ANALYSIS OF CLIMATIC VARIABILITIES AND ROAD TRAFFIC CRASHES IN LOKOJA, KOGI STATE, NIGERIA

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Abstract

Road traffic crashes constitute an escalating public health burden in Nigeria, especially in rapidly urbanising cities that serve as major transportation corridors. This study examined the relationship between selected climatic variables and the incidence of road traffic crashes, injuries, and fatalities in Lokoja, the capital of Kogi State, over a nine year period (2014 to 2024). Climatic data comprising temperature, rainfall, relative humidity, and wind speed were sourced from the Centre for Atmospheric Research of the National Space Research and Development Agency, while crash records were obtained from the Federal Road Safety Corps, Kogi State Sector Command. The data were analysed using descriptive statistics, simple linear regression, and the Pearson Product Moment Correlation Coefficient. The results revealed that December recorded the highest number of traffic crashes, while April had the most fatalities and January the most injuries across the study period. The rainy season accounted for a slightly higher proportion of crashes (53.59%), deaths (52.69%), and injuries (53.21%) compared with the dry season. Regression analysis demonstrated that traffic crashes were a significant predictor of both injuries (R^2 = 0.642) and fatalities (R^2 = 0.210). Pearson correlation analysis indicated that no climatic variable was significantly correlated with the number of traffic crashes. However, rainfall and relative humidity exhibited weak but statistically significant negative correlations with the number of persons injured, while average temperature showed a weak positive correlation with the number of persons killed. These findings suggest that climatic variables are not the primary drivers of traffic crashes in Lokoja but serve as contributing factors, particularly through their indirect effects on road surface conditions, visibility, and driver behaviour. The study recommends the integration of weather responsive traffic management strategies, improved drainage infrastructure, and targeted driver education campaigns to reduce the burden of road traffic casualties in the study area.

Keywords: *Climatic variables; Traffic crashes; Traffic casualties; Traffic injuries; Traffic fatalities; Lokoja; Road safety*

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1. Introduction

Road traffic crashes represent one of the most persistent public health challenges confronting nations across the developing world. In Nigeria, where rapid population growth and urbanisation have far outpaced the provision of adequate road infrastructure, the problem is acute. Road traffic crashes rank as a leading cause of injury and death, placing enormous strain on families, communities, and the already overstretched healthcare system (Atubi, 2012). The situation is further compounded by the absence of effective enforcement mechanisms and the prevalence of risky driving behaviours, including overspeeding and vehicular overloading (National Bureau of Statistics, 2024). Against this backdrop, Kogi State in the north central geopolitical zone of Nigeria deserves particular attention, given that its capital, Lokoja, occupies a strategic position as a vital transit hub at the confluence of the Niger and Benue rivers.

Lokoja functions as a gateway between the northern and southern regions of Nigeria, and its principal arterial routes, including the Abuja to Lokoja to Okene corridor, the Lokoja to Ajaokuta road, and the Lokoja to Obajana to Kabba highway, carry substantial volumes of freight and passenger traffic on a daily basis. The convergence of heavy vehicular movement with substandard road conditions and risky driving culture has contributed to a high and rising incidence of crashes along these corridors (Atomode, 2025; Atomode and Salami, 2025). In recent years, these crashes have claimed hundreds of lives and left thousands injured, imposing a heavy toll on families and the wider economy (Adetunji, 2021).

Climate constitutes an additional dimension of risk that is often underappreciated in road safety discourse. Nigeria's climate is characterised by distinct wet and dry seasons, with heavy monsoon rains dominating the southern and central regions during the months of April through October, and the dry harmattan wind prevailing from November through February. In Kogi State, heavy downpours can render road surfaces slippery, induce localised flooding, and reduce tyre to pavement friction, while harmattan dust and fog during the dry months can impede visibility and compromise driver judgement (Folorunsho *et al.*, 2022). A study conducted in Lokoja covering the period 2011 to 2020 found a significant, albeit weak, correlation between rainfall and crash incidence, with crashes paradoxically higher during the dry season due to increased speeds and traffic volumes (Folorunsho *et al.*, 2022). Similar seasonal patterns have been reported in Lagos, where rainy season accidents were more frequent on account of wet roads and flooding, although harmattan fog contributed to crashes in the dry months (Ayeni and Oni, 2012).

The influence of adverse weather on road crashes is well established in the international literature. Precipitation alters vehicle control and stopping distances, fog diminishes visibility, and strong winds affect the stability of high profile vehicles (Eisenberg, 2004; Andrey and Mills, 2003). Seasonal fluctuations in Nigeria have been linked to higher crash rates through mechanisms ranging from poor tyre grip on wet pavements to behavioural adjustments during heavy downpours (Atubi, 2010). Nonetheless, the unique combination of heavy traffic volume, riverine flooding threats, and variable weather in Lokoja creates localised vulnerabilities that broader national studies tend to overlook.

While previous research has primarily addressed human error factors such as speeding, mechanical failures, and poor road design, the role of climatic variables in shaping the spatial and temporal distribution of crashes in Lokoja remains insufficiently investigated. A notable gap exists in the form of comprehensive analyses that integrate long term weather records with crash data for this specific locality. This study therefore aims to bridge that gap by examining the correlations between variations in rainfall, temperature, relative humidity, and wind speed on the one hand, and the incidence of traffic crashes, injuries, and fatalities on the other, over the period 2014 to 2024. The findings are intended to inform improved road maintenance practices, the development of weather responsive traffic policies, and the implementation of targeted safety measures to reduce the toll of road crashes in this critical and vulnerable region.

2. Literature Review

2.1 The African and Global Context

Road traffic crashes represent a disproportionate burden across the African continent. The estimated road traffic injury and death rate in Africa stands at approximately 26.6 per 100,000 population, which is substantially higher than the global average and is driven by a combination of poor road conditions, inadequate vehicle maintenance, and adverse weather (Adeloye *et al.*, 2016). In sub Saharan Africa, the adverse effects of climate change are exacerbating extreme weather patterns, and research has shown that severe rainfall and reduced visibility increase crash risk by rendering road surfaces slippery, flooding roadways, and damaging infrastructure (Kifle *et al.*, 2025). Weather conditions such as rain and fog are known to increase crash severity globally by reducing driver reaction times and degrading vehicle control, and in African settings these effects are amplified by inadequate drainage systems and deferred maintenance.

2.2 The Nigerian Context

Within Nigeria, climatic factors have increasingly been linked to road traffic crash patterns. A national level study employing dynamic autoregressive distributed lag modelling found that temperature, rainfall, and cloud cover all exhibit strong long term correlations with traffic crash incidence, with temperature and rainfall exerting the most pronounced short term effects (Adams *et al.*, 2024). This finding implies that warmer and wetter conditions may elevate crash risk through mechanisms such as reduced visibility and hydroplaning. In northern Nigeria, research conducted in Zaria, Kaduna State, similarly identified low visibility as a prominent driver of weather related crashes, although the strength of quantitative associations varied by season (Mohammed *et al.*, 2016). A seasonal dimension is also evident, with higher crash rates during the so called ember months (September to December) attributed to drier, faster road surfaces and occasional fog events (Afolabi *et al.*, 2024). Not all studies converge on the primacy of climate, however; human variables such as speeding and poor enforcement can overshadow weather effects, as illustrated by the empirical analysis of accident trends in Kogi State, which revealed consistent increases without significant seasonal fluctuations (Afolayan *et al.*, 2013).

2.3 Lokoja Specific Evidence

Research conducted within Lokoja provides more granular insights into the interaction between climatic variability and local traffic dynamics. Using data from the Nigerian Meteorological Agency and the Federal Road Safety Corps, Folorunsho *et al.* (2022) investigated the relationship between rainfall and crashes from 2011 to 2020. They reported a weak but statistically significant negative correlation, with rainfall accounting for only 5.4 percent of accident variation. Notably, crashes were higher during the dry season, which contributed 54 percent of total incidents, apparently because drivers increase speed and cover longer distances during dry weather, whereas wetter months saw fewer incidents as cautious driving became prevalent. This counterintuitive finding is consistent with behavioural adaptation theory but stands in tension with infrastructure focused research.

Adetunji (2021) examined the effects of extreme rainfall on Lokoja's road transport infrastructure and documented significant disruptions, including pothole formation, flooding in low lying areas such as Ganaja and Felele, and elevated vehicle maintenance costs during the rainy season. The study, based on surveys of 300 motorists, established that rainfall volume significantly influences crash rates, fatalities, and vehicle involvement. Heavy rains and fog were identified as environmental contributors to crashes along the Abuja to Lokoja highway, alongside dominant human factors such as overspeeding and reckless driving (Maina, 2015). Broader assessments of Kogi State reinforce these themes, with the Federal Road Safety Corps acknowledging that weather related visibility problems remain a persistent concern despite ongoing enforcement efforts (Olagunju, 2023).

Despite this growing body of evidence, a comprehensive study that integrates long term weather data with recent crash records for Lokoja remains absent. Most existing studies focus on national trends or other cities, thereby overlooking Lokoja's unique riverine setting, heavy traffic volume, and acute flooding risk. This gap impedes the development of targeted interventions such as improved drainage, real time driver weather alerts, and climate resilient road designs. The present study addresses this gap by examining the relationships between meteorological variables and road traffic crashes in Lokoja from 2014 to 2024, with the aim of generating practical recommendations for enhancing road safety in the region.

3. The Study Area

Lokoja, the administrative capital of Kogi State, is located in the north central zone of Nigeria near the confluence of the Niger and Benue rivers. The city lies between latitudes 7°45′27.56″N and 7°51′04.34″N, and between longitudes 6°41′55.64″E and 6°45′36.58″E. Lokoja is approximately 160 km southwest of Abuja, the national capital, and about 390 km northeast of Lagos, making it an important node in the national transportation network (Adeoye, 2012). The climate is classified as tropical wet and dry (Aw) under the Köppen system, with mean annual temperatures averaging 27.7°C and peak temperatures reaching 37.9°C in March (Animashaun *et al.*, 2020). The wet season extends from April to October, while the dry season, characterised by the northeast trade wind (harmattan), runs from November to March. Annual rainfall ranges from 804.5 mm to 1767.1 mm, with a long term mean of approximately 1,231 mm (Olatunde and Adejoh, 2018). Relative humidity ranges from 60 to 83 percent during the rainy months. The city's central location and high traffic volumes make it well suited for investigating the nexus between weather variability and road traffic crash patterns.

4. Research Methods

This study adopted a quantitative research design drawing on secondary data from two principal sources. Climatic data comprising temperature at 2 metres (T2M), relative humidity at 2 metres (RH2M), wind speed at 2 metres (WS2M), wind speed at 10 metres (WS10M), and corrected precipitation totals (PRECTOTCORR_SUM) were obtained from the Centre for Atmospheric Research, National Space Research and Development Agency (CAR NASRDA), housed at the Federal University Lokoja. These data were derived from the Modern

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Era Retrospective Analysis for Research and Applications, version 2 (MERRA 2) reanalysis product. Road traffic crash records, including the number of reported crashes, injuries, and fatalities, were sourced from the Federal Road Safety Corps (FRSC), Kogi State Sector Command. All data covered the period 2014 to 2024, providing a nine year temporal baseline for analysis.

The collected data were sorted and summarised at monthly, seasonal, and annual timescales to enable temporal analysis. Frequency distribution tables, simple percentages, measures of central tendency, and graphical representations (bar charts and line graphs) were used to describe the distribution of climatic elements and traffic crashes across the study period. Simple linear regression analysis was employed to assess the extent to which traffic crashes predict traffic injuries and fatalities. In this model, the number of traffic casualties (injuries and fatalities) served as the dependent variable, while the number of reported crashes was the independent variable. The regression model takes the form:

$$Y = a + bX \qquad (1)$$

where Y represents the dependent variable (traffic casualties), a is the constant, b is the regression coefficient, and X is the independent variable (traffic crashes). Furthermore, the Pearson Product Moment Correlation Coefficient (PPMC) was computed to evaluate the direction and strength of the linear relationship between each climatic variable and the traffic crash indicators. A significance threshold of $p < 0.05$ was adopted for all inferential tests.

5. Results and Discussion

5.1 Distribution of Climatic Variables

The mean annual distributions of the climatic variables measured in Lokoja from 2014 to 2024 are presented in Table 1 and illustrated in Figure 2. The analysis revealed that the annual average temperature ranged from 25.41°C in 2022 to 27.70°C in 2014, reflecting a modest cooling trend over the period. Rainfall exhibited considerable inter annual variability, with the lowest mean recorded in 2014 (62.84 mm) and the highest in 2021 (166.71 mm). Relative humidity ranged from 67.26 percent in 2015 to 78.07 percent in 2022. Wind speed at both the 2 metre and 10 metre levels showed a general decline, with the highest values recorded in 2015 (1.92 km/h at 2 m; 2.79 km/h at 10 m) and the lowest in 2022 (1.60 km/h at 2 m; 2.41 km/h at 10 m).

Table 1. Mean annual distributions of climatic variables in Lokoja (2014–2024).

Year	Temp (°C)	Rain (mm)	RH (%)	WS 2m	WS 10m
2014	27.70	62.84	68.87	1.83	2.64
2015	27.49	63.72	67.26	1.92	2.79
2016	27.32	93.60	69.33	1.75	2.57
2017	27.14	93.16	72.10	1.68	2.47
2018	26.78	86.57	72.57	1.83	2.68
2019	27.26	101.51	71.41	1.74	2.54
2020	26.63	112.06	72.59	1.75	2.58
2021	26.64	166.71	74.51	1.67	2.47
2022	25.41	119.81	78.07	1.60	2.41
2023	26.54	117.33	73.83	1.72	2.54
2024	26.50	123.49	74.08	1.70	2.51

Source: CAR NASRDA

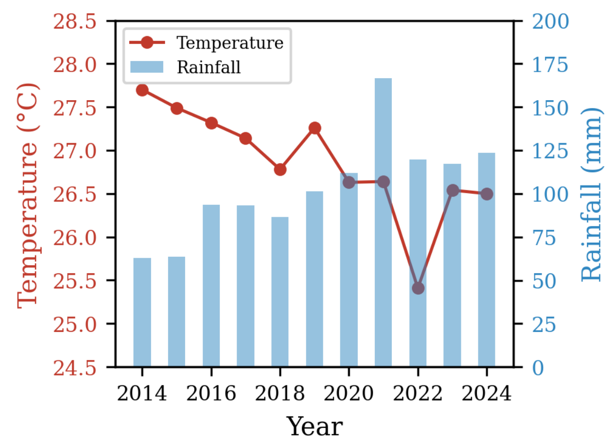

Figure 2: *Mean annual temperature and rainfall distribution in Lokoja (2014–2024).*

At the monthly scale (Table 2 and Figure 3), March recorded the highest average temperature (29.47°C), while August had the lowest (25.32°C). Rainfall peaked in September (225.22 mm) and was at its minimum in February (9.48 mm). Relative humidity was highest in September (86.22 percent) and lowest in January (49.91 percent). April had the highest average wind speed at both measurement heights (2.39 km/h at 2 m; 3.34 km/h at 10 m), while November recorded the lowest wind speeds. These monthly patterns reflect the well documented seasonality of the West African monsoon system and its interaction with the harmattan circulation (Animashaun *et al.*, 2020; Olatunde and Adejoh, 2018).

Table 2. Mean monthly distributions of climatic variables in Lokoja.

Month	Temp (°C)	Rain (mm)	RH (%)	WS 2m	WS 10m
Jan.	26.08	14.86	49.91	1.70	2.53
Feb.	28.16	9.48	51.73	1.77	2.52
Mar.	29.47	27.84	65.37	2.30	3.16
Apr.	29.06	67.59	70.61	2.39	3.34

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May	27.91	129.22	78.05	1.97	2.85
Jun.	26.56	161.06	82.61	1.76	2.61
Jul.	25.75	174.10	84.43	1.82	2.71
Aug.	25.32	203.94	85.84	1.84	2.76
Sep.	25.56	225.22	86.22	1.48	2.25
Oct.	26.17	153.11	83.71	1.30	2.01
Nov.	26.72	44.57	70.93	1.19	1.85
Dec.	25.50	33.55	57.42	1.42	2.19

Source: CAR NASRDA

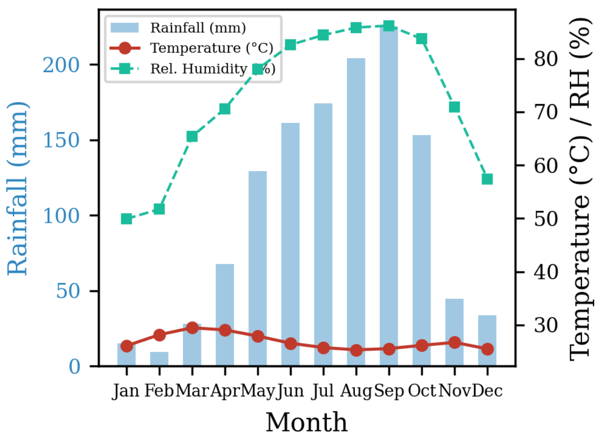

Figure 3: *Mean monthly temperature, rainfall, and relative humidity in Lokoja.*

5.2 Distribution of Traffic Crashes and Casualties

The temporal distribution of reported traffic crashes and casualties in Lokoja from 2014 to 2024 is displayed in Figure 4. At the annual scale, the highest number of crashes (183) was recorded in 2021, while 2015 had the greatest number of fatalities (203) and injuries (572). In contrast, the lowest incidences of crashes (68), injuries (175), and fatalities (47) were all recorded in 2016. These results align with the findings of Atomode and Salami (2025), who reported that the highest incidence of freight vehicle crashes in Lokoja occurred in 2021, while 2015 accounted for the greatest share of casualties in freight traffic.

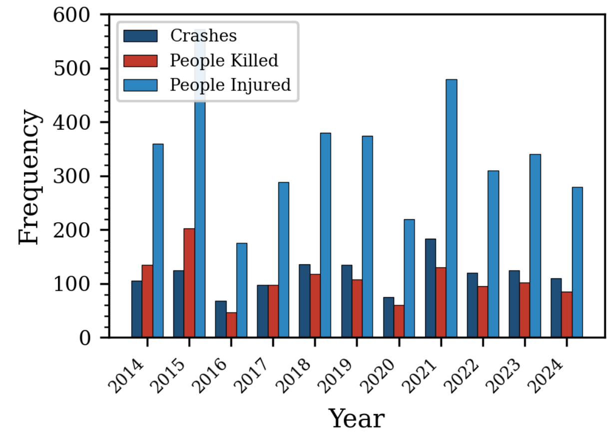

Figure 4: *Annual distribution of traffic crashes and casualties in Lokoja (2014–2024).*

At the monthly level (Figure 5), December recorded the highest number of crashes (164), a finding that may be attributed to the characteristically high vehicular traffic volumes associated with the festive season and end of year travel. April had the highest number of fatalities (173), while January recorded the most injuries (510). These findings are consistent with those of Folorunsho *et al.* (2022), who reported that crashes and casualties peaked in December and were lowest in October between 2014 and 2021. The elevated fatality count in April may be connected to the onset of the rainy season, when sudden downpours catch unprepared drivers on still dusty road surfaces, creating a particularly hazardous combination of conditions.

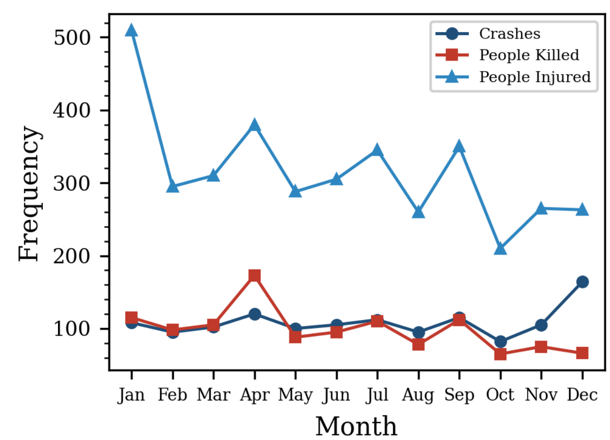

Figure 5: *Monthly distribution of traffic crashes and casualties in Lokoja (2014–2024).*

The seasonal distribution (Figure 6) reveals that the rainy season accounted for a marginally higher proportion of crashes (53.59 percent), fatalities (52.69 percent), and injuries (53.21 percent) compared with the dry season. These results corroborate the findings of Atomode and Salami (2025) in the same study area, who reported that roughly 54 percent of freight traffic crashes and 52 percent of casualties occurred during the wet season. A parallel observation was made by Ayeni and Oni (2012) in Lagos, where 53.31 percent of traffic accidents occurred during the rainy season between 2005 and 2010. The slightly elevated wet season figures may reflect the combined effects of slippery road surfaces, reduced visibility during heavy rainfall, and the tendency for flooding to create sudden obstacles or diversions on major routes (Adetunji, 2021).

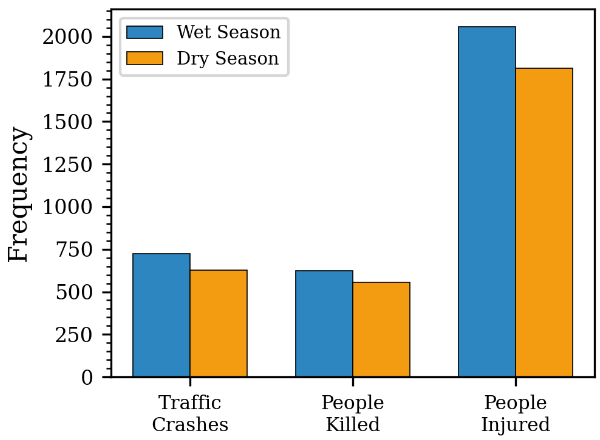

Figure 6: *Seasonal distribution of traffic crashes and casualties in Lokoja.*

5.3 Regression Analysis: Crashes as Predictors of Casualties

A simple linear regression analysis was conducted to evaluate the extent to which traffic crashes predict traffic injuries. The results (Table 3 and Figure 7) revealed a statistically significant relationship ($F(1,130) = 233.21$, $p < 0.001$). The coefficient of determination (R^2) was 0.642, indicating that traffic crashes explained approximately 64 percent of the variance in traffic injuries. The regression equation was: Traffic Injuries = 2.21 + 3.13(Traffic Crashes). In practical terms, each additional crash incident was associated with an increase of approximately 3.13 persons injured. The 95 percent confidence interval for the slope ranged from 2.73 to 3.54, confirming the robustness of the estimate.

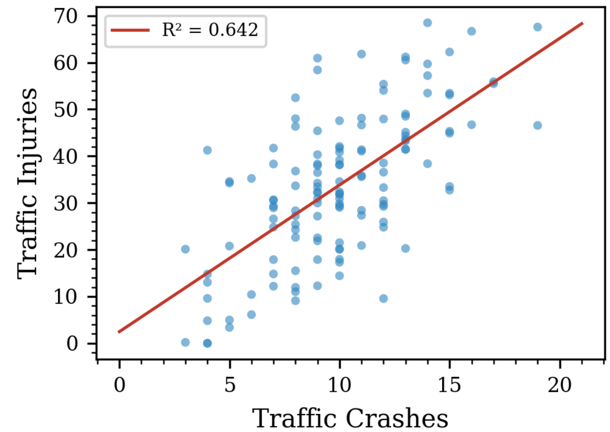

Figure 7: *Scatter plot showing the regression of traffic injuries on traffic crashes in Lokoja.*

Table 3. Regression results: Traffic crashes and traffic injuries.

Parameter	Value
R	0.801
R^2	0.642
Adjusted R^2	0.639
F statistic	233.207
p value	< 0.001
Slope (b)	3.134
95% CI for b	2.728 – 3.540

A similar regression was performed to assess the predictive capacity of crashes for traffic fatalities (Table 4 and Figure 8). A significant effect was found ($F(1,127) = 33.78$, $p < 0.001$), with an R^2 of 0.210, indicating that crashes explained approximately 21 percent of the variance in fatalities. The regression equation was: Traffic Fatalities = –1.15 + 0.84(Traffic Crashes). Each additional crash was associated with an increase of approximately 0.84 fatalities. The lower explanatory power for fatalities compared with injuries suggests that crash severity, and hence the likelihood of death, is influenced by additional factors beyond crash frequency, including vehicle speed at impact, seatbelt usage, emergency response time, and proximity to medical facilities (Atomode and Salami, 2025).

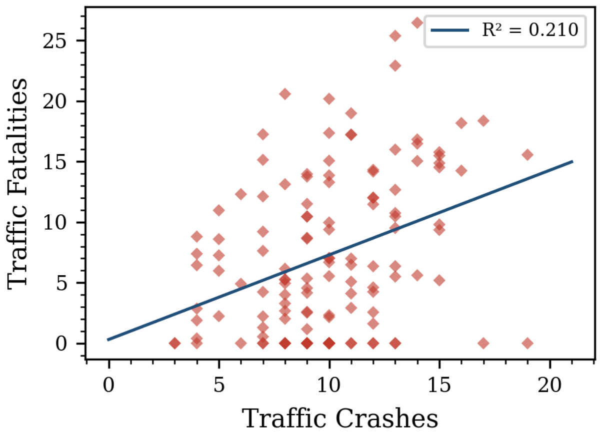

Figure 8: *Scatter plot showing the regression of traffic fatalities on traffic crashes in Lokoja.*

Table 4. Regression results: Traffic crashes and traffic fatalities.

Parameter	Value
R	0.458
R^2	0.210
Adjusted R^2	0.204
F statistic	33.783
p value	< 0.001
Slope (b)	0.844
95% CI for b	0.557 – 1.132

5.4 Correlation between Traffic Crashes and Climatic Variables

The Pearson correlation analysis (Table 5) assessed the relationships between the three traffic indicators (crashes, injuries, and fatalities) and the five climatic variables. The number of traffic crashes was not significantly correlated with average temperature (r = –0.03, p = 0.760), rainfall (r = –0.16, p = 0.067), relative humidity (r = –0.13, p = 0.144), wind speed at 2 metres (r = 0.01, p = 0.946), or wind speed at 10 metres (r = –0.004, p = 0.960). These results indicate that none of the selected climatic variables exerted a statistically significant direct influence on crash frequency during the study period. Earlier research has yielded mixed findings on this issue, with some studies reporting a predominantly negative link between temperature and crash frequency (Brijs *et al.*, 2008; El Basyouny and Kwon, 2012), while others have identified a contrasting positive effect (Bergel Hayat *et al.*, 2013; Yannis and Karlaftis, 2010).

Table 5. Pearson correlations between traffic crash indicators and climatic variables.

Variable	Temp	Rain	RH	WS 2m	WS 10m
Crashes (r)	–0.03	–0.16	–0.13	0.01	–0.004
Crashes (p)	0.760	0.067	0.144	0.946	0.960
Injured (r)	0.08	–0.20*	–0.18*	0.05	0.04
Injured (p)	0.371	0.020	0.042	0.542	0.650
Killed (r)	0.19*	–0.17	–0.19*	0.09	0.07
Killed (p)	0.033	0.051	0.033	0.305	0.408

** Significant at 0.05 level (two tailed).*

The number of persons injured in traffic crashes exhibited a weak but statistically significant negative correlation with rainfall (r = –0.20, p = 0.020) and relative humidity (r = –0.18, p = 0.042), but was not significantly associated with temperature, or wind speed at either height. The negative direction of these correlations implies that higher rainfall and humidity were associated with fewer injuries, a finding that is consistent with the behavioural adaptation hypothesis: drivers tend to reduce speed and exercise greater caution during adverse weather, thereby lowering the severity of crash outcomes even when road conditions deteriorate (Folorunsho *et al.*, 2022).

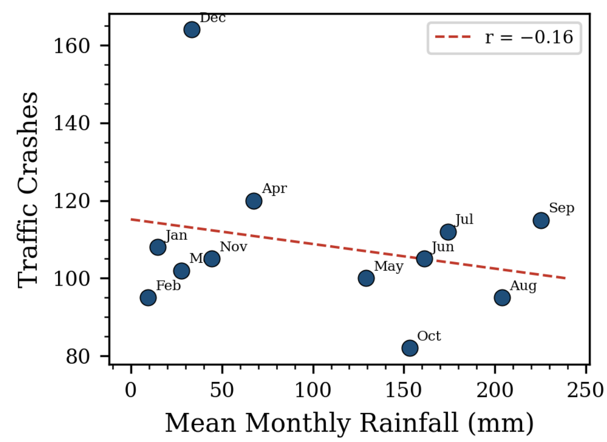

Figure 9: *Scatter plot of mean monthly rainfall against traffic crashes in Lokoja.*

In contrast, the number of persons killed displayed a weak but significant positive correlation with average temperature (r = 0.19, p = 0.033) and a weak significant negative correlation with relative humidity (r = –0.19, p = 0.033). The positive association with temperature may reflect the tendency for hotter conditions to induce driver fatigue, drowsiness, and reduced concentration, factors that are known to increase crash severity and the probability of fatal outcomes (Adams *et al.*, 2024). The negative association with relative humidity mirrors the rainfall finding and is likely mediated by similar behavioural mechanisms. Rainfall itself approached but did not achieve statistical significance for fatalities (r = –0.17, p = 0.051), suggesting a borderline effect that larger sample sizes might confirm.

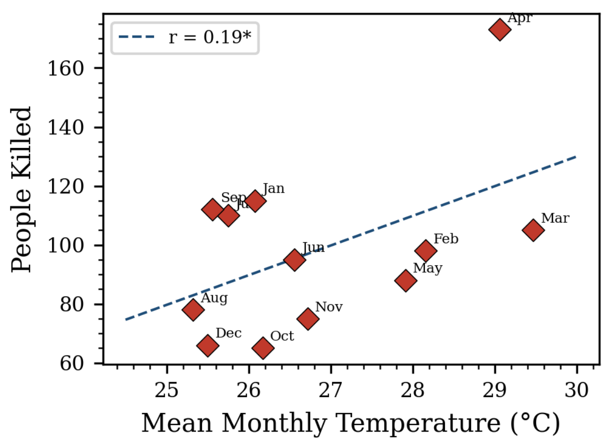

Figure 10: *Scatter plot of mean monthly temperature against traffic fatalities in Lokoja.*

These results are broadly consistent with earlier Nigerian research. Olawole (2016) reported that correlations between road traffic accidents and meteorological factors in Ondo State did not exceed 0.41, underscoring the generally modest magnitude of weather related effects on crashes. The present findings reinforce the consensus that climatic variables function as contributing rather than primary determinants of traffic crash patterns in Nigerian urban environments, where human factors such as speeding, overloading, and poor enforcement constitute the dominant risk drivers (Afolayan *et al.*, 2013; Olagunju, 2023). Nonetheless, the statistically significant associations identified here, particularly the temperature and fatality link and the rainfall and injury relationship, carry practical implications for road safety planning and deserve further investigation with higher resolution data and multivariate modelling frameworks.

6. Conclusion and Recommendations

This study examined the relationship between selected climatic variables and road traffic crashes, injuries, and fatalities in Lokoja, Kogi State, over the period 2014 to 2024. The temporal analysis established that March has the highest average temperature, August receives the most rainfall, and September has the highest relative humidity. With respect to crash patterns, December recorded the most crashes, April the most fatalities, and January the most injuries. The rainy season accounted for a slightly higher proportion of all three indicators compared with the dry season.

Regression analysis confirmed that traffic crashes are a significant predictor of both injuries and fatalities, with the model explaining 64 percent and 21 percent of the respective variances. Pearson correlation analysis revealed that no climatic variable was significantly correlated with the number of traffic crashes. However, rainfall and relative humidity exhibited weak but significant negative correlations with traffic injuries, while temperature showed a weak positive correlation with fatalities. These findings collectively suggest that climatic variables are not the primary drivers of traffic crashes in Lokoja but serve as contributing factors, particularly through their indirect effects on road surface conditions, visibility, and driver behaviour.

On the basis of these findings, the following recommendations are offered. First, road safety authorities should integrate real time weather monitoring into traffic management operations, deploying electronic signage along major corridors to warn drivers of adverse conditions. Second, investments in drainage infrastructure are urgently needed, particularly in flood prone low lying areas such as Ganaja and Felele, to mitigate the indirect effects of heavy rainfall on road usability and crash risk. Third, targeted driver education campaigns focusing on safe driving during extreme heat and heavy rainfall should be developed and disseminated through community radio and social media platforms. Fourth, future research should employ multivariate statistical models and higher resolution spatial data to disentangle the complex interactions between climatic variables, traffic volumes, road geometry, and crash outcomes in Lokoja and comparable Nigerian cities.

Acknowledgments

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