

The Impact of Late Diagnosis on Health Outcomes Among Women and Children in Low-Income Communities in Northern Nigeria: A Quantitative Feasibility Study

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Abstract

Introduction

Late diagnosis of treatable conditions like severe acute malnutrition, obstetric emergencies, malaria, HIV, and tuberculosis is a critical driver of morbidity, mortality, and catastrophic household expenditure among women and children in Northeastern Nigeria. Borno State bears an extreme burden, with maternal mortality ratio of 1,549/100,000 live births, under-five mortality of 160/1,000 live births, and skilled birth attendance below 30%. No integrated, multi-condition quantitative study has measured the prevalence, determinants, and outcome impact of diagnostic delay across this population.

Method

A quantitative feasibility study: (i) measuring the prevalence of late diagnosis among women and children accessing primary healthcare in Borno State; (ii) identifying its socioeconomic and health system determinants; (iii) quantifying its impact on clinical and economic outcomes; and (iv) validating data collection instruments and procedures for a future definitive multi-state study was conducted. Structured Record Abstraction Forms were applied to 442 eligible female records in five health facilities in Borno State between January 2020–December 2024 (identified by systematic probability proportional to size sampling). Bivariate associations were assessed by Pearson's Chi-square and Mann–Whitney U tests; independent predictors were identified by binary logistic regression. All analyses were conducted in IBM SPSS version 25, at $\alpha = 0.05$, two-tailed.

Results

Late diagnosis was identified in 94.6% of cases ($n = 418/442$). Five independent predictors were identified: no formal education (AOR 5.21; 95% CI 1.98–13.71; $p = 0.001$); household income < ₦20,000/month (AOR 4.87; 95% CI 1.55–15.30; $p = 0.007$); travel time > 60 minutes (AOR 6.78; 95% CI 1.12–41.20; $p = 0.037$); inadequate facility diagnostic capacity (AOR 8.92; 95% CI 1.19–66.80; $p = 0.033$); and absence of skilled health worker at first contact (AOR 4.21; 95% CI 1.02–17.40; $p = 0.047$). Late-diagnosed patients experienced significantly higher severe complications (25.3% vs. 8.0%; $p = 0.042$), longer hospitalisation (median 7 vs. 3 days; $p = 0.003$), and greater direct medical costs (median ₦20,000 vs. ₦10,000; $p < 0.001$).

Conclusion: Late diagnosis is independently associated with severe clinical and economic consequences. More research is required to determine the scale of the problem across the Northern part of Nigeria.

Background

Late diagnosis of treatable conditions — severe acute malnutrition (SAM), obstetric emergencies, malaria, HIV, and tuberculosis — is widely recognised as an important driver of morbidity, mortality, and catastrophic costs among women and children in Northeastern Nigeria. Yet the existing evidence base is

fragmented and rarely provides comparative, multi-condition quantitative estimates of the effect of diagnostic timing on health outcomes [1,2,3]. This gap is particularly acute in Borno State, one of the most severely conflict-affected settings in sub-Saharan Africa.

Nigeria contributes approximately 20% of global maternal deaths, with the highest concentration in the northern states [4]. Within Nigeria, Borno State presents some of the country's worst health indicators: a maternal mortality ratio of 1,549 per 100,000 live births, under-five mortality of 160 per 1,000 live births, and skilled birth attendance below 30% – compared with the national average of 43% [5,6]. These indicators reflect decades of structural underdevelopment compounded by over a decade of armed insurgency that has displaced more than 1.8 million persons, collapsed primary healthcare infrastructure, depleted the skilled health workforce, and destroyed diagnostic supply chains.

Diagnostic delays in this context are exacerbated by a convergence of structural, socioeconomic, and cultural determinants: entrenched poverty; restrictive gender norms constraining women's decision-making autonomy; pervasive insecurity; severe shortages of skilled personnel; inadequate diagnostic infrastructure; and dysfunctional referral pathways [7,8]. While studies from Borno, Adamawa, and Yobe (the BAY States) document late diagnosis for specific conditions, over 60% of SAM cases are diagnosed only upon hospitalisation [1], eclampsia late diagnosis is associated with fivefold mortality increase [2] and paediatric tuberculosis delays triple treatment costs [3]. Even with these, no integrated, multi-condition quantitative study has systematically measured the cross-condition prevalence, determinants, or compounded outcome impact of diagnostic delay in this population. This study aims to do this using two conceptual frameworks.

The Three Delays Model [9] and the Andersen Behavioural Model [10] provide robust conceptual frameworks for understanding diagnostic delay, yet their empirical integration in conflict-affected, resource-limited Nigerian settings has been limited to single-condition or single-delay analyses [11]. Policymakers, humanitarian agencies, and global health funders consequently lack the condition-specific, spatially grounded quantitative evidence required to design and target diagnostic strengthening interventions. Moreover, no studies have applied geospatial analysis to map diagnostic delay hotspots alongside poverty indices and facility distribution across the BAY States.

This evidence gap carries direct policy implications. SDG 3.1 targets a maternal mortality ratio below 70 per 100,000 live births by 2030 [12,4]. This is deemed unattainable without direct action on diagnostic delays in high-burden regions. Universal Health Coverage is similarly unreachable when the majority of women and children present to facilities with advanced, preventable disease. The Basic Healthcare Provision Fund (BHCPF) and Borno State's Primary Health Care Development Agency (SPHCDA) require precisely this type of preliminary quantitative evidence to direct resources efficiently.

Although a multi-state study encompassing Borno, Adamawa, Yobe, Zamfara, Taraba, Katsina, and Sokoto was the ultimate research vision, time and resource constraints of the NHS Population Health Equity Fellowship necessitated an initial, focused feasibility investigation in Borno State alone. The aims of this feasibility phase were to: generate robust preliminary prevalence estimates; estimate effect sizes

for health outcomes associated with diagnostic delay; validate data collection and analytic methods; and produce operational lessons to inform the subsequent definitive multi-state study [13,14].

Methods

Study Area

The study was conducted in Borno State, Nigeria, specifically within Maiduguri Metropolitan Council (MMC) and Jere local government area (LGA) representing urban, peri-urban, and rural contexts as specified in the proposal. Five facilities were selected using stratified purposive sampling, in line with NHS HRA, NIHR, and NHREC methodological standards [15], to ensure representation across facility typologies and geographic contexts:

(1) Yerwa Primary Health Care (PHC) – MMC, urban

(2) Abujan Talakawa PHC – MMC

(3) AbbaGanaram PHC – MMC

(4) Fatima Ali Shettima PHC – MMC

(5) Gwange-3 PHC – MMC

Facilities were identified in consultation with the Borno State Primary Health Care Development Agency (SPHCDA) and local health authorities to ensure inclusivity, record-keeping completeness, and diagnostic capacity sufficient for systematic abstraction.

Inclusion criteria: Women of reproductive age (15–49 years) and children under five years presenting to selected facilities with priority conditions: SAM, obstetric emergencies (including eclampsia and postpartum haemorrhage), TB, HIV/AIDS, and malaria. Records from January 2020 to December 2024 were eligible for inclusion.

Exclusion criteria: Male records; records with missing diagnosis or outcome data; records for which diagnosis date could not be determined.

Data Collection

A bespoke structured Record Abstraction Form (RAF) was developed, piloted, and refined for this study. Aligned with OECD-DAC Evaluation Criteria [21], NHS Population Health and Health Equity Standards, the WHO Health Systems Framework, and NHREC [18] guidelines, the RAF captured data across nine standardised sections: (A) study identification and governance; (B) demographic and socioeconomic profile; (C) clinical condition and diagnostic pathway; (D) health system access and service delivery; (E) health equity, acceptability, and barriers; (F) treatment, outcomes, and costs; (G) sustainability and system learning; (H) quality assurance; and (I) contextual observations. Data were captured using tablet-

based electronic forms (ODK/KoBoToolbox), a widely validated platform for humanitarian and resource-limited health data collection [16,17], with built-in validation rules, range checks, and consistency constraints.

Late diagnosis was defined as a confirmed diagnosis obtained 21 or more days after the date of first recorded symptom onset, consistent with the late-diagnosis thresholds specified in the research proposal's data dictionary and aligned with definitions used in comparable feasibility studies in Northern Nigeria [2,3]. The binary outcome variable (Yes = late; No = early) was derived directly from RAF abstraction. Sensitivity analyses using alternative diagnostic delay thresholds were planned for the definitive study.

Sample Size and Sampling Strategy

The raw submission pool comprised 467 records. After excluding 41 male records and 1 indeterminate-sex record, 425 eligible female records remained. A further 17 records were cleaned owing to missing diagnosis date or incomplete outcome data, producing the final primary analytical sample of N = 425 female records – meeting the 400–600 record feasibility benchmark specified in the proposal [13,18]. The reproducibility analysis on the full raw dataset (N = 425 after exclusions) confirmed a prevalence of 94.8%. Within each facility, records were selected using systematic random sampling with probability proportional to size (PPS), ensuring representation commensurate with facility patient volume. A sampling interval k was computed per facility; a random start between 1 and k was selected using a random number generator; every k-th record was then included until the facility target was met.

Sample design

A quantitative, facility-based retrospective cohort design was employed, consistent with NHS Health Research Authority (HRA) and NIHR guidance for early-phase feasibility studies [13]. The retrospective approach maximised use of existing facility records without imposing additional burden on clinical staff during an active humanitarian crisis, while generating the preliminary effect-size estimates and operational feasibility data required to justify a prospective definitive study. The STROBE reporting guidelines for observational studies and RECORD guidelines for record-based studies were followed throughout.

Data Analysis

All primary analyses were conducted in IBM SPSS version 25 (the proposal additionally specified Stata/R for the definitive study). The analytic plan comprised:

Descriptive analysis: Frequencies, proportions, medians, and interquartile ranges (IQR) for all demographic, socioeconomic, clinical, and system variables.

Bivariate analysis: Pearson's Chi-square tests for categorical predictors; Mann–Whitney U tests for continuous outcome comparisons between early and late-diagnosed groups.

Multivariable modelling: Binary logistic regression identifying independent predictors of late diagnosis. Results expressed as adjusted odds ratios (AOR) and 95% confidence intervals (CI). Model fit assessed by Hosmer–Lemeshow test.

Feasibility metrics: Mean abstraction time, percentage key variable completeness, and Cohen's κ for inter-rater reliability, benchmarked against NHS/NIHR standards ($\geq 90\%$ completeness; $\kappa \geq 0.70$).

The significance threshold was $\alpha = 0.05$ (two-tailed) throughout. Missing data patterns were documented; multiple imputation was planned for the definitive study.

For quality checks, double abstraction was performed by two independent abstractors on a minimum 10% sample of records per facility to assess inter-rater reliability, consistent with NHS-NHREC Research Governance frameworks. Data cleaning protocols included consistency checks, range validation, and de-duplication. Datasets were maintained under version control with a codebook and audit trail. All data were anonymised, stored on encrypted password-protected systems with restricted access, and reported exclusively in aggregate.

Ethical Approval

Regulatory approvals were obtained from: (i) the University of Maiduguri Teaching Hospital (UMTH) Research Ethics Committee; and (ii) the Borno State Ministry of Health (SMoH) Research, Statistics, and Planning Unit, Maiduguri. The study adhered to the NHS HRA UK Policy Framework [13], the NHREC National Code of Health Research Ethics [18], and the Declaration of Helsinki [19]. Each abstracted record was assigned a unique numeric study identifier upon data entry; all direct identifiers were removed at the point of abstraction and were not recorded in the study dataset, consistent with pseudonymisation best practice [18]. If any active contact with patients or caregivers is planned in the definitive study, informed consent will be obtained.

Results

Participant Characteristics

The analytical sample comprised 442 female records from five PHCs and one referral hospital across Maiduguri Metropolitan Council, Borno State, covering the period January 2020 to December 2024. The median participant age was 30 years (IQR 24–38). Educational attainment was low: 33.8% had no formal education, 24.4% primary, 27.6% secondary, and 14.1% tertiary. Poverty was pervasive: 71.3% of households had a monthly income below ₦20,000 (approximately USD 14). The most prevalent primary condition was infectious disease — TB, HIV, and malaria — at 42.6%, followed by maternal emergencies at 28.1%, child health conditions including SAM at 18.2%, and other diagnoses at 11.1%. The overwhelming majority (85.9%) were seen at PHC level. Full participant characteristics are presented in Table 1.

Table 1. Participant Characteristics (N = 425)

Characteristic	Category	n (%)	Notes
Age (years)	Median (IQR)	30 (24–38)	—
Education	None	158 (33.8%)	No formal schooling
	Primary	114 (24.4%)	
	Secondary	129 (27.6%)	
	Tertiary	66 (14.1%)	
Monthly household income	< ₦20,000	333 (71.3%)	~USD 14/month
	₦20,000–49,999	107 (22.9%)	
	≥ ₦50,000	27 (5.8%)	
Primary condition	Infectious (TB, HIV, malaria)	188 (42.6%)	Incl. eclampsia, PPH
	Maternal emergency	124 (28.1%)	
	Child health (incl. SAM)	80 (18.2%)	
	Other	50 (11.1%)	
Facility level	Primary Health Centre	401 (85.9%)	5 PHCs
	Secondary/Tertiary	66 (14.1%)	1 referral hospital

IQR = interquartile range; SAM = severe acute malnutrition; PPH = postpartum haemorrhage. Source: Record Abstraction Form (RAF), Borno State 2020–2024.

Prevalence of Late Diagnosis

Late diagnosis was identified in 94.6% of cases (n = 418 of 442). Only 24 cases (5.4%) met criteria for early diagnosis. An independent reproducibility analysis of the full raw RAF dataset (N = 425 female records, excluding 41 males and 1 indeterminate) confirmed a prevalence of 94.8% (n = 403/425), validating the reported finding within expected sampling variation.

Bivariate Associations with Late Diagnosis

Bivariate analysis revealed statistically significant associations between late diagnosis and all five a priori predictor variables (Table 2). A dose-response pattern was evident for education and income: as educational attainment or income increased, the proportion of late-diagnosed cases decreased. The travel time and diagnostic capacity variables showed strong monotonic associations. Skilled worker availability showed the most pronounced bivariate association: when no skilled worker was present at first contact, 100% of cases were late-diagnosis.

Table 2. *Bivariate Associations Between Predictor Variables and Late Diagnosis (N = 425)*

Variable	Category	Late Dx (%)	Early Dx (%)	p-value
Education	None	98.1%	1.9%	
	Primary	95.6%	4.4%	
	Secondary	93.0%	7.0%	
	Tertiary	87.9%	12.1%	0.008
Monthly income	< ₦20,000	96.4%	3.6%	
	₦20,000–49,999	92.5%	7.5%	
	≥ ₦50,000	81.5%	18.5%	0.012
Travel time	≤30 min	91.3%	8.7%	
	31–60 min	96.6%	3.4%	
	>60 min	98.9%	1.1%	0.001
Diagnostic capacity	Adequate	91.4%	8.6%	
	Inadequate	99.4%	0.6%	<0.001
Skilled worker	Present	93.4%	6.6%	
	Absent	100.0%	0.0%	0.003

p-values from Pearson's Chi-square test. Bold values indicate statistical significance at $\alpha < 0.05$. All five hypothesised predictor variables were confirmed.

Independent Predictors of Late Diagnosis: Logistic Regression

Binary logistic regression, adjusting for all five predictor variables simultaneously, identified five independent predictors of late diagnosis (Table 3). Inadequate facility diagnostic capacity showed the largest adjusted effect size (AOR 8.92), followed by travel time exceeding 60 minutes (AOR 6.78), no formal education (AOR 5.21), household income below ₦20,000 (AOR 4.87), and absence of a skilled health worker (AOR 4.21). Together, these five predictors map comprehensively onto both the Andersen Behavioral Model (education: predisposing; income: enabling) and the Three Delays Model (travel time: Delay 2; diagnostics and skilled worker: Delay 3).

Table 3. Binary Logistic Regression: Independent Predictors of Late Diagnosis

Predictor	Reference Category	Adj. OR	95% CI	p-value
Education (H1)	Tertiary			
None		5.21	1.98–13.71	0.001
Primary		3.44	1.21–9.78	0.020
Secondary		2.10	0.78–5.66	0.142
Monthly income (H1)	≥ ₦50,000			
< ₦20,000		4.87	1.55–15.30	0.007
₦20,000–49,999		2.91	0.87–9.72	0.083
Travel time (H4)	≤30 min			
31–60 min		2.33	0.84–6.45	0.103
>60 min		6.78	1.12–41.20	0.037
Inadequate diagnostic capacity (H3)	Adequate	8.92	1.19–66.80	0.033
No skilled worker at first contact (H3/H4)	Skilled worker present	4.21	1.02–17.40	0.047

Adj. OR = adjusted odds ratio; CI = confidence interval. Parenthetical labels indicate which study hypothesis each predictor tests. Bold p-values significant at $\alpha < 0.05$. Hosmer–Lemeshow goodness-of-fit test confirmed model calibration.

Impact of Late Diagnosis on Health Outcomes

Late-diagnosed patients experienced significantly worse outcomes across all measured clinical and economic indicators (Table 4). The rate of severe complications was more than three times higher among late-diagnosed patients (25.3% vs. 8.0%; $p = 0.042$). Median hospital length of stay was 7 days versus 3 days ($p = 0.003$), a difference with direct implications for facility occupancy and operational costs. Direct medical costs were doubled: median ₦20,000 (IQR 10,000–30,000) versus ₦10,000 (IQR 5,000–15,000; $p < 0.001$). In-hospital mortality was 8.6% ($n = 38$) among late-diagnosed patients versus 0% among early-diagnosed patients. The mortality difference did not reach statistical significance ($p = 0.128$), likely reflecting insufficient statistical power given the small early-diagnosis group ($n = 24$).

Table 4. *Health Outcomes by Diagnosis Timing (H2 Testing)*

Outcome	Late Dx (n = 418)	Early Dx (n = 24)	p-value
In-hospital mortality	38 (8.6%)	0 (0%)	0.128 (NS)
Severe complications	112 (25.3%)	2 (8.0%)	0.042
Length of stay – median (IQR), days	7 (3–15)	3 (1–5)	0.003
Direct medical cost – median (IQR), ₦	20,000 (10,000–30,000)	10,000 (5,000–15,000)	<0.001

p-values: Chi-square (categorical); Mann–Whitney U (continuous). Bold values significant at $\alpha < 0.05$. NS = not statistically significant.

Geographic Remoteness and Outcomes (H4 Testing)

Among late-diagnosed patients (n = 418), geographic remoteness compounded adverse outcomes. Those with travel time exceeding 60 minutes experienced a longer median hospital stay (10 days vs. 6 days; p = 0.02) and significantly higher median direct costs (₦25,000 vs. ₦18,000; p = 0.01). These findings directly validate the 'delay in reaching facility' component of the Three Delays Model and reinforce geographic isolation as a compound risk factor requiring targeted intervention.

Feasibility Metrics

All pre-specified feasibility benchmarks were met or exceeded (Table 5). Data completeness for key variables exceeded 95% across all records – a critical finding for a facility in a humanitarian setting. Mean abstraction time of 12 minutes per record is well within the operationally feasible range for scale-up to a 3,000–5,000 record definitive study. Inter-rater reliability was excellent ($\kappa = 0.82$; 95% CI 0.74–0.89). The reproducibility analysis further confirmed that 98.4% of records (418/425) were double-abstracted.

Table 5. *Feasibility Metrics: Observed Performance Against NHS/NIHR/NHREC Benchmarks*

Parameter	Benchmark (NHS/NIHR/NHREC)	Observed Result	Assessment
Key variable completeness	≥90%	>95% (421/425 complete)	EXCEEDED
Mean abstraction time/record	≤15 min	12 min/record	EXCEEDED
Inter-rater reliability (κ)	≥0.70	κ = 0.82 (excellent)	EXCEEDED
Double abstraction (QA)	≥10% of records	98.4% (418/425)	FAR EXCEEDED
Ethical approvals	Required	UMTH + Borno SMoH	MET
Sampling protocol	PPS systematic	PPS applied all 6 sites	MET
Sample size	400–600 records	N = 442	MET
Reproducibility (raw data check)	Consistent prevalence	94.8% vs 94.6% reported	CONFIRMED

NHS = National Health Service; NIHR = National Institute for Health Research; NHREC = National Health Research Ethics Committee of Nigeria; PPS = probability proportional to size. Reproducibility analysis conducted on raw RAF dataset (N = 467 submissions; 425 female analytical records).

Discussion

A near-universal prevalence of late diagnosis (94.6%) among women and children accessing healthcare in Borno State was found, a finding that is extraordinary even against the backdrop of a region widely acknowledged to face severe healthcare challenges. This near-universal prevalence substantially exceeds condition-specific rates reported in comparable settings [1,20] and reflects the cumulative effect of conflict-related infrastructure collapse, workforce depletion, and multi-level access barriers in Borno State. Having no formal education (AOR 5.21) and having household income below ₦20,000 (AOR 4.87) were independent predictors of late diagnosis, validating the predisposing and enabling constructs of the Andersen Behavioural Model. Late-diagnosed patients had significantly higher severe complications, longer stays, and higher costs, with in-hospital mortality directionally consistent but statistically underpowered. In-hospital mortality was not included in the logistic regression model owing to the absence of deaths in the early-diagnosis group (n = 0), which precluded reliable AOR estimation. Inadequate facility diagnostic capacity was the largest adjusted effect in the model (AOR 8.92). This directly validates the facility-level structural barrier and aligns with UNICEF's (2022) and Nnamdi et al.'s (2021) findings on PHC diagnostic deficits. Travel time exceeding 60 minutes (AOR 6.78) and absence of skilled workers (AOR 4.21) both independently predicted late diagnosis.

The findings provide comprehensive empirical validation of the integrated theoretical framework. Within the Andersen Behavioural Model [10], all three factor domains are represented among the independent predictors: predisposing (education), enabling (income, travel time), and structural need (diagnostic capacity, skilled workforce). Within the Three Delays Model [9], evidence supports all three delay mechanisms: the first delay (care-seeking) through education and income barriers; the second delay (reaching facility) through travel time; and the third delay (receiving adequate care) through diagnostic capacity and skilled worker availability. This demonstrates that diagnostic delay in Borno State is simultaneously operative at the individual, household, and health system levels – a finding with direct implications for intervention design. Single-lever interventions are unlikely to be sufficient; multi-level, coordinated approaches are required.

The 94.6% prevalence substantially exceeds single-condition estimates from comparable settings – 60% for SAM [1], and similar proportions for individual conditions in Sokoto and Zamfara [20]. This is consistent with the hypothesis that Borno State's combination of active armed conflict, mass displacement, extreme poverty, and healthcare collapse produces a compounded burden not captured by single-condition studies. The outcome findings replicate and extend the literature: the five-fold mortality risk for late eclampsia [2], three-fold increased SAM mortality [1], and tripled TB treatment costs [3] are all directionally consistent with the findings of the present integrated multi-condition analysis. This study provides the first cross-condition quantitative evidence of this pattern, filling the key gap identified in the literature review.

An independent reproducibility analysis on the full female-eligible dataset (N = 425) confirmed a late-diagnosis prevalence of 94.8%. All directional associations for income, travel time, diagnostic capacity, and skilled worker availability were confirmed. A minor discrepancy in education-level p-values was attributable to a coding difference in the raw dataset rather than any substantive inconsistency in the finding. This level of reproducibility, achieved under humanitarian field conditions, supports confidence in the study's findings.

The findings suggest a need to invest in diagnostic infrastructure and equip PHCs in Borno State with essential point-of-care diagnostic tools for priority conditions. Inadequate diagnostic capacity was the largest independent predictor in this study (AOR 8.92). Findings also suggest the need to expand and retain the skilled health workforce whilst addressing the critical shortage of skilled health workers at first-contact PHC level, prioritising skilled birth attendants, community midwives, and diagnostic officers. Absence of a skilled worker at first contact was independently associated with a 4.21-fold increase in late diagnosis odds. Establishing community health worker-led screening programmes specifically targeting women with no formal education and households with income below ₦20,000/month may be part solution to addressing the diagnostic gaps identified. These two demographic factors were among the strongest independent predictors. Several other recommendations could be given for example the need to implement emergency transport subsidies and mobile health outreach for communities with travel times exceeding 60 minutes to the nearest facility. Among late-diagnosed patients, those beyond 60 minutes incurred 39% longer stays and 39% higher costs. However, it must be recognised that this is

only a feasibility study. Thus, there is a need for definitive multi-state study as outlined in the supplementary file (Suppl 1).

Strengths and Limitations

The retrospective design relied on existing facility records, introducing potential misclassification and missing data, particularly for symptom onset dates. Second, the facility-based sampling frame did not capture community deaths or those who never sought care, likely underestimating true population-level late diagnosis prevalence. Third, the small early-diagnosis group (n = 24) substantially reduced statistical power for mortality comparisons. Also, the single-state design limits generalisability to other conflict-affected or resource-limited settings without independent replication across the proposed multi-state study sites. There were also unmeasured/uncontrolled for confounders such as conflict intensity, seasonal variation, displacement status, and supply chain disruptions. These limitations are inherent to the feasibility phase and will be systematically addressed through the prospective design and expanded sample of the planned multi-state study.

Conclusion

Late diagnosis is near-universal among women and children seeking care in Borno State, driven by a deeply interlocking set of individual, socioeconomic, and health system barriers operating simultaneously across all three stages of the Three Delays Model. It is independently associated with significantly higher rates of severe complications, longer hospitalisation, and catastrophic direct medical costs. All four study hypotheses were confirmed. The feasibility study exceeded all NHS/NIHR/NHREC benchmarks for data quality, abstraction efficiency, and inter-rater reliability, and its core findings were independently reproduced on the raw dataset. These preliminary findings constitute a robust, policy-relevant evidence base that demands urgent response from government, humanitarian agencies, and global health funders.

Abbreviations

AOR	Adjusted Odds Ratio
BAY	Borno, Adamawa, Yobe
BHCPF	Basic Healthcare Provision Fund
CI	Confidence Interval
HIV	Human Immunodeficiency Virus
IQR	Interquartile Range;
LGA	Local Government Area

MMC	Maiduguri Metropolitan Council
NDHS	Nigeria Demographic and Health Survey
NHREC	National Health Research Ethics Committee;
NHS	National Health Service
NIHR	National Institute for Health Research
NHS HRA	National Health Service Health Research Authority
ODK	Open Data Kit
PHC	Primary Health Centre
PPS	Probability Proportional to Size
PPH	Postpartum Haemorrhage
QA	Quality Assurance
RAF	Record Abstraction Form
SAM	Severe Acute Malnutrition
SDG	Sustainable Development Goal
SMoH	State Ministry of Health
SPHCDA	State Primary Health Care Development Agency
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology TB Tuberculosis
UHC	Universal Health Coverage
UMTH	University of Maiduguri Teaching Hospital
WHO	World Health Organization

Declarations

Authors' contributions

II conceived the study, contributed to the conceptual and theoretical framework, guided study design and methodology, critically revised the manuscript for intellectual content, and approved the final version for

submission. EN co-led the study design, led the ethical approval process in Nigeria, developed and piloted the Record Abstraction Form (RAF), supervised data collection and quality assurance across all six facilities, conducted all statistical analyses, and drafted the manuscript. All authors read and approved the final manuscript.

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Declarations

Ethics approval and consent to participate

Ethical approval for this study was obtained from the University of Maiduguri Teaching Hospital (UMTH) Research Ethics Committee and the Borno State Ministry of Health (SMoH) Research, Statistics, and Planning Unit, Maiduguri, Nigeria. The study was conducted in accordance with the NHS Health Research Authority (HRA) UK Policy Framework for Health and Social Care Research (2023), the Nigerian National Health Research Ethics Committee (NHREC) National Code of Health Research Ethics (2016), and the Declaration of Helsinki [19]. As this was a retrospective review of existing anonymised facility records posing minimal risk, a waiver of individual informed consent was granted by the approving ethics committees. No direct patient contact was involved.

Consent for publication

Not applicable. This study did not include any individual person's data in any form (including individual details, images, or videos).

Availability of data and materials

The datasets generated and analysed during the current study are not publicly available due to the sensitive nature of the health record data from a conflict-affected humanitarian setting and restrictions imposed by the approving ethics committees. Anonymised aggregate data are available from the corresponding author on reasonable request and subject to ethical approval.

Clinical trial number

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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