

Rural–Urban Disparities in Traffic Fatalities in Iowa: A Local vs. State Perspective

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Abstract: This study examines differences in traffic accident fatalities across local and state road systems in Iowa, with the goal of identifying key factors influencing variations in fatality rates. Iowa’s extensive roadway network—spanning state, county, municipal, and institutional roads—presents challenges for analyzing safety across jurisdictions. Using a comparative approach, this research explores patterns, risk factors, and spatial disparities associated with fatal crashes. Data were obtained from the Iowa Department of Transportation, including the Iowa Crash Analysis Tool (ICAT) and roadway inventory systems. The study analyzes approximately 25,000 crash incidents involving over 99,000 individuals between 2020 and 2024 (Iowa Department of Transportation, 2025a). Findings indicate that while state highways account for a larger share of total fatalities due to higher speeds and traffic volumes, locally controlled and rural roads exhibit higher fatality rates per crash. Contributing factors include environmental conditions, roadway design, behavioral risks such as impaired driving and seatbelt non-use, and delayed emergency response times in rural areas. The analysis highlights key differences between urban and rural crash dynamics, as well as the role of infrastructure, enforcement, and policy interventions in shaping outcomes. Results suggest that targeted strategies—such as increased investment in rural road safety, stronger impaired driving enforcement, and improved nighttime visibility—can reduce fatality risks. By integrating local and statewide perspectives, this study provides a more comprehensive understanding of road safety in Iowa and offers evidence-based insights to inform policy, enforcement, and prevention efforts aimed at reducing fatalities.

Keywords: Fatality Rates, Crash Severity, Transportation Safety, Geographic Variation, Traffic Fatalities, Rural–Urban Disparities, Road Safety, Local Vs. State Analysis, Motor Vehicle Crashes, Public Safety Policy, Rural Infrastructure, Urban Traffic, Pattern Risks, Factors in Highway Safety

Introduction

A comprehensive understanding of road safety in Iowa necessitates a comparative analysis of traffic fatalities across local and state roadway systems, as well as an examination of the factors contributing to observed disparities. Iowa’s roadway infrastructure exceeds 115,000 miles, the majority of which is administered by county and municipal jurisdictions, resulting in substantial variability in roadway design, maintenance standards, enforcement practices, and exposure to crash risk (Iowa Department of Transportation [Iowa DOT], 2025a). This study analyzes traffic fatality data from 2015 to the present in order to identify temporal trends, spatial patterns, and principal determinants associated with fatal crashes at both local and state levels.

State-level analysis offers a macro-level perspective on systemic contributors to traffic fatalities, including rural roadway conditions, distracted driving behaviors, and enforcement limitations. In contrast, local-level data provide a more granular understanding of risk factors such as speeding, impaired driving, failure to use seatbelts, and the presence of high-risk crash locations. Distinct differences are also evident between urban and rural contexts, with urban areas more frequently affected by congestion and pedestrian safety challenges, while rural areas demonstrate disproportionately higher fatality rates, often associated with limited infrastructure, greater travel distances, and delayed emergency medical response (National Highway Traffic Safety Administration [NHTSA], 2023).

Although Iowa has recently recorded historically low fatality rates, motor vehicle crashes continue to impose substantial social and economic burdens. By integrating both macro- and micro-level perspectives, this study underscores the importance of context-specific interventions tailored to regional conditions. Overall, the findings contribute to a more nuanced understanding of how local and state-level factors jointly influence traffic fatality outcomes in Iowa. The results support the development of evidence-based policy measures and targeted enforcement strategies aimed at reducing fatalities, enhancing roadway safety, and preserving human life across the state.

Literature Review

Iowa Traffic Fatality Counts

The primary sources for understanding how fatalities are distributed across state highways and locally controlled roads in Iowa are the statistical resources maintained by the Iowa Department of Transportation, including *Transportation Facts* (Iowa DOT, 2025a) and the DMV Statistics and Research website (2025). These sources provide annual crash and fatality data that can be used to compare roadway types over time. State highways often account for a larger absolute share of fatalities because they carry heavier traffic volumes and tend to have higher travel speeds. At the same time, rural county and township roads may present elevated fatality risks per-mile due to narrower lanes, limited shoulders, and less forgiving roadway design. This pattern suggests that raw fatality counts alone do not fully capture roadway risk and that rate-based measures by roadway type and geographic area are necessary for a more accurate assessment.

Safe Route Planning

Safe-route algorithms, such as those examined by Sarraff and McGuire (2018), add an important dimension to route selection by incorporating both crash frequency and crash severity into the definition of the “safest” path. Their data-driven approach shows that safety cannot be evaluated solely by counting crashes; the severity of those crashes must also be considered when assigning risk weights. In Iowa, for example, a highway route may involve fewer crashes overall but a higher proportion of fatal crashes because of greater speeds and traffic volumes, whereas local streets may experience more frequent but less severe collisions due to lower operating speeds. As a result, route choice may vary depending on trip purpose, distance, and user vulnerability, with state routes often remaining preferable for long-distance travel when the goal is to reduce exposure to common crash types and minimize overall severity risk.

Contributing Factors Affecting Road Fatalities

Hauer’s (1997) work on observational before-and-after studies, the Federal Highway Administration summary (2004) on road diet lane reductions, and the studies by Huang et al. (2002) and Knapp et al. (2001) provide a useful and well-documented framework for

examining why state and local roadway systems evolve differently over time. Hauer's work emphasizes the importance of evaluating safety effects within specific roadway contexts rather than relying on short-term fluctuations or general comparisons, which is especially relevant when interpreting changes in fatality patterns between state and local roads. The FHWA summary and the studies by Huang et al. and Knapp et al. examine four-lane to three-lane conversions and generally report safety-neutral to modestly beneficial effects on crash frequency and severity, particularly on urban and suburban roadways where speed management and intersection conflicts are important concerns. In Iowa, these findings suggest that roadway design changes, implementation timing, engineering improvements, and road classification can all influence how fatality rates differ across the state and local systems over time, especially when analyzed using multi-year Transportation Facts data.

Empirical Questions

This study was guided by the following research questions:

1. How do statewide traffic fatalities occurring on state-maintained highways compare with those occurring on locally maintained roadways in Iowa, and what differences emerge in terms of frequency, rate, and contributing crash factors?
2. In what ways does the incorporation of crash severity metrics within safe-route algorithm models influence the identification of optimal travel routes on state highways versus local road networks in Iowa?
3. Do Iowa counties with a higher proportion of traffic fatalities occurring on local roads differ systematically in demographic composition, land-use patterns, or infrastructure characteristics from counties in which fatalities are primarily concentrated on state highway systems?

These research questions examine how structural and contextual factors shape traffic fatality patterns across rural and urban Iowa. They compare local and state roadway systems to assess how infrastructure, jurisdiction, and geography influence crash frequency and severity, while also considering roadway design, enforcement, and environmental conditions. The study further evaluates how crash severity is integrated into safe-route models and whether counties with higher local-road fatalities differ in demographics or land use. Collectively, these questions highlight how spatial, infrastructural, and population factors interact to produce disparities in traffic fatalities and inform evidence-based safety interventions.

Methodology/Research Design

This study employs a quantitative comparative research design to examine variations in traffic fatalities across local and state roadway systems in Iowa. The methodological framework is intended to identify patterns, risk factors, and spatial disparities associated with fatal crashes while distinguishing among roadway classifications such as state highways, county roads, municipal streets, and institutional roadways. This approach makes it possible to assess differences in fatality rates across roadway types and to evaluate how roadway ownership and management may influence crash severity outcomes. Using a comparative lens also allows for the examination of both statewide trends and local variations within roadway networks under different forms of jurisdictional control.

In addition, the design incorporates geographic and contextual variables such as urban versus rural location, roadway design characteristics, and environmental conditions. These factors are essential for understanding how place-based conditions contribute to disparities in traffic fatalities. The quantitative structure of the study also supports the use of

standardized crash data, which allows for consistent measurement and comparison across jurisdictions and time periods.

Overall, this methodological framework provides a rigorous basis for analyzing traffic fatality patterns in Iowa and for generating evidence-based insights into roadway safety across administrative and geographic contexts.

Data Analysis

Procedure

Data were analyzed using descriptive statistical techniques, cross-tabulation procedures, and comparative rate analyses to examine differences in the distribution of traffic fatalities across roadway systems. These methods enabled the systematic summarization and comparison of crash characteristics, severity outcomes, and contributing factors across jurisdictional classifications.

In addition, geographic and jurisdictional comparisons were conducted to identify spatial patterns in crash severity and to assess variations in fatality outcomes between state-maintained and locally maintained roadways. This spatial approach allowed for the evaluation of how roadway ownership and location influence crash risk and severity distributions across Iowa's transportation network. To ensure comparability across roadway systems with differing levels of exposure, fatality rates per crash were calculated and standardized. This approach facilitated consistent cross-jurisdictional comparisons between state and local road networks, allowing for a more accurate assessment of relative risk rather than relying solely on raw fatality counts.

Study Sample

The study sample comprises approximately 25,000 reported traffic crashes involving more than 99,000 individuals over the period from January 1, 2020, to December 31, 2024. Specifically, the dataset includes 99,184 persons across 25,000 crash incidents involving 45,047 vehicles and spans all 99 counties in Iowa, thereby capturing a broad spectrum of roadway environments, environmental conditions, and crash severity outcomes. The sample incorporates all major roadway user groups, including drivers, passengers, pedestrians, and bicyclists involved in reportable traffic crashes. This inclusive structure allows for a comprehensive assessment of traffic safety outcomes across diverse populations and crash contexts. In addition, the dataset reflects variation in exposure across urban and rural settings, differences in roadway infrastructure, and disparities in access to emergency response services, all of which are critical factors in understanding crash severity and fatality risk.

Because the data span multiple years, they also facilitate the analysis of temporal trends in crash frequency and severity, enabling the identification of changes in roadway safety patterns over time. Overall, this large, multi-year, and geographically diverse sample provides a robust empirical foundation for examining traffic fatality disparities and assessing roadway safety conditions across Iowa.

The study population had a near-equitable gender distribution, with males accounting for 51.0% ($n = 50,543$) and females comprising 49.0% ($n = 48,641$) of all involved individuals (National Highway Traffic Safety Administration [NHTSA], 2023; Iowa Department of Transportation, 2025b). This balance closely matches the demographic composition of Iowa's licensed driving population and is consistent with national crash involvement patterns reported by the National Highway Traffic Safety Administration (NHTSA), supporting the representativeness of the sample (Federal Highway Administration [FHWA], 2004).

Data Collection

Crash data were obtained from the standardized Iowa Investigating Officer's Report of Motor Vehicle Accident forms, completed by responding law enforcement officers at the scene of each reportable crash. This standardized reporting mechanism enhances consistency, reliability, and completeness in crash documentation across all jurisdictions within the state.

Data collection followed a structured five-stage protocol. The first stage, scene investigation, required officers to document key crash elements, including environmental conditions, vehicle positions, witness statements, roadway characteristics, and preliminary injury assessments. The second stage, report submission, involved electronic transmission of completed reports to the Iowa Department of Transportation (Iowa DOT) via the Traffic and Criminal Software (TraCS) system (Federal Highway Administration [FHWA], 2004).

The third stage, quality assurance, consisted of systematic review by Iowa DOT personnel to ensure accuracy, completeness, and consistency in coding practices. The fourth stage, database integration, involved validating, geocoding, and linking crash records to specific roadway segments within the state roadway inventory system. The final stage, annual compilation, entailed aggregating validated records into the official statewide crash database in accordance with the Federal Highway Administration's Model Minimum Uniform Crash Criteria (MMUCC) standards (Federal Highway Administration [FHWA], 2004).

Variables and Measures

The primary dependent variable in this study is crash severity, operationalized as a dichotomous outcome distinguishing fatal from non-fatal traffic crashes. The key independent variables include roadway classification (state versus local systems), geographic context (urban versus rural settings), environmental conditions (weather, lighting, and road surface conditions), and behavioral risk factors, including speeding, impaired driving, and seatbelt use. In addition, several contextual covariates are incorporated into the analysis, including roadway design characteristics and the accessibility and response time of emergency services. These variables are included to further explain variation in crash outcomes and to account for structural and environmental influences across Iowa's transportation network.

Analytical Approach

A comparative analytical framework was employed to examine differences in fatality outcomes across roadway classifications. Rural-urban distinctions were incorporated into the analysis to evaluate the extent to which geographic context influences crash severity and associated risk patterns. This approach facilitates the identification of systemic disparities within Iowa's transportation network and supports a more rigorous, evidence-based interpretation of roadway safety outcomes across differing environmental and infrastructural contexts.

Results

Statistical Findings

During the study period, 25,000 reportable traffic crashes occurred in Iowa, involving 45,047 vehicles and 99,184 individuals. These incidents resulted in 476 fatalities and 7,431 injuries, with estimated property damage exceeding \$298.6 million. Collectively, these outcomes underscore significant implications for transportation policy, enforcement

prioritization, and statewide roadway safety planning. Although winter-related crashes are generally less severe on a per-incident basis, they contribute substantially to overall system burden due to their high frequency ($n = 7,237$), resulting in 2,196 injuries and considerable economic costs. These findings suggest that winter safety strategies should prioritize both crash prevention and severity reduction rather than focusing solely on fatal outcomes.

Alcohol-impaired driving remains a leading contributor to fatal crashes, with findings indicating approximately a two-to-one overrepresentation in fatal incidents. This highlights the continued importance of enforcement-based interventions, including sobriety checkpoints, high-visibility patrols, and ignition interlock programs, which are well-supported countermeasures for reducing alcohol-related fatalities. Rural roadway environments present a disproportionate safety risk, with a 35.8% higher fatality rate compared to urban areas. This disparity supports targeted infrastructure improvements such as rumble strips, cable barriers, enhanced signage, and expanded emergency medical services to reduce response times and improve survivability (National Highway Traffic Safety Administration [NHTSA], 2023).

Nighttime crashes in dark, unlighted conditions exhibit the highest fatality risk (1.35%), reinforcing the need for enhanced lighting in high-risk corridors, increased nighttime enforcement, and improved reflective signage and pavement markings. Additionally, seatbelt non-use remains a preventable contributor to injury severity, with a statewide usage rate of 89.1%, indicating the need for sustained public education and strengthened primary enforcement. Overall, these findings support a comprehensive, multi-strategy approach integrating enforcement, engineering, and education to reduce traffic fatalities and injuries across Iowa.

Presentation of Statistics

The results provide partial support for the hypothesis that adverse environmental conditions are associated with increased crash frequency in Iowa, but a more limited relationship with crash severity. Winter months accounted for 28.9% of all crashes over the five-year period, exceeding the expected baseline of 25.0%, with December representing the peak month (10.1%). This seasonal increase aligns with known weather-related risks such as snow, ice, and reduced visibility.

However, severity outcomes did not increase under winter conditions as expected. Snow and ice conditions were associated with lower fatality rates (0.72% and 0.33%, respectively) compared to clear conditions (0.97%), and winter crashes overall showed a slightly lower fatality rate (0.8%) than non-winter crashes (1.0%) (Iowa Department of Transportation, 2025b; Cox, 2026; Kleen, 2026). These patterns suggest a behavioral adaptation effect in which drivers reduce speed and increase caution under visible hazard conditions, resulting in less severe crash outcomes. A trend consistent with national findings reported by the Federal Highway Administration and the National Highway Traffic Safety Administration (Federal Highway Administration, 2014; National Highway Traffic Safety Administration [NHTSA], 2023).

In contrast, light conditions demonstrated a stronger association with fatality risk. Crashes occurring in dark, unlit conditions had the highest fatality rate (1.35%), representing a 69% increase over daylight conditions (0.80%). This may reflect reduced visibility, impaired driving prevalence, and decreased driver attentiveness at night. Behavioral risk factors also showed strong relationships with crash severity. Alcohol involvement appeared in 13.9% of all crashes but 28.1% of fatal crashes, indicating a disproportionate 2:1 representation. Seatbelt usage remained high at 89.1%, yet all ejections resulted in serious injury or death, reinforcing the protective effect of restraints. Speed

further demonstrated a clear dose–response relationship, with fatality rates increasing from 0.67% at 25–35 mph to 1.10% at 40–55 mph.

Rural–urban comparisons revealed persistent disparities. Rural crashes accounted for 55.1% of incidents but 62.6% of fatalities, with a higher per-crash fatality rate (2.16% vs. 1.59%). These differences are likely driven by higher speeds, roadway design characteristics, and longer emergency response times in rural areas. Overall, the findings support targeted interventions addressing nighttime driving, impaired driving, speed management, and rural infrastructure improvements to reduce fatal crash outcomes in Iowa (National Highway Traffic Safety Administration [NHTSA], 2023; Iowa Department of Transportation, 2025a).

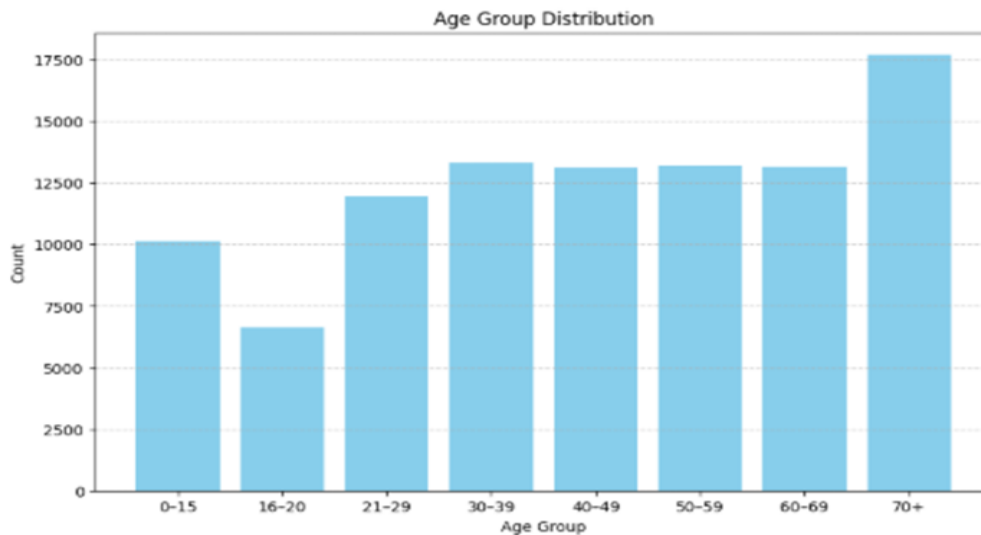


Figure 1. Demographic Age Distribution of Crash Involvement

Source: Iowa Department of Transportation (2025b)

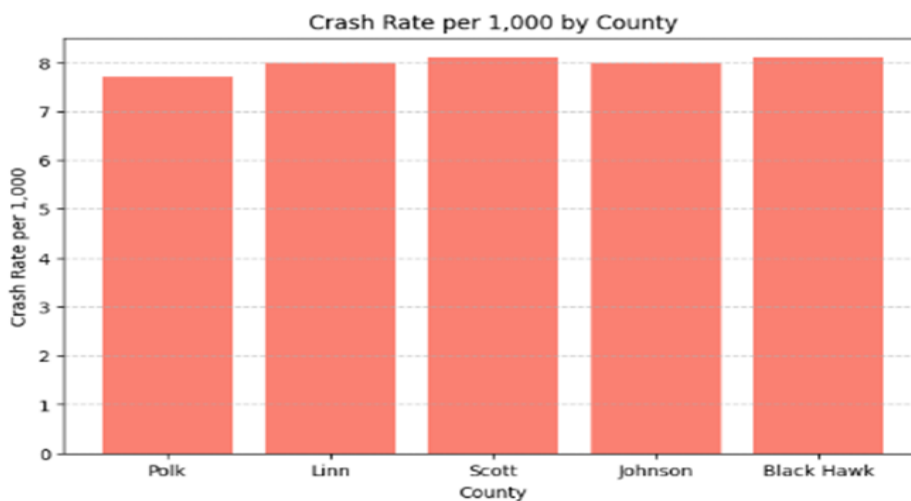


Figure 2. Geographic Distribution of Crash Rates

Source: Iowa Department of Transportation (2025b)

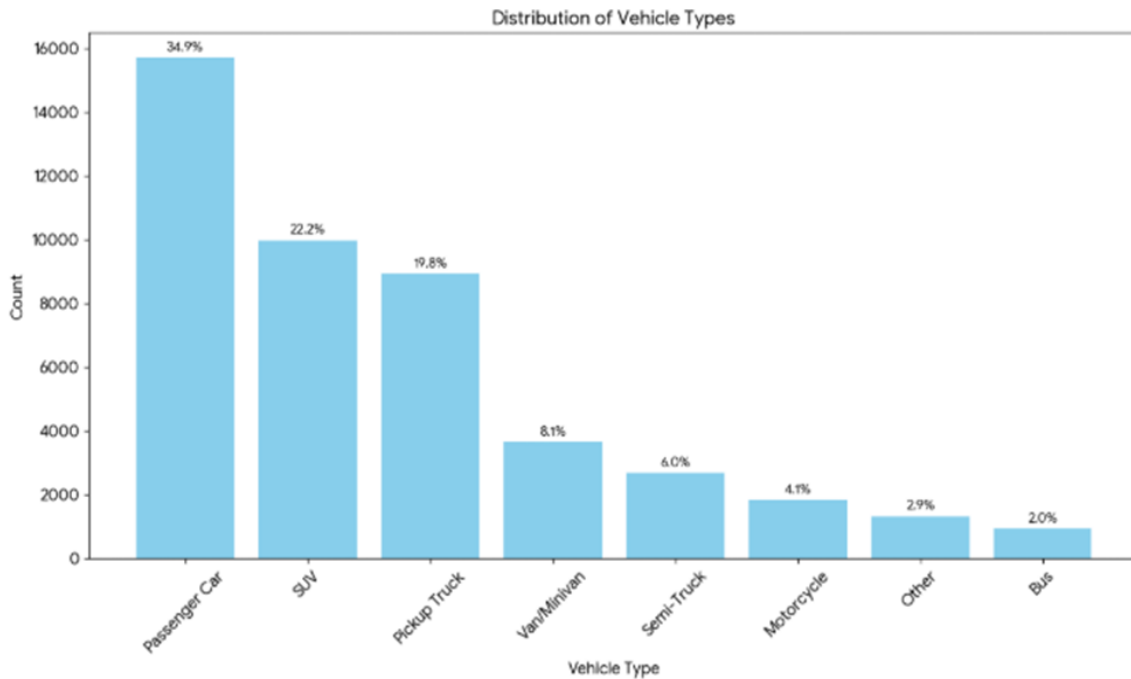


Figure 3. Vehicle Type Distribution in Crash Data
 Source: Iowa Department of Transportation (2025b)

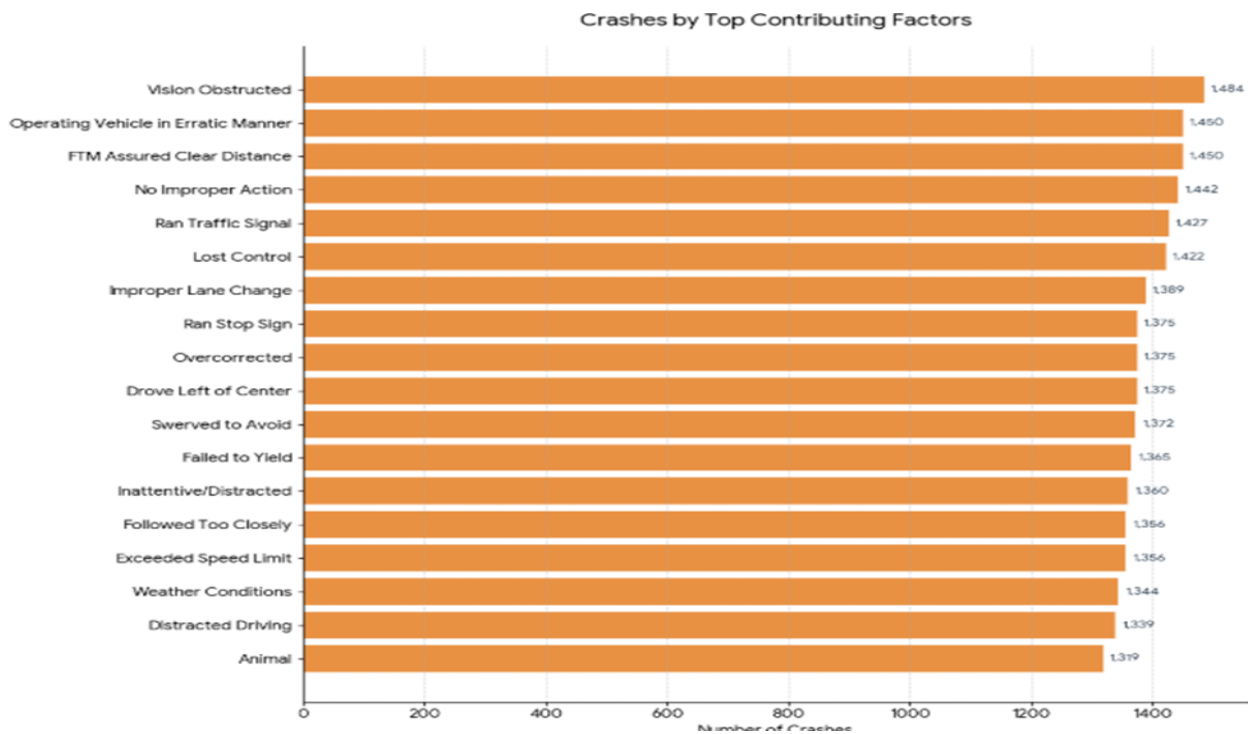


Figure 4. Contributing Factors to Traffic Crashes
 Source: Iowa Department of Transportation (2025b)

Discussion/Recommendations

This study finds that Iowa traffic fatality risk is influenced by behavioral, environmental, infrastructural, and geographic factors. While state highways account for more total

fatalities due to higher volumes and speeds, rural and local roads have higher fatality rates per crash, reflecting greater severity risk outside urban areas. Rural roadways show elevated risk due to speed, longer travel distances, limited design features, and slower emergency response, while urban areas face risks tied to congestion and pedestrian exposure. Key behavioral factors—including alcohol impairment, speeding, lack of seatbelt use, and nighttime driving—significantly increase fatal crash risk, reinforcing the need for combined enforcement, education, and engineering strategies. Overall, spatial and infrastructural differences across counties highlight the importance of localized, data-driven traffic safety planning.

Rural roadway safety should be prioritized through infrastructure improvements such as widened shoulders, rumble strips, better signage, and curve enhancements. Impaired driving countermeasures should be expanded using targeted enforcement, sobriety checkpoints, ignition interlocks, and public awareness campaigns. Nighttime safety requires improved lighting, reflective infrastructure, and increased enforcement against speeding and impaired driving, particularly in rural areas. Speed management should combine roadway design changes, targeted enforcement, and traffic calming in high-risk corridors. Finally, data-driven approaches integrating roadway, behavioral, and spatial factors should guide predictive modeling and targeted interventions, improving the identification of high-risk locations and enabling more proactive safety planning.

Conclusions and Future Scope

This five-year analysis of 25,000 Iowa traffic crashes examines environmental, behavioral, and infrastructural factors affecting crash outcomes. Winter conditions increase crash frequency (28.9% vs. 25% expected) but do not raise fatality risk per crash, likely due to more cautious driving behavior. In contrast, alcohol impairment is the strongest predictor of fatal crashes, appearing in 28.1% of fatal crashes compared to 13.9% overall, highlighting impaired driving as the leading preventable cause of traffic fatalities in Iowa.

Geographic differences highlight clear risk disparities. Rural roads have higher fatality rates than urban roads (2.16% vs. 1.59%), likely due to higher speeds, delayed emergency response, and road design. Nighttime crashes in dark conditions show the highest risk (1.35%). Crash patterns also follow population distribution, with Polk County and the top five counties accounting for 37.1% of crashes, aligning with national trends.

Future research should apply advanced predictive modeling, including machine learning and connected vehicle data, to forecast crash risks in real time and enhance proactive management strategies like dynamic speed control and emergency response. Roadway design measures such as road diets should be tested through longitudinal evaluations to assess Iowa-specific effectiveness. Studies should also quantify the full economic costs of crashes. Further priorities include analyzing risks for pedestrians and bicyclists in major cities to guide equitable infrastructure, modeling climate impacts on crash trends, and examining whether certain demographic or geographic groups face disproportionate outcomes to support fairer safety resource distribution.

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