ORIGINAL RESEARCH

TRAUMA-RELATED MORTALITY IN A RESOURCE-LIMITED SETTING: A 12-MONTH PROSPECTIVE ANALYSIS OF EPIDEMIOLOGY, OUTCOMES, AND SYSTEMIC CHALLENGES AT A NIGERIAN TERTIARY HOSPITAL

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Abstract

Introduction: Trauma-related mortality remains a critical public health challenge in low-resource settings. This study aimed to determine the incidence, predictors, and systemic challenges of trauma-related mortality at a Nigerian tertiary hospital over 12 months.

Methods: A prospective observational study was conducted at Alex Ekwueme Federal University Teaching Hospital (January–December 2022). All trauma patients aged ≥12 years admitted to the Accident & Emergency unit were included. Data on demographics, injury mechanisms, clinical parameters (Glasgow Coma Scale [GCS], Revised Trauma Score [RTS]), interventions, and outcomes were analyzed.

Results: Among 3,290 trauma admissions, 118 fatalities occurred (3.6% mortality rate). Most victims were males (84.0%) aged 16–39 years (55.1%). Road traffic accidents (RTAs) caused 67.7% of deaths, predominantly motorcycle collisions (58.8%). Severe head/neck injuries (67.7%) and delayed hospital arrival (median: 3.2 hours) were common. The RTS strongly predicted mortality: 68.6% of fatalities scored ≤4 (severe) versus survivors' mean RTS of 6.4 (p<0.001). Multivariate analysis identified RTS ≤4 (aOR=5.1), head injuries (aOR=3.8), and prehospital delays >3 hours (aOR=2.4) as independent mortality predictors. Critical care limitations included absent CT scans, ventilators, and neurosurgical capacity. Most deaths (75.4%) occurred within 24 hours, linked to hypotension (41.5%) and tachypnea (57.6%). Basic interventions (analgesics: 96.1%, IV fluids: 93.4%) were common, but advanced care (e.g., craniotomies) was unavailable.

Conclusion: Preventable trauma deaths in Nigeria reflect systemic gaps in prehospital care, emergency infrastructure, and workforce shortages. Policy reforms should prioritize motorcycle safety laws, trauma registries, and context-specific interventions like community first-responder training. Aligning with WHO's Decade of Road Safety, these findings advocate for multisectoral collaboration to strengthen trauma systems in low-resource settings.

Keywords: Trauma-related mortality, Low-resource setting, Revised Trauma Score, Road traffic accidents, Nigeria.

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INTRODUCTION

Trauma remains a leading cause of preventable mortality worldwide, accounting for over 4.4 million deaths annually, with 90% occurring in low- and middle-income countries (LMICs).[1] In sub-Saharan Africa, this burden is exacerbated by rapid urbanization, inadequate road safety policies, and fragile healthcare systems.[2] Nigeria, Africa's most populous nation, exemplifies this crisis, with road traffic accidents (RTAs) alone claiming over 41,000 lives yearly—a fatality rate three times the global average.[3] Despite this, trauma care infrastructure in Nigeria remains critically underdeveloped, characterized by delayed prehospital response, limited diagnostic imaging capabilities, and fragmented referral systems.[4] The World Health Organization (WHO) estimates that up to 60% of trauma deaths in LMICs could be averted through improved prehospital care, timely interventions, and strengthened health systems.[5]

In high-income countries (HICs), advancements such as integrated trauma registries, tiered emergency medical services (EMS), and advanced resuscitative protocols have reduced trauma mortality by over 50% in the past three decades.[6] Conversely, Nigerian hospitals grapple with systemic challenges, including reliance on non-specialized transport (e.g., motorcycles and tricycles), shortages of blood products, and a scarcity of trauma-trained specialists.[7] Head injuries dominate mortality statistics in these settings due to limited neurosurgical capacity and reliance on basic imaging modalities like X-rays rather than computed tomography (CT) scans.[8]

Existing studies on trauma outcomes in Nigeria have primarily focused on epidemiological patterns, with few prospectively analyzing mortality predictors or evaluating triage tools like the Revised Trauma Score (RTS) in resource-constrained environments.[9] The Alex Ekwueme Federal University Teaching Hospital (AE-FUTHA) in Abakaliki, a tertiary referral center serving southeastern Nigeria, provides a critical vantage point to examine these issues. The region's trauma burden is compounded by high rates of commercial motorcycle use, intercommunal conflicts, and limited access to specialized care.[10]

This study addresses gaps in context-specific evidence by prospectively analyzing trauma-related mortality at AE-FUTHA, with three objectives: (1) characterize the epidemiology and clinical outcomes of trauma fatalities, (2) identify modifiable risk factors and systemic care gaps, and (3) evaluate the prognostic utility of RTS in guiding triage and resource allocation. By focusing on preventable deaths, this work aligns with the WHO's Decade of Action for Road Safety 2021–2030 and underscores the urgency of tailored interventions to mitigate trauma's socioeconomic toll in LMICs.[11]

MATERIALS AND METHODS

Research Design

A 12-month prospective observational study was conducted to analyze trauma-related mortality epidemiology, outcomes, and systemic challenges.

Study Area

The study was conducted at Alex Ekwueme Federal University Teaching Hospital (AE-FUTHA), a tertiary referral center in Abakaliki, Southeast Nigeria.

Study Setting

- Healthcare Context: AE-FUTHA's Accident & Emergency (A&E) unit operates in a resource-limited setting with no on-site CT scanner, intermittent blood bank shortages, and limited ventilator capacity.
- Timeframe: Data were collected from January 1 to December 31, 2022.

Study Population/Participants

- Inclusion Criteria: Trauma patients aged ≥12 years arriving alive at the A&E unit who subsequently died during admission. Trauma patients aged ≥12 years arriving alive at the A&E unit (which manages adolescent and adult trauma). Adolescents are triaged to this unit per institutional protocols due to resource constraints, as the pediatric emergency unit focuses on non-traumatic emergencies in younger children
- Exclusion Criteria: Dead-on-arrival (DOA) cases, isolated burns/poisoning, or incomplete medical records.

Sample Size Determination

All eligible trauma-related fatalities during the study period were included (total: 118 deaths from 3,290 admissions).

Sampling Method

Consecutive sampling of all trauma deaths meeting inclusion criteria.

Study Instrument

Data Collection Tool: A pretested, structured proforma captured:

- Demographics (age, sex, occupation).
- Injury context (mechanism, prehospital time, transport mode).
- Clinical parameters (GCS, RTS, injury patterns).
- Interventions and outcomes.
- Data Sources: A&E admission logs, nursing/physician charts, and ward registers.

Study Variables

- Primary Outcome: Trauma-related mortality.
- Independent Variables: Age, injury mechanism, prehospital time, RTS, transport mode, and clinical interventions.

Bias

- Measurement Bias Mitigation: Two trained research assistants cross-verified data entries.
- Selection Bias: Addressed via consecutive sampling and strict adherence to inclusion criteria.

Data Analysis

- Software: SPSS v26.0.
- Statistical Tests: Descriptive statistics, Chi-square tests, logistic regression, and Kaplan-Meier survival analysis (significance: $p < 0.05$).

Validity/Reliability of Instrument

- Pretesting: The proforma was piloted on 20 non-study trauma cases to ensure clarity.
- Training: Research assistants underwent standardization workshops.
- Quality Control: A senior surgeon audited 20% of records for accuracy.

Ethical Considerations

Approval was obtained from AE-FUTHA's Ethics Committee (Approval Number: AEFUTHA/NHREC/16/05/22/384. Patient identifiers were anonymized

RESULTS

Table 1: Demographic and Injury Characteristics of Trauma Fatalities (n=118)

Variable	Category	Frequency	Percentage (%)
Sex	Male	99	84.0
	Female	19	16.0
Age Group	16–39 years	65	55.1
	40–59 years	32	27.1
	≥60 years	21	17.8
Mechanism of Injury	Road Traffic Accident	80	67.7
	Assault	16	13.6
	Fall	11	9.3
Transport Mode	Tricycle	45	37.8
	Private Vehicle	58	49.3
	Ambulance	3	2.5

Table 1 highlights the predominance of young males and motorcycle-related RTAs in trauma deaths, with informal transport (tricycles/private vehicles) used by 87.1% of patients.

Clinical Outcomes

Severe head/neck injuries (67.7%) and critical physiological derangements (hypotension: 41.5%; tachypnea: 57.6%)

were common. The Revised Trauma Score (RTS) strongly predicted mortality, with 68.6% of fatalities scoring ≤4.

Table 2: Clinical Parameters and Outcomes

Parameter	Category	Frequency	Percentage (%)
Glasgow Coma Scale (GCS)	≤8 (Severe)	75	63.6
	9–12 (Moderate)	28	23.7
	≥13 (Mild)	15	12.7
Revised Trauma Score	≤4 (Severe)	81	68.6
	4.1–5.9 (Moderate)	29	24.6
	≥6 (Mild)	8	6.8
Time to Death	<24 hours	89	75.4
	24–72 hours	23	19.5

Table 2 *underscores the high frequency of severe neurological compromise (GCS ≤8 in 63.6% of deaths) and rapid mortality, with 75.4% dying within 24 hours of admission.*

Predictors of Mortality

Multivariate analysis identified RTS ≤4, head injuries, and prehospital delays >3 hours as independent predictors of mortality.

Table 3: Multivariate Analysis of Mortality Predictors

Variable	Adjusted Odds Ratio (aOR)	95% CI	p-value
RTS ≤4	5.1	2.1–8.3	<0.001
Head/Neck Injury	3.8	1.9–7.6	0.002
Prehospital Time >3 hours	2.4	1.3–4.5	0.01

Table 3 demonstrates that patients with severe trauma (RTS ≤4) faced 5.1-fold higher odds of death, emphasizing the prognostic utility of RTS in low-resource triage.

Survivors vs. Fatalities

Fatalities were more likely to be male (84.0% vs. 70.6%, $p<0.001$) and present with severe GCS ≤8 (63.6% vs. 19.5%, $p<0.001$).

Table 4: Comparison of Survivors and Fatalities

Characteristic	Survivors (n=3,172)	Fatalities (n=118)	p-value
Male Sex	2,240 (70.6%)	99 (84.0%)	<0.001
RTA Mechanism	1,872 (59.0%)	80 (67.7%)	<0.001
GCS ≤8 on Admission	620 (19.5%)	75 (63.6%)	<0.001

Table 4 highlights significant disparities in sex distribution and injury severity between survivors and fatalities.

DISCUSSION

Trauma-related mortality in southeastern Nigeria presents a critical public health challenge characterized by preventable deaths among young adults, systemic care gaps, and infrastructural deficits.[14] This study, conducted at a tertiary hospital in Abakaliki, highlights the disproportionate burden of road traffic accidents (RTAs) and head injuries, which together account for over 70% of fatalities.[15] This alarming statistic underscores the urgent need for comprehensive interventions targeting both prevention and improved trauma care. The predominance of males (84%) and individuals aged 16–39 years (55%) mirrors trends across sub-Saharan Africa, where high-risk occupations like commercial motorcycling and informal mining expose young men to injury-prone environments.[16–17] This demographic pattern underscores the socioeconomic ripple effects of trauma, as these individuals often serve as primary breadwinners, leaving families vulnerable to poverty and hardship upon their death.[18] The loss of young, productive members of society further hinders economic development

and perpetuates cycles of poverty within affected communities.

The disproportionate mortality of young males—who constituted 55.1% of fatalities in our cohort and often serve as primary income earners—creates a devastating socioeconomic ripple effect, entrenching cycles of poverty. Their deaths deprive households of financial stability, forcing families to withdraw children from school, sell productive assets (e.g., livestock), or incur catastrophic debts. In southeastern Nigeria's agrarian communities, such as those served by AE-FUTHA, losing a breadwinner frequently precipitates food insecurity and reduced agricultural output, compounded by systemic barriers to widows' economic autonomy. Orphaned children face heightened risks of disrupted education and exploitation, perpetuating intergenerational deprivation. These dynamics, observed across LMICs, underscore trauma prevention as both a public health and economic priority. Our findings reinforce the need for policies that protect high-risk groups (e.g., commercial motorcyclists) while expanding social safety nets to disrupt this cycle. These socioeconomic consequences amplify the urgency of addressing the clinical and infrastructural gaps identified in this study, such as delayed hospital arrival and limited neurosurgical capacity

RTAs emerged as the leading cause of mortality (67.7%), a finding consistent with national data[19] but exceeding rates reported in urban Nigerian centers like Lagos (52%).[20] This discrepancy may be attributed to several factors, including differences in road infrastructure, traffic enforcement, and the prevalence of motorcycle use. Motorcycle collisions dominated the RTA category in this study, reflecting Abakaliki's reliance on poorly regulated commercial motorcycles ("okada") for intracity transport. The affordability and accessibility of motorcycles make them a popular mode of transportation, but the lack of stringent safety regulations and enforcement, including helmet laws and speed limits, contributes significantly to the high fatality rate associated with their use. Unlike HICs, where vehicle safety standards, robust traffic laws, and public awareness campaigns have drastically reduced RTA mortality, Nigeria's lax enforcement and limited public awareness campaigns perpetuate high fatality rates.[21] For instance, Germany's introduction of mandatory speed governors and seatbelt laws reduced road deaths by 68% between 1991 and 2011, demonstrating the potential impact of policy reforms and stricter enforcement.[22] Adopting similar strategies, tailored to the Nigerian context, could significantly reduce RTA-related deaths.

Head and neck injuries were responsible for 67.7% of deaths in this study, a rate double that of HICs, where advanced neurotrauma care plays a crucial role in mitigating mortality.[23] This disparity highlights the critical need for improved neurotrauma care in resource-limited settings. The absence of on-site CT scanners and dedicated neurosurgical services at the study hospital forced clinicians to rely on clinical exams and X-rays—tools insufficient for detecting evolving intracranial hemorrhages or diffuse axonal injuries, which often require prompt surgical intervention.[24] This diagnostic gap underscores the challenges faced by LMICs, where 93% of the global neurosurgical gap exists, leaving millions without access to life-saving interventions.[25] Investing in diagnostic equipment and training specialized personnel are crucial steps towards improving outcomes for patients with head injuries. The Revised Trauma Score (RTS) demonstrated utility in risk stratification, with scores ≤4 predicting fivefold higher mortality odds.[26] This finding supports the use of RTS as a valuable triage tool in resource-constrained settings. However, RTS's reliance on GCS may underestimate the severity of injury in head-injured patients without neuroimaging, as alterations in consciousness may not fully reflect the extent of underlying brain damage.[27] This limitation suggests the need for context-specific triage protocols that integrate mechanism of injury, clinical findings, and available resources to improve prognostic accuracy and guide treatment decisions.

For instance, integrating RTS with injury mechanisms (e.g., motorcycle collisions) and physiological parameters (e.g., pupillary reactivity) could enhance risk stratification, as demonstrated in a Kenyan study where combined triage tools reduced undertriage rates by 22%.[32] Similarly, Malawi's adaptation of the South African Triage Scale—modified to account for limited imaging and surgical capacity—improved mortality prediction by 18%.[33] Such context-driven models are critical in LMICs, where over-reliance on HIC-derived scores may misalign with local diagnostic realities. By prioritizing actionable variables

(e.g., respiratory rate, systolic blood pressure) and leveraging machine learning algorithms tailored to sparse datasets, hospitals like AE-FUTHA could optimize resource allocation for high-risk patients. Prehospital delays further exacerbated outcomes, with a median injury-to-hospital interval of 3.2 hours—far exceeding the "golden hour" window for critical interventions.[28] This delay represents a significant barrier to effective trauma care, as timely access to definitive treatment is crucial for improving survival rates. Only 2.9% of patients arrived via ambulance, while 37.8% used tricycles and 49.3% private vehicles, often without basic stabilization measures or trained personnel.[29] This reliance on informal transport systems highlights the inadequacy of existing emergency medical services in the region. These informal transport options often lack the necessary equipment, trained personnel, and communication systems to provide optimal prehospital care, potentially exacerbating injuries and delaying definitive treatment. This contrasts sharply with South Africa's integrated EMS networks, which achieve 62% ambulance utilization and median prehospital times of 45 minutes.[30] Developing a robust and integrated EMS system, including a centralized dispatch system, trained paramedics, and a fleet of well-equipped ambulances, is essential for reducing prehospital delays and improving trauma outcomes. Delays in hemorrhage control and airway management, often consequences of inadequate prehospital care, likely contributed to the high in-hospital mortality rate (75%) within 24 hours of admission, paralleling findings from Tanzania and Kenya, where preventable deaths from treatable complications remain pervasive.[31]

In our cohort, 41.5% of fatalities presented with hypotension (systolic BP <90 mmHg), a condition reversible with timely fluid resuscitation and blood transfusions—interventions often delayed due to erratic blood bank supplies. Similarly, 57.6% exhibited tachypnea (>30 breaths/min), indicative of correctable causes like tension pneumothorax or airway obstruction, yet tube thoracostomy supplies were frequently unavailable. A 2023 Ghanaian study identified analogous gaps, with 63% of trauma deaths attributable to untreated hemorrhagic shock and sepsis, compounded by antibiotic shortages.[34] These findings underscore the lethal synergy between resource constraints and clinical acuity: even basic interventions (e.g., chest decompression) become unfeasible without sustained investments in infrastructure and supply chains.

The high mortality rate observed in this study underscores the urgent need for a multi-faceted approach to improve trauma care in southeastern Nigeria. This approach should encompass strengthening prehospital care through the development of integrated EMS networks, improving hospital infrastructure and resources, including access to CT scanning and neurosurgical services, implementing and enforcing road safety regulations, and investing in training and education for healthcare professionals and the public. Addressing the social determinants of health, such as poverty and access to transportation, is also crucial for reducing the burden of trauma in the region. Furthermore, community-based injury prevention programs, targeting high-risk groups like commercial motorcyclists, can play a significant role in reducing the incidence of trauma. By implementing these comprehensive strategies, Nigeria can move towards a more effective and equitable trauma system that prioritizes the health and well-being of its citizens. Continued research and data collection are essential for monitoring progress, identifying ongoing challenges, and refining interventions to maximize their impact. Collaboration between government agencies, healthcare providers, researchers, and community organizations is crucial for achieving sustainable improvements in trauma care and reducing preventable deaths.

Study Limitations

This study has several limitations. First, missing prehospital data, such as exact injury times and initial interventions, hindered precise quantification of care delays. Second, the single-center design may limit generalizability to hospitals with dedicated pediatric trauma units and to rural clinics with fewer resources. Third, the absence of autopsies prevented definitive cause-of-death attribution, particularly for polytrauma cases. Fourth, one fatality (0.8%) had undocumented injury patterns, likely representing polytrauma not fully captured by primary clinical assessments. Finally, the lack of CT scans precluded detailed injury severity scoring, potentially underestimating the neurosurgical burden.

CONCLUSION

Trauma mortality in Abakaliki is a preventable crisis rooted in systemic inequities rather than clinical inevitability. The high prevalence of RTAs and head injuries among young males underscores the urgent need for multisectoral reforms. By integrating prehospital innovations, hospital-level investments, and legislative action, Nigeria can transform its trauma care landscape, aligning with global mandates to halve road traffic deaths by 2030. Prioritizing trauma system development is not only a public health imperative but a moral obligation to safeguard vulnerable populations.

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