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ASSESSMENT OF ROAD SAFETY INTERVENTIONS IN REDUCING TRAFFIC CRASH SEVERITY IN NIGERIA

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Abstract

Road traffic crashes (RTCs) remain a major public health challenge globally, contributing significantly to mortality, morbidity, and economic losses, particularly in low- and middle-income countries such as Nigeria. This study assesses the effectiveness of road safety interventions in reducing RTC severity in Nigeria over the past two decades. The research evaluated key interventions including speed management, impaired driving prevention, vehicle safety standards, and road infrastructure improvements to identify implementation gaps and propose solutions. An explanatory sequential mixed-methods design was adopted, combining quantitative analysis of time series data from 2002 to 2022 with qualitative data from key stakeholders, including road safety officials and the general public. Quantitative data were analyzed using trend analysis, while qualitative data were analyzed thematically to explore stakeholder perceptions of intervention effectiveness. Results revealed a paradoxical outcome: while total RTCs declined significantly, injuries sustained during crashes increased substantially, indicating that interventions reduced crash frequency but not crash severity. This points to critical gaps in emergency response systems and vehicle safety standards. Stakeholders expressed mixed views on traffic law enforcement, with many indicating that speed limits and impaired driving laws are inconsistently applied across regions. The study recommends strengthening enforcement mechanisms through automated technologies, ensuring equitable infrastructure improvements, enhancing emergency response systems, and establishing comprehensive crash data systems for evidence-based policymaking. These measures can lead to sustained improvements in road safety outcomes, contributing to Nigeria's commitment to the UN Decade of Action for Road Safety 2021-2030.

Keywords: Road traffic crashes (RTCs); Road Safety Interventions; Crash Severity; Enforcement; Traffic Laws

1.0 Introduction

Road traffic crashes (RTCs) have emerged as a pressing global public health concern, contributing significantly to mortality, morbidity, and economic losses worldwide. The World Health Organization (WHO) reports that approximately 1.35 million people lose their lives annually due to road traffic injuries, positioning RTCs among the leading causes of death and disability globally (WHO, 2020). The economic impact of these crashes is equally staggering, with most countries experiencing losses estimated at 3% of their Gross Domestic Product (GDP) per annum (WHO, 2020). This dire situation is particularly pronounced in low- and middle-income countries (LMICs), where the burden of road traffic injuries is disproportionately high.

In the context of this global crisis, Nigeria stands out as a nation grappling with severe road safety challenges. As the most populous country in Africa, Nigeria's road safety landscape is characterized by a high incidence of traffic deaths and injuries, exacerbated by rapid population growth, increasing urbanization, and a complex interplay of socioeconomic factors. The Federal Road Safety Corps (FRSC) consistently reports thousands of crashes on Nigerian roads each year, resulting in a devastating toll of injuries and fatalities (FRSC, 2020). In 2018 alone, Nigeria recorded 11,363 RTC cases, with 5,134 deaths and 30,236 injuries (FRSC, 2020). These incidents not only lead to immeasurable human suffering but also inflict severe economic disruptions, including substantial expenditures on medical care, significant productivity losses, and extensive damage to infrastructure.

The multifaceted nature of road safety issues in Nigeria necessitates a comprehensive, multisectoral approach to address the various factors contributing to RTCs. These factors encompass a wide range of issues, including infrastructure deficiencies in road design, inadequate

signage, lack of pedestrian facilities, enforcement gaps stemming from workforce limitations and logistical constraints, corruption within law enforcement agencies, and societal attitudes toward road safety and driver behavior. Understanding the complex interplay of these factors is crucial for developing effective interventions aimed at reducing RTC risks and improving road safety outcomes.

Over the years, the Nigerian government has implemented several road safety interventions in an attempt to address this crisis. These include the establishment of the Federal Road Safety Corps, the development of the Nigeria Road Safety Strategy, public awareness campaigns, and improvements in road infrastructure. However, the persistent high rate of RTCs suggests that there are significant gaps in the current road safety measures. The effectiveness of these interventions in reducing crash severity remains poorly assessed, hindering evidence-based policymaking and efficient resource allocation.

1.1 Statement of the Problem

Nigeria faces a severe road traffic crash crisis despite decades of intervention efforts, recording 11,363 crash cases in 2018 alone that resulted in 5,134 deaths and 30,236 injuries—approximately 14 deaths and 83 injuries daily—positioning Nigeria among countries with the highest global fatality rates. Despite implementing numerous interventions over the past two decades, including establishing the Federal Road Safety Corps (1988), developing national road safety strategies, infrastructure investments, public awareness campaigns, and enforcement measures, Nigeria continues experiencing unacceptably high crash severity levels, suggesting current interventions are inadequately designed, poorly implemented, or fundamentally unsuited to the Nigerian context. The core problem is compounded by critical deficiencies: the conspicuous absence of systematic,

evidence-based evaluation of existing interventions makes it impossible to determine which measures effectively reduce crash severity, forcing policymakers to allocate limited resources to interventions of unknown effectiveness; the lack of comprehensive, long-term trend analysis prevents understanding whether crash severity is improving or deteriorating over time, undermining strategic planning; persistent implementation barriers including enforcement inconsistencies, corruption, technological limitations, inadequate public education strategies, infrastructure maintenance challenges, and inter-agency coordination failures systematically undermine intervention effectiveness; and Nigeria lacks a context-specific, evidence-based framework for selecting and implementing interventions adapted to the country's unique characteristics. The continuation of high crash severity rates represents a crisis of public health and economic development, with impacts estimated at 3% of GDP annually, while Nigeria's commitment to the UN Decade of Action for Road Safety 2021-2030, targeting 50% reduction in road deaths by 2030, heightens the urgency for comprehensive research to evaluate existing intervention effectiveness, analyze long-term crash severity trends, identify implementation barriers, and develop evidence-based frameworks tailored to the Nigerian context.

1.2 Justification of the Study

This study is particularly timely and relevant given the significant public health and economic impacts of RTCs in Nigeria. By providing evidence-based insights into the effectiveness of various interventions and developing a context-specific framework for future actions, this research has the potential to:

1. Inform policy decisions: The findings will provide policymakers with a clear understanding of which interventions have been most effective in reducing crash severity, guiding future policy formulation and resource allocation.

2. Improve intervention strategies: By identifying implementation barriers and proposing strategies to overcome them, the study will contribute to more effective implementation of road safety measures.

3. Enhance cross-sectoral collaboration: The development of a comprehensive framework will facilitate better coordination among various stakeholders involved in road safety, including government agencies, NGOs, and the private sector.

4. Contribute to global road safety efforts: The insights gained from this study will add to the growing body of knowledge on road safety in developing countries, potentially informing interventions in other similar contexts.

5. Support progress towards SDG targets: By focusing on reducing RTC severity, this research aligns with and supports global efforts to achieve the United Nations Sustainable Development Goal 3.6 of halving global deaths and injuries from road traffic crashes by 2030.

1.3 Study Objectives and Approach

The overarching aim of this study is to evaluate the effectiveness of key road safety interventions in reducing traffic crash severity in Nigeria and to determine the trend of road traffic crashes for the past 20 years. Specifically, the study seeks to:

1. To evaluate the effectiveness of key road safety interventions in reducing traffic crash severity in Nigeria.
2. Determine the trend in road traffic crash severity (fatalities) in Nigeria over the past 20 years.

In conclusion, this study represents a critical step towards addressing the pressing issue of road safety in Nigeria. By providing a comprehensive assessment of current interventions, identifying barriers to implementation, and proposing an enhanced framework for future actions, this research has the potential to contribute significantly to reducing the burden of RTCs on Nigerian society. The findings and recommendations from this study will not only inform policy and practice in Nigeria but also contribute to the broader global efforts to improve road safety in developing countries.

2.0 Literature Review

2.1 Global Context and Best Practices

To fully appreciate the challenges and opportunities in Nigeria's road safety landscape, it is essential to consider the global context and best practices in road safety interventions. Worldwide, road safety interventions typically fall into three broad categories: engineering, enforcement, and education measures (Peden et al., 2004). Engineering measures focus on improving road design, installing safety features, and enhancing vehicle standards. Enforcement measures involve the implementation and monitoring of laws and regulations, such as speed limits, drink-driving laws,

and seatbelt use mandates. Education measures aim to raise awareness and provide public education about road safety practices.

In many high-income countries, significant progress has been made in reducing RTC fatalities through the implementation of comprehensive road safety strategies. For instance, Sweden's Vision Zero approach, adopted in 1997, has been widely recognized as a successful model for road safety (Belin et al., 2012). This approach is based on the ethical stance that no loss of life in traffic is acceptable and emphasizes shared responsibility between road users and system designers. By focusing on safe speeds, safe roads, safe vehicles, and safe road users, Sweden has achieved one of the lowest traffic fatality rates in the world.

Similarly, the Netherlands has implemented a Sustainable Safety vision, which aims to prevent crashes and, where this is not possible, to minimize their consequences (Wegman et al., 2008). This approach emphasizes the importance of creating a road environment that accounts for human limitations and vulnerabilities. The success of these strategies in high-income countries provides valuable insights that could be adapted to the Nigerian context, taking into account the unique challenges and opportunities present in the country.

2.2 Nigerian Road Safety Landscape

To fully understand the road safety situation in Nigeria, it is crucial to examine the specific challenges and contextual factors that contribute to the high incidence of RTCs in the country. Nigeria's road network, spanning approximately 200,000 kilometers, is the largest in West Africa (Oluwasegun & Daramola, 2019). However, a significant portion of this network is in poor condition, with inadequate maintenance, poor design, and lack of safety features contributing to the high crash rates.

The rapid urbanization and population growth in Nigeria have led to increased motorization without a corresponding improvement in road infrastructure and traffic management systems. This mismatch has resulted in congested roads, particularly in urban areas, increasing the risk of crashes. Additionally, the prevalence of commercial motorcycles (popularly known as "okada") and three-wheeled vehicles ("keke napep") in urban areas presents unique challenges to road safety, as these vehicles often operate without adequate regulation or safety measures (Oluwasegun & Daramola, 2019).

Another critical factor contributing to the high RTC rates in Nigeria is the behavior of road users. Speeding, drunk driving, non-use of safety devices such as seatbelts and helmets, and general disregard for traffic rules are common issues (Adejugbagbe et al., 2015). These behaviors are often exacerbated by inadequate enforcement of traffic laws and a low level of public awareness about road safety.

The socioeconomic context of Nigeria also plays a significant role in shaping road safety outcomes. High levels of poverty and unemployment have led to the proliferation of poorly maintained vehicles and untrained drivers in the commercial transport sector. Moreover, corruption within law enforcement agencies and the vehicle inspection system has undermined efforts to enforce safety standards and traffic regulations (Oluwasegun & Daramola, 2019).

2.3 Current Road Safety Interventions in Nigeria

In response to the road safety crisis, Nigeria has implemented various interventions over the years. The establishment of the Federal Road Safety Corps (FRSC) in 1988 marked a significant milestone in the country's efforts to improve road safety. The FRSC is mandated to prevent and

minimize RTCs on the nation's highways, educate road users on proper use of highways, and clear obstructions on public highways, among other responsibilities (FRSC, 2020).

The Nigeria Road Safety Strategy (NRSS) 2021-2030, developed by the FRSC in collaboration with other stakeholders, provides a comprehensive framework for addressing road safety issues in the country. The strategy aligns with the United Nations Decade of Action for Road Safety 2021-2030 and aims to reduce road traffic deaths and injuries by 50% by 2030 (FRSC, 2021).

Other interventions include:

1. Speed management: Implementation of speed limits and the use of speed cameras on major highways.
2. Drunk driving prevention: Introduction of breath alcohol testing and increased penalties for drunk driving offenses.
3. Vehicle safety standards: Implementation of periodic vehicle inspection and enforcement of safety standards for imported vehicles.
4. Road infrastructure improvements: Ongoing efforts to rehabilitate and upgrade road networks, including the installation of road signs, markings, and safety barriers.
5. Public education and awareness campaigns: Regular public enlightenment programs on road safety issues through various media channels.
6. Emergency response: Establishment of emergency response units along major highways to provide prompt medical assistance to crash victims.

Nigeria's road safety framework has attracted varied assessments from researchers, with most acknowledging the existence of comprehensive intervention efforts while identifying significant weaknesses in their implementation and effectiveness. The legislative framework underpinning road safety efforts, centered around the Federal Road Safety Corps and its mandate to enforce traffic laws, represents both a foundational strength and a source of considerable frustration for stakeholders. While researchers like Umar et al. (2021) acknowledge the importance of having dedicated institutional capacity for road safety management, they raise significant concerns about enforcement inconsistencies that fundamentally undermine the system's potential effectiveness. Their critique highlights the gap between policy intentions and implementation realities, demonstrating how institutional weaknesses can neutralize otherwise sound regulatory frameworks.

The challenge of enforcement inconsistency is further compounded by technological limitations that prevent effective monitoring and prosecution of traffic violations. Olayemi et al. (2021) argue that the lack of adequate technological support, particularly automated traffic violation detection systems, creates enforcement gaps that allow dangerous behaviors to persist without consequences. This technological deficit reflects broader challenges in Nigeria's public sector capacity, including limited financial resources for capital investments, inadequate technical expertise for system maintenance, and institutional barriers that prevent effective coordination between technology providers and enforcement agencies.

Perhaps most troubling among the enforcement challenges identified by researchers is the persistent problem of corruption within law enforcement ranks, which fundamentally undermines the entire regulatory system. Ibrahim and Mohammed (2020) provide detailed documentation of

how corruption creates parallel systems where traffic violations can be resolved through informal payments rather than legal processes, effectively negating the deterrent effect of traffic laws. This corruption not only undermines specific safety regulations but also erodes public confidence in the fairness and legitimacy of the entire transportation regulatory system, creating conditions where compliance becomes increasingly voluntary rather than mandatory.

The limitations of traditional awareness campaigns become particularly apparent when considering their failure to incorporate modern communication strategies and technologies that might enhance their reach and impact. Ekanem (2023) highlights the campaigns' failure to effectively engage younger drivers through digital platforms and social media, representing a significant missed opportunity given that younger demographics often represent high-risk groups for traffic crashes. This generational disconnect reflects broader challenges in public sector communication strategies that rely on traditional media channels while failing to adapt to changing patterns of information consumption and social interaction.

The integration of technology into Nigeria's road safety framework presents both promising opportunities and significant implementation challenges that reflect broader issues within the country's technological infrastructure and institutional capacity. Researchers have documented various attempts to incorporate technological solutions into safety efforts, including speed cameras, GPS tracking systems for commercial vehicles, automated traffic management systems, and digital platforms for reporting and responding to crashes. While these technologies offer significant potential for improving safety outcomes, their effectiveness has been consistently limited by implementation challenges that reflect systemic weaknesses in Nigeria's technological and institutional capacity.

Torbaghan et al. (2021) recognize the theoretical potential of technological interventions while documenting their systematic underutilization across many regions that lack the basic infrastructure necessary for effective implementation. This infrastructure deficit encompasses not only physical requirements such as reliable electricity supplies and telecommunications networks but also institutional capacity for system maintenance, data management, and integration with existing enforcement processes. The authors emphasize that technology deployment without corresponding investments in infrastructure and capacity building often results in expensive but ineffective systems that fail to achieve their intended safety benefits.

Even where technological tools have been successfully deployed, researchers have identified inadequate training of law enforcement personnel as a major constraint on their effectiveness. Ekanem (2023) documents cases where sophisticated equipment remains unused or underutilized because operators lack the technical skills necessary for effective operation, highlighting the need for comprehensive training programs that accompany technology deployments. This training challenge reflects broader human resource development needs within Nigeria's public sector, where rapid technological change often outpaces institutional capacity for adaptation and skills development.

Infrastructure improvements across Nigeria's road network represent a critical component of road safety efforts that has received considerable attention from researchers, with studies generally acknowledging the importance of these investments while identifying significant limitations in their planning, implementation, and maintenance. The scale of Nigeria's infrastructure challenge is enormous, encompassing not only the rehabilitation of existing roads that have deteriorated due to inadequate maintenance but also the construction of new facilities designed to accommodate

growing traffic volumes and changing transportation patterns. While these infrastructure investments represent important commitments to improving transportation safety, their effectiveness has often been limited by various implementation challenges that reflect broader weaknesses in Nigeria's public sector capacity and governance systems.

Researchers have documented significant disparities in infrastructure improvement efforts between urban and rural areas, with urban centers receiving disproportionate attention while rural communities continue to rely on road networks that pose significant safety risks. Abdu et al. (2019) acknowledge the positive efforts made in major cities, including construction of new roads, installation of improved signage systems, and implementation of traffic management infrastructure, while highlighting the concerning neglect of rural areas where poor road conditions continue to contribute to high accident rates. This urban-rural divide reflects broader patterns of development investment in Nigeria and suggests that infrastructure improvement strategies may inadvertently exacerbate existing inequalities in access to safe transportation.

International collaboration efforts, particularly partnerships with organizations such as the World Health Organization (WHO) and the Global Road Safety Partnership (GRSP), have been recognized by researchers as valuable components of Nigeria's road safety strategy, yet these relationships face sustainability challenges that limit their long-term impact on safety outcomes. These partnerships provide access to technical expertise, funding, international best practices, and global networks of safety professionals that can significantly enhance Nigeria's domestic capacity for addressing road safety challenges. However, researchers have identified several structural limitations in these collaborations that constrain their effectiveness and sustainability.

Torbaghan et al. (2021) acknowledge the substantial benefits that flow from international partnerships, including access to cutting-edge research, proven intervention strategies, technical training opportunities, and financial resources that supplement domestic investments in road safety. These partnerships have supported various capacity building initiatives, technology transfers, policy development processes, and research activities that have enhanced Nigeria's overall approach to road safety management. However, the authors also note that these benefits often remain concentrated within specific agencies or geographic areas, limiting their broader impact on national safety outcomes.

Abdu et al. (2019) advocate for greater local ownership of road safety programs, emphasizing the need for interventions that are specifically adapted to Nigeria's unique cultural, economic, and infrastructural context rather than simply importing solutions that have been successful in other countries with different conditions. This perspective reflects growing recognition in the international development community that effective interventions must be contextually appropriate and locally owned to achieve sustainable impact. The researchers argue that while international expertise and resources can provide valuable support, lasting improvements in road safety require domestic commitment, resources, and institutional capacity that cannot be provided by external partners.

One of the most significant weaknesses identified across multiple studies of Nigeria's road safety framework is the persistent lack of comprehensive and reliable crash data, a problem that has far-reaching implications for evidence-based policymaking, effective resource allocation, and systematic evaluation of intervention effectiveness. The absence of quality data creates a vicious cycle where policymakers lack the information necessary to make informed decisions about

intervention priorities, resource allocation, and strategy development, while the lack of systematic evaluation makes it impossible to learn from experience and improve future interventions. This data deficit represents more than a technical challenge; it fundamentally undermines the scientific basis for road safety policy and creates conditions where interventions may be based on assumptions, political considerations, or external pressures rather than empirical evidence about what works in the Nigerian context.

3.0 Methodology

This study employed an explanatory sequential mixed-methods design to evaluate the effectiveness of road safety interventions in reducing traffic crash severity across all 36 Nigerian states and the Federal Capital Territory over a 20-year period (2002-2022). Quantitative data were obtained from the Federal Road Safety Corps (FRSC) National Road Traffic Crash Database, including annual crash cases, injuries, fatalities, and severity classifications, supplemented by WHO Global Health Observatory and National Bureau of Statistics reports. Time series analysis was conducted using R Statistical Software (Version 4.3.0) with trend decomposition, ARIMA modeling, and structural break tests to identify intervention impact points. Qualitative data were collected through semi-structured interviews with 35 purposively selected key informants, including FRSC officials (n=8), state transportation officials (n=6), law enforcement officers (n=5), academic researchers (n=4), healthcare professionals (n=4), civil society representatives (n=4), and transport operators (n=4), alongside focus group discussions and documentary analysis of policy documents and intervention reports.

Data integration followed a convergent parallel approach, with thematic analysis of qualitative data using NVivo 12 and Braun and Clarke's six-phase framework achieving inter-coder reliability

(Cohen's kappa = 0.83). Statistical analyses included linear trend modeling, descriptive statistics, and multiple regression to assess relationships between intervention periods and crash outcomes. Study limitations included potential underreporting of crashes in rural areas, changes in reporting standards over time, and the observational design's constraints on establishing causal relationships, which were mitigated through data triangulation, sensitivity analyses, and conservative interpretation of findings.

4.0 Results

Table 1. Perceived effectiveness of speed-limit enforcement in reducing road traffic crashes

	Frequency	Percent	Valid Percent	Cumulative Percent
Very effective	230	21.9	21.9	21.9
Effective	191	18.2	18.2	40.1
Neutral	216	20.6	20.6	60.7
Ineffective	189	18.0	18.0	78.7
Very ineffective	223	21.3	21.3	100.0
Total	1049	100.0	100.0	

Source: Field survey (2024).

Table 2: Perceived consistency of speed-management enforcement by road-safety authorities

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	196	18.7	18.7	18.7
Agree	211	20.1	20.1	38.8
Neutral	189	18.0	18.0	56.8
Disagree	219	20.9	20.9	77.7
Strongly disagree	234	22.3	22.3	100.0
Total	1049	100.0	100.0	

Field survey (2024).

Table 3: Perceived effectiveness of laws and penalties against impaired driving in preventing road traffic crashes

	Frequency	Percent	Valid Percent	Cumulative Percent
Very effective	205	19.5	19.5	19.5
Effective	205	19.5	19.5	39.1
Neutral	200	19.1	19.1	58.2
Ineffective	214	20.4	20.4	78.6
Very ineffective	225	21.4	21.4	100.0
Total	1049	100.0	100.0	

Field survey (2024).

Table 4: Reported recent road-infrastructure improvements in respondents' local areas

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	390	37.2	37.2	37.2
No	302	28.8	28.8	66.0
Not sure	357	34.0	34.0	100.0
Total	1049	100.0	100.0	

Field survey (2024).

Table 5: Perceived effect of road-safety interventions on the number of crashes in respondents' areas

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	208	19.8	19.8	19.8
Agree	233	22.2	22.2	42.0
Neutral	225	21.4	21.4	63.5
Disagree	176	16.8	16.8	80.3
Strongly disagree	207	19.7	19.7	100.0
Total	1049	100.0	100.0	

Field survey (2024).

Time Series Trend Analysis

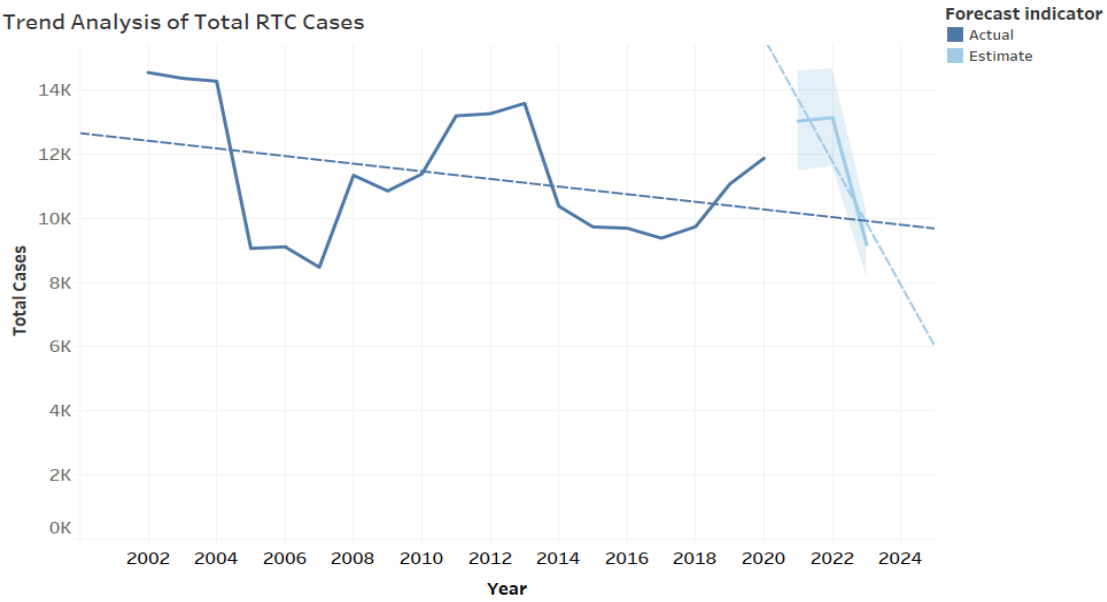


Figure 1. Annual number of road traffic crashes in Nigeria over a 20-year period, with fitted trendline.

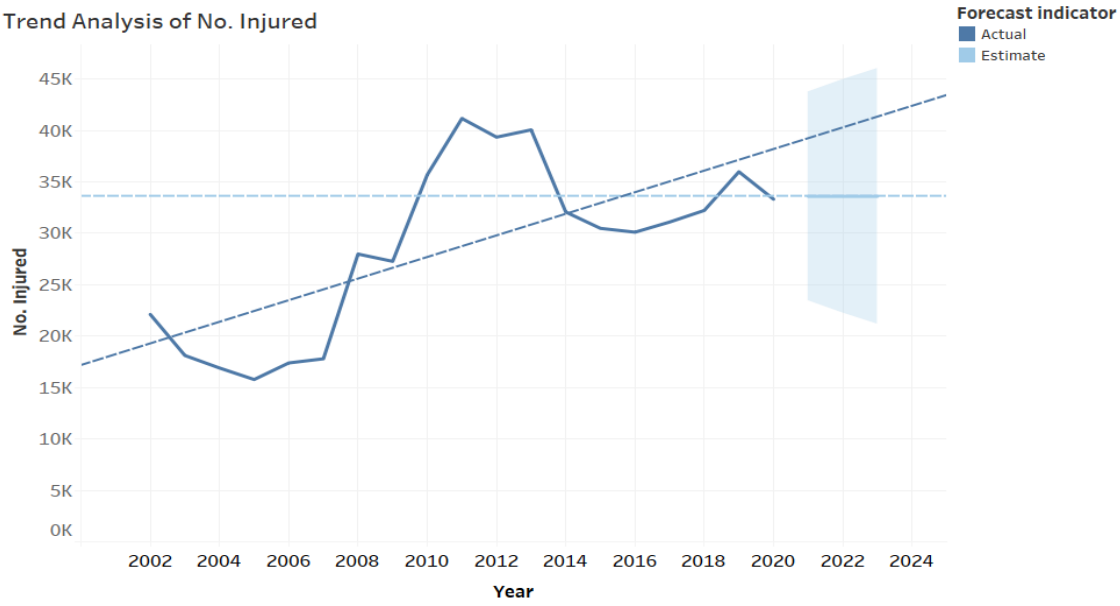


Figure 2. Annual number of persons injured in road traffic crashes in Nigeria over a 20-year period, with fitted trendline.

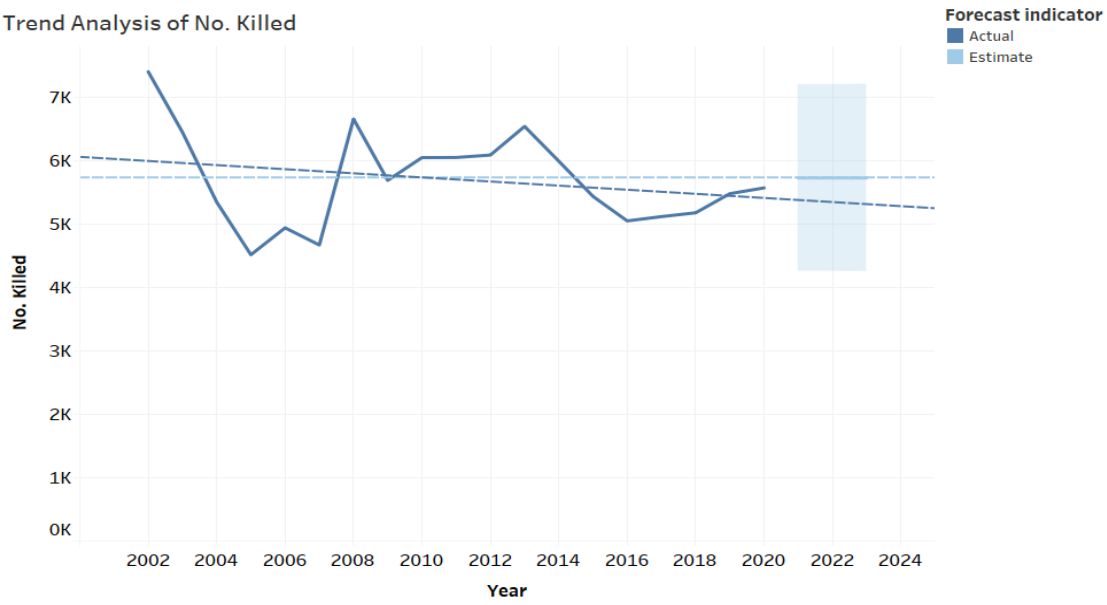


Figure 3. Annual number of road traffic fatalities in Nigeria over a 20-year period, with fitted trendline.

5.0 Discussion

This mixed-methods study reveals a complex picture of road safety interventions in Nigeria, characterized by mixed effectiveness and significant implementation challenges. The integration of quantitative time series data with qualitative stakeholder perceptions provides critical insights into why certain interventions have succeeded while others have fallen short.

The most striking finding is the paradoxical relationship between crash frequency and injury severity over the 20-year study period. While Figure 1 demonstrates a clear downward trend in total road traffic crashes (declining from approximately 14,000 cases in 2002 to projected levels below 8,000 by 2024), Figure 2 reveals a concerning upward trend in injuries sustained during these crashes. This contradiction suggests that interventions have been successful in reducing crash

frequency but less effective in mitigating crash severity when crashes occur. The qualitative data provides context for this paradox, revealing significant gaps in enforcement consistency, infrastructure improvements, and emergency response capabilities.

The perception data regarding speed management interventions illustrates the enforcement challenges that undermine intervention effectiveness. Only 40.1% of respondents view speed limit enforcement as effective (Table 1), while 43.2% disagree that speed management measures are consistently enforced (Table 2). These findings align with Umar et al. (2021) and Ibrahim and Mohammed (2020), who identified enforcement inconsistencies and corruption as major barriers to effective traffic law implementation. The technological limitations documented by Olayemi et al. (2021), particularly the lack of automated traffic violation detection systems, further explain these enforcement gaps. This inconsistent application likely explains why overall crash reduction has not been accompanied by proportional improvements in injury outcomes, as poorly enforced speed limits may allow crashes to occur at higher speeds, resulting in more severe injuries despite fewer total incidents.

Similarly, the divided opinions on impaired driving laws (Table 3), with 41.8% viewing them as ineffective compared to 39.0% who see them as effective, underscore broader enforcement challenges. The uneven distribution of infrastructure improvements (Table 4), where only 37.2% of respondents reported recent improvements in their areas, suggests significant regional disparities. This finding supports Abdu et al. (2019) regarding the urban-rural divide in infrastructure investments, where improvements concentrate in major cities while rural communities rely on dangerous road networks. The maintenance challenges highlighted by Umahi (2023), who documented how infrastructure improvements deteriorate rapidly due to inadequate funding continuity, may further explain this disparity. This uneven development may explain why

crash numbers declined while injury severity increased—crashes may be shifting to areas with poorer road conditions, resulting in more severe outcomes.

The modest positive perceptions regarding overall intervention effectiveness (Table 5), where 42.0% agree that interventions have reduced crashes locally, suggests some success. However, the substantial portion disagreeing (36.5%) indicates that benefits are not uniformly distributed, likely reflecting the implementation challenges documented throughout the study.

The temporal patterns in the time series analysis provide additional insights. The significant crash reduction between 2002 and 2008 (Figure 1) coincides with early implementation of major road safety initiatives. However, subsequent fluctuations, particularly peaks around 2012 and 2020, suggest inconsistent intervention effectiveness over time, possibly reflecting periods when enforcement efforts relaxed or funding decreased.

The contrasting trend in fatalities (Figure 3), showing overall decline despite fluctuations, offers a more optimistic perspective. The reduction from approximately 7,000 deaths in the early 2000s to around 5,000 by 2020 suggests some interventions have successfully prevented the most severe outcomes. This may indicate that emergency response improvements, healthcare enhancements, or vehicle safety standards have contributed to reducing fatality rates even when crashes result in injuries.

The increasing injury trend despite declining crash numbers raises important questions about the changing nature of road traffic incidents. Several factors may contribute: crashes occurring at higher speeds due to improved road surfaces combined with inadequate speed enforcement; shifts toward more vulnerable vehicle types like commercial motorcycles; concentration of traffic in

urban areas creating more complex crash scenarios; or inadequate post-crash emergency response systems that fail to minimize injury severity.

These findings highlight the importance of addressing systemic issues that undermine intervention effectiveness. The persistent data quality problems identified in the literature continue hampering evaluation efforts. Without reliable crash data, policymakers cannot make informed decisions about resource allocation, allowing ineffective measures to persist while promising approaches remain underutilized.

The mixed effectiveness of public education campaigns suggests that awareness-raising alone is insufficient. As Ekanem (2023) noted, traditional campaigns fail to engage effectively with younger demographics and lack sustained reinforcement mechanisms, meaning behavioral changes quickly dissipate without consistent enforcement or supporting infrastructure improvements. The broader evaluation challenges identified by Obi et al. (2022), who highlighted limited empirical evidence of campaign effectiveness, further support this finding. Additionally, the international collaboration limitations discussed by Torbaghan et al. (2021), particularly the concentration of benefits within specific agencies rather than broader impact, may explain why awareness efforts have not translated into systematic behavioral changes across the population.

The study's findings have important implications for future road safety interventions. A more integrated, systems-based approach is needed—one addressing not only individual intervention components but also underlying implementation barriers. This should include strengthening enforcement mechanisms through improved training, better technology deployment, and corruption reduction; ensuring equitable distribution of infrastructure improvements; developing

sophisticated emergency response systems; and creating robust monitoring systems for evidence-based policymaking.

The findings underscore the importance of addressing socioeconomic factors contributing to road safety challenges. The proliferation of poorly maintained vehicles and untrained drivers, driven by poverty and unemployment, represents a fundamental challenge requiring comprehensive interventions beyond enforcement and infrastructure measures.

Moving forward, Nigeria's road safety strategy should focus on achieving consistent implementation of existing interventions rather than introducing new measures. The evidence indicates that many current interventions have effectiveness potential but are undermined by implementation challenges. Addressing these barriers through institutional reforms, capacity building, and improved coordination may be more important than developing new approaches.

The study's mixed-methods approach has proven valuable in revealing complex relationships between intervention implementation and outcomes. Integrating quantitative trends with qualitative stakeholder perceptions provides more nuanced understanding than either approach alone, suggesting future evaluations should adopt similar integrated approaches capturing both statistical patterns and contextual factors influencing intervention success.

6.0 Conclusion

This study evaluated the effectiveness of road safety interventions in reducing traffic crash severity in Nigeria over a 20-year period (2002-2022). The findings reveal a paradoxical outcome: while the total number of road traffic crashes has declined significantly, the number of injuries sustained during crashes has increased, indicating that interventions have been more successful in reducing crash frequency than in mitigating crash severity.

The mixed-methods analysis demonstrates that key interventions such as speed management and impaired driving prevention face significant implementation challenges. Stakeholder perceptions reveal inconsistent enforcement of traffic laws, uneven distribution of infrastructure improvements, and limited effectiveness of public education campaigns. These implementation gaps explain why crash severity outcomes have not improved proportionally with crash frequency reductions.

The study recommends strengthening enforcement mechanisms through automated technologies, ensuring equitable distribution of infrastructure improvements across urban and rural areas, enhancing emergency response systems to reduce injury severity, and establishing comprehensive crash data systems for evidence-based policymaking. Additionally, addressing underlying socioeconomic factors that contribute to road safety challenges through integrated approaches is essential.

While Nigeria has made progress in reducing road traffic crashes, urgent action is needed to address injury severity and improve intervention implementation consistency. The findings contribute valuable insights for achieving Nigeria's commitment to the UN Decade of Action for Road Safety 2021-2030 and advancing global road safety objectives under the Sustainable Development Goals framework.

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