and Technology Research*, 2(2).
21. Oulha R, Boumediene A, Amara K, Benyoucef S, Hamadouche MA, Brahimi K. Using Qualitative Study and GIS to Explore Road Accident Black Areas in Algeria. *Periodica Polytechnica Transportation Engineering*. 2016;44(4):209-214.10.3311/pptr.8446
22. Molla MM, Stone ML, Lee E. Geostatistical Approach to Detect Traffic Accident Hot Spots and Clusters in North Dakota. *UGPTI Department Publication*. 2014;.https://www.ugpti.org/resources/reports/downloads/dp-276.pdf
23. Kundakci E. (2014). *Identification of Urban Traffic Accident Hot Spots and Their Characteristics by Using GIS*. Master's Thesis, Middle East Technical University, Ankara.
24. Svetlana M. Temporal Analysis of the Traffic Accidents Occurrence in Province of Vojvodina. *Transport Problems*. 2013;8(1):87-93.https://www.researchgate.net/publication/289164458_Temporal_analysis_of_the_traffic_accidents_occurrence_in_province_of_Vojvodina
25. Ivan K, Haidu L. (2012). The Spatio-Temporal Distribution of Road Accidents in Cluj-Napoca. Geographia Technica.
26. Soltani A, Askari S. Analysis of Intra-Urban Traffic Accidents Using Spatiotemporal Visualization Techniques. *Transport and Telecommunication Journal*. 2014;15(3):227-232.10.2478/ttj-2014-0020
27. Jain A, Menezes RG, Kanchan T, Gagan S, Jain R. Two wheeler accidents on Indian roads – a study from Mangalore, India. *Journal of Forensic and Legal Medicine*. 2009;16(3):130-133.10.1016/j.jflm.2008.08.019
28. Rodriguez JM, Penaloz RE, Montoya JM. Road Traffic Injury Trends in the City of Valledupar, Colombia. A Time Series Study from 2008 to 2012. *PLOS ONE*. 2015;10(12):e0144002.10.1371/journal.pone.0144002
29. Amarasingha N. Characteristics of Three-Wheeler Crashes. *International Research Symposium on Engineering Advancements, SAITM*. 2015;.https://www.researchgate.net/publication/286473386_Characteristics_of_Three-Wheeler_Crashes
30. Misra A, Singh SK. Road Accident Analysis: A Case Study of Patna City. *Urban Transport Journal*. 2004;2(2):60-75.https://ssrn.com/abstract=570441
31. Yang BM, Kim J. Road traffic accidents and policy interventions in Korea. *Injury Control and Safety Promotion*. 2003;10(1-2):89-94.10.1076/icsp.10.1.89.14120
32. Ndung'u CW, Bonface RM, Mwai LK. Analysis of Causes and Response Strategies of Road Traffic Accidents in Kenya. *IOSR Journal of Business and Management*. 2015;17(4):58-77.10.9790/487X-17435877
33. Kharola PS, Tiwari G, Mohan D. Traffic Safety and City Public Transport System: Case Study of Bengaluru, India. *Journal of Public Transportation*. 2010;13(4):63-91.10.5038/2375-0901.13.4.4
34. Government of Karnataka, Police Department. (2024). *Road Accidents in Karnataka – 2023*. State Crime Records Bureau (SCRB) & Police Computer Wing, Bengaluru.
35. Ministry of Road Transport and Highways (MoRTH), Government of India. (2023). *Road Accidents in India – 2022*. Transport Research Wing, New Delhi.
36. World Health Organization. (2023). *Global Status Report on Road Safety 2023*. WHO, Geneva.