

Unveiling Roadway Environmental Characteristics that Influences Road Traffic Crashes occurrences and Fatality in Oyo State Nigeria

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Abstract This study sought to ascertain the effect of environmental highway elements on traffic crashes. Using statistics on traffic accidents from the Federal Road Safety Corps (FRSC) for the years 2020–2022, a study was carried out in the Nigerian state of Oyo. Blackspots along different routes were discovered from the record, along with the kind of collision and environmental conditions on the roadway. Environment factors like the accident site, weather, highway flaws and geometry, and road surface condition contributed to blackspots. 9886 traffic crashes were included in the analysis. Compared to 3.19% and 3.57% at dawn and sunset, respectively, the proportion of traffic crashes resulting in injuries was 12.60% and 12.97%. When it comes to road traffic collision occurrences, crash scene light and roadway segment geometry have a stronger significant link than road surface quality, which has a very weak significant relationship with road hazardous environmental elements. The degree of light at the collision site, which is symbolised by sunrise and sunset, exacerbates the severity. misty, foggy, stormy, or wet, four-way intersections, limited or single lanes, flat or straight roads, lack of a conventional road guard, and insufficient road shoulder Pot holes and dry or wet patches on the road have p values that are less than the alpha set value of 0.005, making them statistically significant factors in fatality and injury crashes.

Keywords Traffic crashes, Environmental factors, Road geometry, Crash severity, Road conditions

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1. Introduction

In road traffic collisions (RTCs), around 50 million people are wounded and 1.2 million people are killed globally each year, according to the World Health Organisation's (WHO) global status report on road safety (Penden et al., 2004). Researchers have long been interested in the impact of the environment on a number of health conditions. For example, it is well recognised that climatic conditions may affect people's health. An increasing number of studies have examined the connection between environmental variables and RTCs in the field of RTCs (Toro et al., 2009). (Alkaabi, Disanayake, and Bird, (2011); Al Marzooqi, Badi, and Jack, 2010). In several papers, environmental factors such as weather and other seasonal influences were analysed together with traffic volume, pedestrian volume, and route geometry. Donroe et al. (2008), Al Marzooqi, Badi, and El Jack (2010)). Others spoke about how RTCs are affected by day-time and nighttime light conditions. Numerous studies have examined various facets of RTCs. On the other hand, there aren't many published studies discussing how environmental variables affect RTCs. The current study set out to ascertain the relationship between environmental variables and RTCs

in Nigeria in order to shed light on the possible impact of these factors on RTCs and enhance preventative efforts.

2. Methodology

Road Safety International 2020 states that, in the 1980s, when the Victorian blackspot programme began in Australia, a site had to have 12 fatalities in three years in order to be classified as a "blackspot." Today, that need is reduced to three fatalities in five years. A blackspot is an area where there are a lot of fatal, major, or minor collisions. It might be a stretch of road or a junction (road segment). The most crucial information used to achieve the accomplishments consists of:

- Where the crash occurred (location)
- When (time) it happened (day/night) revealing scene light
- The road users involved (causality level)
- Conditions at the time were rain, wind, fog, and sun
- Roadway characteristic assessment.

2.1. Research Design

A descriptive, correlational research design was employed for this investigation. This made it possible for

the researcher to collect the necessary data, understand how road safety is managed, and identify any possible connection between the state of Oyo's traffic crashes and the state's road environment.

2.2. Study Area

The approximate location of Oyo State is $7^{\circ} 22' N$ and $3^{\circ} 58' E$ on the Greenwich Meridian. That being said, the region, often known as the metropolitan area, lies between latitudes $7^{\circ} 15'$ and $7^{\circ} 30'$ north of the equator and longitudes $3^{\circ} 45'$ and $4^{\circ} 00'$ east of the Greenwich Meridian. It is located in the southwest of the nation and is bordered to the east, north, and south by Osun State, Lagos State, and Kwara State. Oyo State is one of the states that form the Nigerian Federation. It's around 145 kilometres northeast of Lagos.

Lagos' most direct connection forms its western boundary with the Republic of Benin; nonetheless, the city is directly connected to several locations in Nigeria by a network of highways, trains, and air lines. Ibadan is a key break-bulk point for trading products from the southwest to the north and from the north to the southwest, and it is traversed by the railway that leads to the northern states.

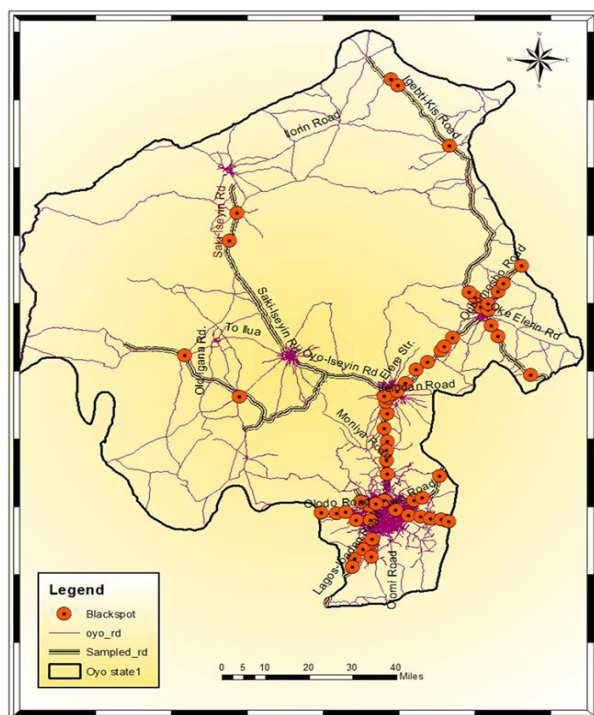


Figure 1. Map of Oyo state showing the blackspots

In descending order of significance, Oyo State residents engage in trade, work in public service, and agriculture. The sheer amount and variety of food product demand fueled the desire for agricultural output in the city's environs. A large number of city dwellers work in agriculture. Furthermore, the land left over after urbanisation has been turned into gardens known for their

biological richness and variety due to people's expertise and economic demands. Cassava, maize, and vegetables such as Chinese spinach, okra, aubergine, cucumber, tomatoes, and pepper are the main crops grown in Ibadan. Socioeconomic facilities in Ibadan include marketplaces such as Alesiloye and Oja-oba, retail malls, and fast-food restaurants spread across the city, as well as an excellent road network that facilitates simple movement of people and products. Fig 1.

2.3. Method of Data Gathering

This includes gathering feedback from the blackspot locations determined by the FRSC Oyo State Sector, as shown in Fig. 1. This research is primarily concerned with the roads that the FRSC covers in Nigeria's Oyo State in order to evaluate the state of the road in connection with determining the environmental factors that encourage traffic accidents along the different road segments. The Federal Road Safety Corps (FRSC) traffic collision database in Oyo state sector 2020–2022 served as the researcher's primary source of data. Georeferenced maps of Oyo State, road network maps, satellite images (Landsat and Google Maps), and data from road segments with identified traffic crash blackspots were collected during a field survey. These locations were measured, and the picked coordinates were recorded using a handheld GPS device to make them easy to recognise in a GIS environment.

2.4. Sources and Data Collection Instruments

The data collection processes are as follows:

1. **Personal Observation:** The researcher conducted a field survey of the identified road segments in the study area in order to identify these road segments with traffic crash black spots, observe their unique physical properties, and create an attribute table for the various road segments.

2. **Secondary Data**

The data used for this study include the satellite imagery of Landsat and Google Earth with spatial resolutions of 30 and 5 metres, respectively, which were acquired and used to extract the route for the study area, the coordinates of the crash segments with the aid of GPS, and the crash record of the study area obtained from the Federal Road Safety Corps (FRSC) with the attribute data below:

1. Time of occurrence of crash
2. Location or route of the crash
3. Number of vehicles involved
4. Type of crash (fatal, severe, major, or minor)
5. Causes of the crash
6. The number of people involved in the crash

3. Data Analysis and Results

The figure 2 shows the roadway environmental characteristics, sub-elements, number of crashes, injuries, deaths, and fatalities as reported by the FRSC.

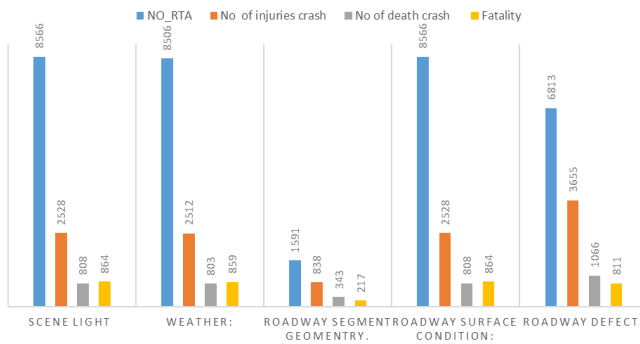


Figure 2. Number of crash related to each environmental factors

3.1. The Roadway Environmental Factors and Roadway Traffic Crash

H_1 : There is no significant impact of roadway environment factors on traffic crash occurrence.

The chart in Fig. 2 shows that roadway defects produce the highest level of injury and death crashes, even with the second-lowest occurrence of roadway traffic crashes in the study area. Other influencers of roadway traffic crashes are the time of crash (scene light) and roadway surface condition, which have equal contributions to injuries and deaths. Roadway segment geometry has the lowest influence on causing roadway traffic crashes, with the lowest injuries and deaths associated. Weather is associated with the second highest roadway traffic crash occurrence and the third highest injury level of death crash.

The statistical assessment of the effect of roadway environmental factors on roadway traffic crash occurrences is to statistically evaluate the significance of the relationship between roadway traffic crash occurrence and roadway environment using multiple regression analysis.

Multiple Regression Analysis

Multiple regression is a statistical method used to examine the relationship between a dependent variable and two or more independent variables. It allows us to understand how the independent variables collectively relate to or influence the dependent variable. By controlling for the effects of other variables, multiple regression helps us identify which independent variables have a significant impact on the dependent variable and to what extent. According to Gulden, Kaya Uyanik and Nese Guier (2013) found that it can be used to assess the importance of the independent variable in a given regression equation. In this study, multiple regression is used with a view to finding out the level of importance or contribution of the independent variables (time of crash, roadway alignment, and roadway surface condition) to road traffic crash occurrence by analysing the beta coefficients to show the importance of each coefficient, as exemplified by Kaya

Uyanik and Nese Guier (2013). The magnitude indicates the size of the impact that a specific independent variable has on the dependent variable. A larger absolute beta coefficient value suggests a stronger influence. While statistical significance is determined by the p-values associated with the beta coefficients. Multiple regression model is stated as below (see Table1).

Table 1. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.751a	0.564	0.430	0.290
Change statistics				
R Square Change	F Change	df1	df2	Sig. F Change
0.564	4.203	4	13	0.021

The R-value represents the correlation between the dependent and independent variables, which is 0.751, which implies that there is a 75.1% correlation between the dependent (roadway traffic crash occurrence) and independent variables, with the R square value at 0.564, meaning that the model explains 56.4% of the variance in road traffic crash occurrences. While the adjusted variable of 0.430 implies that 43% of the variance of the dependent variable is explained by the independent variables.

Table 2. ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
1					
Regression	1.410	12	0.352	4.203	0.021
Residual	1.290	13	0.084		
Total	2.500	17			

a. Predictors: (Constant), Roadway segment geometry, Roadway surface defect, Road Surface Condition, Time of crash

b. Dependent Variable: Road traffic crash.

Important Model: We reject the null hypothesis because the p-value (0.021) is less than the standard alpha threshold of 0.05, which shows that at least one of the independent variables has a significant relationship with the dependent variable, indicating that the regression model strongly predicts the dependent variable. Overall Fit: The large F-value of $F(4,13) = 4.203$ suggests that the model accounts for a sizable percentage of the variation in the dependent variable (road traffic crash). The multiple regression model is statistically significant, as indicated by the ANOVA table, which suggests that the independent variables together offer a strong match for predicting the dependent variable at $R^2 = 0.564$, indicating that the model explains 56% of the variance in road traffic crash occurrence.

The unstandardized coefficient, or B, is 0.762. This is the projected value of the dependent variable when all independent variables are zero, or the intercept of the regression line. 1.500 is the t-value. To see if the constant deviates noticeably

from zero, use this value. P-value (signature): 0.158. This result indicates that the constant is not statistically significant because it is bigger than 0.05. Time of crash B: 0.634.

Keeping all other factors fixed, the dependent variable is predicted to grow by 0.634 units for every unit increase in crash time.

Table 3. Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	0.762	0.508		1.500	0.158	-0.336	1.860
Time of crash	0.634	0.197	0.851	3.219	0.007	0.209	1.059
Road Surface Condition	-0.757	0.279	-0.677	-2.716	0.018	-1.360	-0.155
Roadway defect	0.192	0.048	1.060	4.005	0.001	0.088	0.295
Roadway geometry	0.039	0.049	0.159	.798	0.439	-0.067	0.145
Weather condition	0.211	0.38	1.099	3.061	0.021	0.071	0.311

Dependent Variable: Road traffic crash.

The unstandardized coefficient, or B, is 0.762. This is the projected value of the dependent variable when all independent variables are zero, or the intercept of the regression line. 1.500 is the t-value. To see if the constant deviates noticeably from zero, use this value. P-value (signature): 0.158. This result indicates that the constant is not statistically significant because it is bigger than 0.05. Time of crash B: 0.634. Keeping all other factors fixed, the dependent variable is predicted to grow by 0.634 units for every unit increase in crash time.

The standardised coefficient, or beta, is 0.851. This suggests that there is a significant positive correlation between the dependent variable (road traffic crash occurrence) and the time crash t-value: 3.219. This figure determines whether the coefficient deviates noticeably from zero. Significance: 0.007. This number is less than 0.05, indicating statistical significance for the time of crash for B, the 95% confidence interval is 0.209–1.059.

Road surface condition, B: -0.757. The dependent variable (road traffic crash) is predicted to fall by 0.757 units for every unit increase in the road surface condition (assuming higher values imply poorer conditions), keeping all other factors constant. Beta is -0.677. This suggests that the dependent variable and road surface condition have a strong negative connection. t-value: -2.716. Significance: 0.018. The road surface condition is statistically significant because this value is smaller than 0.05. B's 95% Confidence Interval: -0.155 to -1.360.

Roadway defect: B: 0.192. Keeping all other factors equal, the dependent variable (road traffic crash) should rise by 0.192 units for every unit increase in highway defect. Beta is 1.060. This suggests that there is a highly significant positive correlation between the dependent variable and the roadway defect. 4.005 is the t-value. Significance: 0.001. Roadway defect is statistically significant since this value is smaller than 0.05. For B, the 95% confidence interval is 0.088–0.295.

Roadway geometry: B is 0.039. Keeping all other factors fixed, the dependent variable (road traffic crash) is predicted

to rise by 0.039 units for every unit increase in roadway geometry. Beta: 0.159. This suggests that the roadway geometry and the dependent variable have a weakly positive correlation (t-value: 0.798). Significance: 0.439. The roadway geometry is not statistically significant, as this value is more than 0.05. -0.067 to 0.145 is the 95% confidence interval for B. Zero is included in this interval, confirming its absence of importance.

Weather Condition B is 0.211: Keeping all other factors fixed, the dependent variable (road traffic crash) is predicted to rise by 0.211 units for every unit increase in weather condition. Beta = 1.099: This suggests that there is a highly significant positive correlation between the dependent variable and the weather condition. 3.06 is the t-value: Significance: 0.021: The weather condition is statistically significant since this value is smaller than 0.05, for B = 95%. The confidence interval is 0.071–0.311.

Significant Predictors: The dependent variable (road traffic crash) may be statistically predicted by the time of the crash, roadway condition, and roadway defects. Non-Significant Predictors: There is no statistically significant correlation between the roadway geometry and the constant.

Connections: The dependent variable (road traffic crash) has a positive correlation with the time of the crash, weather condition, and road defect. There is a negative correlation between the dependent variable (road traffic crash) and road surface condition. Repairing road imperfections and enhancing road surface conditions may have a big effect on road traffic crashes.

In testing the null hypothesis, which states that "there is no significant effect of roadway environment factors on traffic crash occurrence," looking at the elements of the roadway environmental factor, which are time of crash, road surface condition, Roadway defect, Roadway geometry and weather condition as the independent variables. We can conclude that there is significant evidence to reject the null hypothesis that states that there is no significant effect of roadway

environment factors on traffic crash occurrence, and hence state that “there is a significant effect of roadway environment factors on traffic crash occurrence.”.

3.2. Factors Causing High Odd of Death and Injuries Crash

There is no significant effect of the elements of roadway environmental factor on roadway traffic crash resulting to death and injuries.

The road way environmental factors refers to the prevailing unique conditions on the road that have an impact on traffic crash. Some of these variables have been identified by Kamran et, al (2019). In this study there are five road crash

related environmental factors considered in the study area Table 4 show the various environmental factors and the component variable within them and the number of crash related to each environmental factors respectively.

Table 4 contains the environmental factors and the elements within the factors in relation to the number of crashes and the type of crash. The table is important in the quest to find the odd roadway traffic crash that has a chance to produce death or injury. Multinomial logistic regression was then conducted.

Table 4. No of crash related to each environmental factors

N	Elements	Factors	NO. RTC	injuries crash	death crash	Serious crash	minor Crash
1	Time of Crash	Day Sunrise	3571	1246	315	353	1657
		Night Sunset	4995	1282	493	511	2709
2	Weather	Clear	384	168	50	58	108
		Cloudy	282	112	38	54	78
		Foggy	1057	184	380	98	395
		Stormy/rainy	1783	748	335	349	351
3	Roadway segment geometry	4-way intersection	266	110	27	29	100
		Narrow single lane	962	155	92	95	620
		Roundabout	229	114	35	43	37
		Straight flat Up hill	647	424	182	40	1
		Straight/ curved road	87	35	7	7	38
4	Roadway surface condition	Dry	229	114	35	43	37
		Pot holes	29	12	4	4	9
		Wet	817	84	169	308	256
5	Roadway defect	Defective/ No lighting	1947	627	139	141	1040
		Inadequate road shoulder	494	117	158	169	50
		Lack of standard road guard	15	5	4	4	2
		Partial road collapse	1706	182	465	172	887

Source: Author’s Compilation, 2023

The hypothesis investigating the substantial link between roadway traffic crash fatalities (injuries and deaths) and roadway environment parameters was prompted by the knowledge that roadway environmental elements have a variety of effects on the fatality of road traffic crashes. A binomial logistic regression model was created to assess the odds and probability of the fatality of a crash under the combination of various roadway environmental factors, allowing the researcher to determine which of the component variables of the roadway environment factors in this study contributes the most to the fatality of roadway traffic crashes (death and injuries).

Binomial Logistic Regression

From the predictor table (Table 5), it is observed that the roadway environmental factors predators have no significant association with roadway traffic crash fatalities.

Table 5. Predictors' Unique Contributions in the binomial Logistic Regression

Predictor	x	df	p-value
Time of crash	0.005	1	0.94
Weather	2.173	1	0.34
Road Segment alignment	1.773	1	0.18
Road Surface Condition	0.096	1	0.76
Roadway Defect	1.425	1	0.53

However, with further investigation into the elements within these environmental factors, applying multinomial logistic regression, we are able to ascertain the odds of death and injury fatalities shown in Table 6.

Table 6. Coefficients of factors on road traffic crash fatality

Factor	Coefficient (β)	Odds Ratio (OR)
Night Sunset	0.5	$e^{0.5} \approx 1.65e^{0.5}$ $\approx 1.65e^{0.5} \approx 1.65$
Cloudy	0.2	$e^{0.2} \approx 1.22e^{0.2}$ $\approx 1.22e^{0.2} \approx 1.22$
Foggy	1.0	$e^{1.0} \approx 2.72e^{1.0}$ $\approx 2.72e^{1.0} \approx 2.72$
Stormy/Rainy	0.7	$e^{0.7} \approx 2.01e^{0.7}$ $\approx 2.01e^{0.7} \approx 2.01$
Narrow Single Lane	0.3	$e^{0.3} \approx 1.35e^{0.3}$ $\approx 1.35e^{0.3} \approx 1.35$
Roundabout	0.1	$e^{0.1} \approx 1.11e^{0.1}$ $\approx 1.11e^{0.1} \approx 1.11$
Straight Flat Up Hill	0.6	$e^{0.6} \approx 1.82e^{0.6}$ $\approx 1.82e^{0.6} \approx 1.82$
Straight/Curved Road	-0.1	$e^{-0.1} \approx 0.90e^{-0.1}$ $\approx 0.90e^{-0.1} \approx 0.90$
Pot Holes	0.4	$e^{0.4} \approx 1.49e^{0.4}$ $\approx 1.49e^{0.4} \approx 1.49$
Wet	0.5	$e^{0.5} \approx 1.65e^{0.5}$ $\approx 1.65e^{0.5} \approx 1.65$
Inadequate Road Shoulder	0.7	$e^{0.7} \approx 2.01e^{0.7}$ $\approx 2.01e^{0.7} \approx 2.01$
Lack of Standard Road Guard	1.2	$e^{1.2} \approx 3.32e^{1.2}$ $\approx 3.32e^{1.2} \approx 3.32$
Partial Road Collapse	1.5	$e^{1.5} \approx 4.48e^{1.5}$ $\approx 4.48e^{1.5} \approx 4.48$

Source: Author's Compilation, 2023

Binomial logistic regression is used when the outcome variable is not more than two categories of predictors. These odds ratios compare the odds of an event occurring (roadway traffic crash) given a factor to the odds of an event occurring in the absence of that factor. The fatality of a road traffic crash in this study is defined by the number of deaths and injuries in a crash at a given location and at a particular time. Each coefficient β_i represents the change in the log odds of the dependent variable being 1 for a one-unit change in the

corresponding predictor X_i , holding all other predictors constant. The odds ratio can be computed as e^{β_i} . An odds ratio greater than 1 indicates an increase in the odds of the outcome with an increase in the predictor, while an odds ratio less than 1 indicates a decrease.

Interpretation

Time of Crash with regards to Night Sunset (OR = 1.65), deaths crashes occurring during Night Sunset are 1.65 times more likely to result in death compared to those occurring during Day Sunrise. This indicates that night-time conditions might be more hazardous, leading to more severe outcomes. However injuries conversely, crashes during Night Sunset are less likely to result in injuries compared to Day Sunrise. This suggests that while night-time crashes are less frequent, they tend to be more severe when they do happen.

In the case of the Weather, Cloudy (OR = 1.22), deaths crashes occurring in cloudy weather are 1.22 times more likely to result in death compared to clear weather. Cloudy conditions might reduce visibility or make road conditions slightly more dangerous. In the case of injuries crashes in cloudy weather are less likely to result in injuries compared to clear weather. This indicates that crashes in cloudy conditions are somewhat more severe.

For Foggy (OR = 2.72), deaths crashes occurring in foggy conditions are 2.72 times more likely to result in death compared to clear weather. Fog significantly reduces visibility, leading to more severe accidents. Injuries crashes in foggy conditions are much less likely to result in injuries compared to clear weather. This shows that foggy conditions greatly increase the severity of crashes.

While stormy/Rainy (OR = 2.01), deaths crashes occurring in stormy or rainy conditions are 2.01 times more likely to result in death compared to clear weather. Wet and slippery roads contribute to more severe accidents. While injuries crashes in stormy or rainy conditions are less likely to result in injuries compared to clear weather, indicating a higher severity of crashes.

Whereas roadway segment geometry, narrow single lane (OR = 1.35), deaths crashes occurring on narrow single lanes are 1.35 times more likely to result in death compared to those occurring at 4-way intersections. Narrow lanes can be more dangerous due to limited space for maneuvering. Injuries crashes on narrow single lanes are less likely to result in injuries compared to 4-way intersections. This implies that crashes on narrow lanes tend to be more serious.

With regards to roundabout (OR = 1.11), deaths crashes occurring in roundabouts are 1.11 times more likely to result in death compared to 4-way intersections. Roundabouts might cause confusion, leading to more severe crashes. Injuries crashes in roundabouts are slightly less likely to result in injuries compared to 4-way intersections, suggesting a slightly higher severity.

For a straight flat uphill (OR = 1.82), deaths crashes occurring on straight flat uphill segments are 1.82 times more likely to result in death compared to 4-way intersections. The higher speeds possible on these segments can contribute to

more severe crashes. Injuries crashes on straight flat uphill segments are less likely to result in injuries compared to 4-way intersections, indicating a higher severity of crashes.

Relating with straight/curved road ($OR = 0.90$), deaths crashes occurring on straight or curved roads are 0.90 times as likely to result in death compared to 4-way intersections, meaning they are less likely to be fatal. Injuries crashes on straight or curved roads are more likely to result in injuries compared to 4-way intersections, suggesting that these crashes are less severe.

Concerning roadway surface condition, Pot Holes ($OR = 1.49$): Deaths crashes occurring on roads with pot holes are 1.49 times more likely to result in death compared to those occurring on dry roads. Pot holes can cause vehicles to lose control, leading to severe crashes. Injuries crashes on roads with pot holes are less likely to result in injuries compared to dry roads, indicating a higher severity of crashes.

In the case of wet road condition ($OR = 1.65$), deaths crashes occurring on wet roads are 1.65 times more likely to result in death compared to dry roads. Wet roads can be slippery and increase the likelihood of severe crashes. While Injuries: Crashes on wet roads are less likely to result in injuries compared to dry roads, suggesting that crashes in wet conditions are more severe.

Regarding roadway defect, inadequate Road Shoulder ($OR = 2.01$), deaths crashes occurring on roads with inadequate road shoulders are 2.01 times more likely to result in death compared to roads with no defects. Lack of proper shoulders can prevent safe recovery if a vehicle goes off the road. Injuries crashes on roads with inadequate road shoulders are less likely to result in injuries compared to roads with no defects, indicating higher severity.

About lack of standard road guard ($OR = 3.32$), deaths crashes occurring on roads lacking standard road guards are 3.32 times more likely to result in death compared to roads with no defects. Road guards prevent vehicles from veering off the road or into oncoming traffic. Injuries crashes on roads lacking standard road guards are significantly less likely to result in injuries compared to roads with no defects, indicating much higher severity.

In the case of partial road collapse ($OR = 4.48$), deaths crashes occurring on roads with partial road collapse are 4.48 times more likely to result in death compared to roads with no defects. Road collapses can cause severe crashes due to sudden loss of road structure. Injuries crashes on roads with partial road collapse are substantially less likely to result in injuries compared to roads with no defects, indicating extremely high severity.

4. Conclusions

Odds Ratios > 1 : Indicates an increased likelihood of death and a decreased likelihood of injury. Factors such as night-time crashes, adverse weather conditions (foggy, stormy/rainy), and poor roadway conditions (narrow lanes, pot holes, inadequate road shoulders) significantly increase the likelihood of fatal crashes, making injuries less likely in comparison.

Odds Ratios < 1 : Indicates a decreased likelihood of death and an increased likelihood of injury. For example, crashes on straight or curved roads are less likely to result in death, meaning they are more likely to result in injuries compared to other road types.

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