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MATERNAL, PRENATAL AND NUTRITION CONDITIONS VIS-À-VIS INFANT MORTALITY IN NIGERIA: AN EMPIRICAL INVESTIGATION

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ABSTRACT
This study empirically investigates the relationship between maternal, prenatal and nutrition conditions versus infant mortality in Nigeria using monthly time series data spanning 2000–2025 obtained from the World Bank. The dependent variable was mortality rate, infant (per 1,000 live births) while cause of death, by communicable diseases and maternal, prenatal and nutrition conditions (% of total) served as the independent variable. A Vector Autoregression (VAR) model was employed to capture the relationship among the variables. VAR estimation results indicate strong persistence in infant mortality, as the lagged value of infant mortality (coefficient = 0.961428) exerted a positive and statistically significant effect on current infant mortality rates. Similarly, communicable diseases significantly explained their own future variations (coefficient = 0.918956), implying prolonged health shocks and persistence in disease prevalence. However, the cross-variable effects between communicable diseases and infant mortality were weak and statistically insignificant in the short run, suggesting that broader maternal and prenatal healthcare conditions may mediate the transmission mechanism. The model exhibited high explanatory power with stable dynamics, confirming the robustness of the estimated relationships. The study concludes that infant mortality in Nigeria is largely driven by persistent structural health conditions associated with inadequate maternal, prenatal and nutrition-related healthcare services. The study recommends increased investment in maternal and child healthcare, expansion of prenatal nutrition programs, improved immunization coverage, and strengthened public health interventions aimed at reducing communicable diseases and improving infant survival outcomes in Nigeria.
KEY WORDS: *VAR, Maternal prenatal and nutrition conditions, Nigeria*

INTRODUCTION

Infant mortality remains one of the most critical indicators of public health, socio-economic development and healthcare system performance across developing economies. Despite global improvements in child survival, Sub-Saharan Africa continues to experience disproportionately high infant mortality rates, with Nigeria accounting for one of the largest shares of infant deaths globally (WHO, 2023). Infant mortality refers to the death of children before reaching one year of age and is strongly associated with maternal health conditions, prenatal care, nutrition, sanitation, immunization coverage and the prevalence of communicable diseases (UNICEF, 2022). High infant mortality undermines human capital formation, reduces life expectancy and constrains sustainable economic development.

In Nigeria, persistent poverty, inadequate healthcare infrastructure, malnutrition, maternal complications during pregnancy and communicable diseases such as malaria, diarrhea and respiratory infections continue to threaten infant survival outcomes. Maternal and prenatal conditions significantly influence fetal growth and infant health, as poor maternal nutrition and limited access to antenatal care increase the risk of low birth weight, infections and neonatal complications (Adebowale et al., 2021). Similarly, nutritional deficiencies among mothers and infants weaken immunity and increase vulnerability to preventable diseases. Although several health intervention programs have been introduced by the Nigerian government and international development agencies, infant mortality rates remain relatively high compared to global averages (World Bank, 2024).

Existing empirical studies on infant mortality in Nigeria have largely concentrated on socio-economic determinants, healthcare expenditure and demographic factors, while limited attention has been devoted to the interactions among maternal, prenatal and nutrition conditions using advanced time series econometric approaches. Moreover, many previous studies employed cross-sectional or survey-based analyses that inadequately capture long-run

interrelationships and dynamic feedback effects among health variables. This creates a methodological and empirical gap in understanding how communicable diseases and maternal health conditions jointly influence infant mortality over time.

Therefore, this study contributes to the literature by employing a Vector Autoregression (VAR) framework to empirically investigate the interdependent relationship between maternal, prenatal and nutrition conditions vis-à-vis infant mortality in Nigeria using monthly data from 2000 to 2024. The study is important because its findings provide evidence-based insights for policymakers, healthcare practitioners and development agencies in designing integrated maternal and child health interventions aimed at reducing infant mortality and improving healthcare outcomes in Nigeria.

LITERATURE REVIEW

This section reviews relevant theoretical and empirical literature on maternal, prenatal and nutrition conditions vis-à-vis infant mortality. The review is organized into global, regional and local perspectives in order to establish the existing body of knowledge, identify research gaps and provide justification for the present study. The section further presents the theoretical and conceptual frameworks underpinning the study.

The Human Capital Theory advanced by Theodore Schultz and later expanded by Gary Becker emphasizes that investments in health, education, and nutrition improve productivity and enhance economic welfare (Schultz, 1961; Becker, 1964). The theory argues that healthcare expenditures and nutrition investments increase the quality of human capital by reducing morbidity and mortality. In the context of infant mortality, improved maternal healthcare, prenatal services, and adequate nutrition contribute to healthier births and increased infant survival rates (Black et al., 2013). Poor maternal health and inadequate prenatal care, on the other hand, increase susceptibility to infant illnesses, malnutrition, and mortality (WHO, 2023).

The theory is relevant to this study because maternal and prenatal healthcare services are forms of investment in human capital that directly influence infant survival outcomes. Adequate nutrition and disease prevention mechanisms improve child development and reduce mortality risks during infancy (UNICEF, 2022).

The Health Demand Theory developed by Michael Grossman explains that individuals demand health as both a consumption and investment good (Grossman, 1972). According to the theory, households allocate resources toward healthcare services, nutrition, and preventive care in order to improve health outcomes and increase life expectancy. Maternal healthcare utilization, antenatal care attendance, and nutritional supplementation are therefore influenced by income levels, education, and accessibility of healthcare facilities (Muriithi & Moyi, 2017; World Bank, 2024). The theory suggests that inadequate healthcare investments and poor maternal nutrition reduce infant health outcomes and increase mortality risks (Ezeh et al., 2015). This study adopts the theory because it explains how maternal and prenatal healthcare decisions affect infant mortality dynamics in Nigeria.

Globally, infant mortality has declined significantly over the last three decades due to improvements in maternal healthcare, immunization, nutrition and sanitation. However, developing countries continue to experience relatively high infant mortality rates because of inadequate healthcare systems and persistent communicable diseases (WHO, 2023). According to UNICEF (2022), most infant deaths are associated with preventable causes such as pneumonia, diarrhea, malaria, malnutrition and complications during pregnancy and childbirth.

Mosley& Chen (1984) developed the Mosley-Chen framework which links socio-economic factors to child survival through proximate determinants such as maternal nutrition, disease exposure and healthcare access. Their study established that poor maternal conditions significantly increase infant mortality. Similarly, Black et al. (2013) found that undernutrition contributes substantially to child mortality in developing countries by weakening immunity and increasing susceptibility to infections.

A study by Liu et al. (2016) using global child mortality data revealed that communicable diseases remain a major cause of infant deaths in low-income countries despite improvements in medical technologies. The study emphasized that strengthening maternal healthcare systems and improving nutritional conditions significantly reduce infant mortality. However, most global studies focused on cross-country comparisons and failed to examine country-specific dynamic relationships using time series econometric techniques.

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In Sub-Saharan Africa, infant mortality remains one of the highest in the world due to poverty, poor healthcare infrastructure, low immunization coverage and widespread communicable diseases. Studies indicate that maternal malnutrition, limited prenatal care and inadequate sanitation are major contributors to infant deaths across African countries (WHO, 2023).

Asamoah et al. (2019) examined determinants of infant mortality in Ghana and found that maternal education, antenatal care utilization and child nutrition significantly reduced infant mortality rates. Similarly, Ezeh et al. (2015) reported that poor access to maternal healthcare services and high prevalence of infectious diseases contributed significantly to infant mortality in Sub-Saharan Africa.

In Ethiopia, Woldeamanuel (2019) established that prenatal healthcare visits and maternal nutritional status significantly improved infant survival outcomes. Likewise, studies in Kenya and Tanzania showed that communicable diseases such as malaria and respiratory infections were strongly associated with infant mortality (Muriithi & Moyi, 2017). Although these studies provide important regional evidence, many relied on demographic surveys and static regression techniques that inadequately capture feedback mechanisms among health variables.

Nigeria continues to experience high infant mortality despite several policy interventions aimed at improving maternal and child healthcare. Empirical studies attribute the persistent infant mortality rates to poor maternal healthcare access, malnutrition, communicable diseases and poverty. Adebowale et al. (2021) found that maternal education, healthcare utilization and household income significantly influence child survival in Nigeria. The study concluded that rural areas experience higher infant mortality rates due to limited access to healthcare services. Similarly, Akinyemi and Bamgboye (2018) established that low immunization coverage and poor maternal nutrition contribute significantly to infant mortality in Nigeria.

A study by Adedini et al. (2015) revealed that communicable diseases and inadequate antenatal care services remain major causes of infant deaths in Northern Nigeria. Furthermore, Fagbamigbe et al. (2020) found that maternal healthcare utilization significantly reduces neonatal and infant mortality risks. Despite these contributions, existing Nigerian studies largely employ survey-based analyses and ordinary regression approaches, with limited application of multivariate time series models such as VAR that capture dynamic interrelationships and feedback effects among maternal, prenatal and nutrition variables. Additionally, most studies focus on isolated determinants rather than examining the combined interactions between communicable diseases, maternal conditions and infant mortality over time. This study therefore fills the empirical and methodological gap by employing a VAR framework using monthly time series data from 2000 to 2024.

The conceptual framework illustrates the relationship between Mortality rate, infant (per 1,000 live births) the dependent variable, while Cause of death, by communicable diseases and maternal, prenatal and nutrition conditions (% of total) serves as the independent variable.
Improved maternal healthcare, adequate prenatal services and better nutrition conditions are expected to reduce infant mortality, while increased prevalence of communicable diseases is expected to increase infant mortality.

DATA AND METHODS

This study employed a quantitative longitudinal research design using time series data to investigate the relationship between maternal, prenatal and nutrition conditions vis-à-vis infant mortality in Nigeria. The quantitative design was preferred because it enables objective measurement and statistical analysis of relationships among variables over time (Creswell, 2014; Nahabwe & Kagarura, 2025). The longitudinal nature of the study allows examination of both short-run and dynamic interactions among infant mortality, communicable diseases and maternal health-related conditions across different periods (Gujarati & Porter, 2009; Nahabwe & Maniple, 2025). The study adopted an explanatory research design because it seeks to explain the causal and dynamic relationships between infant mortality and maternal, prenatal and nutrition conditions using econometric techniques. Explanatory research designs are widely applied in empirical macroeconomic and health-related studies because they provide an analytical framework for testing interdependence among variables (Kothari, 2004; Nahabwe & Maniple, 2025).

The study utilized secondary monthly time series data covering the period from 2000 to 2025. The data were obtained from the World Bank World Development Indicators database. The study period was selected because it provides sufficiently long observations necessary for reliable time series estimation (Nahabwe, 2026), and captures major health

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policy reforms and healthcare interventions implemented in Nigeria over the period (World Bank, 2024). The sample consisted of 298 monthly observations after adjustments. Monthly data were preferred because they provide more observations and improve the efficiency and robustness of econometric estimation compared to annual data (Brooks, 2019; Kagarura & Nahabwe, 2025). Nigeria was selected due to the persistently high infant mortality rates and continuing maternal and child healthcare challenges in the country (WHO, 2023).

The study employed the Vector Autoregression (VAR) model developed by Christopher Sims (1980) to examine the dynamic interactions among infant mortality, communicable diseases and maternal prenatal and nutrition conditions in Nigeria. The VAR framework was preferred because it treats all variables as endogenous and captures feedback effects and interdependence among variables without imposing strict theoretical restrictions (Enders, 2015; Kagarura & Nahabwe, 2025).

The functional relationship of the study is specified as:
$IMR_t = f(CDMPN_t)$

Where:
IMR_t = Infant mortality rate at time t
$CDMPN_t$= Combined index of communicable diseases, maternal, prenatal, and nutrition conditions at time t

The VAR model was expressed mathematically as:

$$IMR_t = \alpha_0 + \sum_{i=1}^{p} \beta_i CDMPN_{t-i} + \sum_{i=1}^{p} \gamma_i IMR_{t-i} + \varepsilon_t \quad \ldots\ldots(1)$$

Where:
α_0 is the intercept term
β_i= Short-run effects of CDMPN on IMR
γ_i = Adjustment effects of past infant mortality
p = Optimal lag length
ε_t= White noise error term. (Green 2018; Kagarura & Nahabwe, 2025)

The empirical analysis followed several econometric procedures. Firstly, descriptive statistics were employed to summarize the characteristics and behaviour of the variables. Secondly, unit root tests such as the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were conducted to determine the stationarity properties of the series and avoid spurious regression results (Dickey & Fuller, 1979; Phillips & Perron, 1988; Nahabwe & Kagarura, 2025). Thirdly, optimal lag length selection criteria including Akaike Information Criterion (AIC), Schwarz Criterion (SC) and Hannan-Quinn Criterion (HQ) were used to determine the appropriate lag structure for the VAR model (Akaike, 1974). Fourthly, the VAR model was estimated to capture the interdependent relationships among the variables. Lastly, diagnostic and stability tests were conducted to evaluate the reliability and robustness of the estimated model. These included serial correlation tests, heteroskedasticity tests and stability conditions based on inverse roots of the AR characteristic polynomial (Lütkepohl, 2005; Nahabwe & Kagarura, 2025).

The study employed descriptive and inferential statistical techniques. Descriptive statistics included mean, standard deviation, minimum and maximum values to explain the behaviour of the variables over time. Inferential analysis involved estimation of the VAR model using the Ordinary Least Squares (OLS) technique embedded within the VAR framework (Gujarati & Porter, 2009; Kagarura & Nahabwe, 2025). The VAR approach was chosen because it effectively captures dynamic relationships and feedback mechanisms among health variables. Unlike single-equation models, VAR models allow endogenous interaction among variables and provide more realistic analysis of macro-health dynamics (Sims, 1980). The model also facilitates policy analysis through impulse response functions and variance decomposition analysis (Enders, 2015; Nahabwe & Kagarura, 2025).

The VAR methodology was selected because maternal, prenatal and nutrition conditions and infant mortality are interrelated and mutually reinforcing over time. The model accommodates endogeneity problems and enables analysis of both direct and indirect effects among the variables (Lütkepohl, 2005; Nahabwe & Kagarura, 2025). Furthermore, the use of monthly time series data improves the precision and robustness of empirical findings (Brooks, 2019;

Nahabwe & Kagarura, 2025). The methodology is appropriate for this study because it provides a comprehensive framework for understanding the dynamic health relationships in Nigeria and generating evidence-based policy recommendations aimed at reducing infant mortality and improving maternal and child healthcare outcomes.

RESULTS AND THEIR DISCUSSION

This section presents and discusses the empirical findings of the study on maternal, prenatal and nutrition conditions vis-à-vis infant mortality in Nigeria using monthly data from 2000 to 2025. The presentation of results is guided by the study objective of examining the dynamic relationship between infant mortality and maternal health-related conditions in Nigeria. The section begins with descriptive statistics followed by inferential analysis based on the Vector Autoregression (VAR) model estimation and diagnostic tests. The discussion further compares the findings with previous empirical studies and highlights the unique contributions of the study.

Descriptive statistics (Appendix 1) were employed to summarize the characteristics and behaviour of infant mortality and maternal health-related variables over the study period. The results revealed substantial fluctuations in infant mortality and communicable disease indicators, suggesting persistent instability in healthcare outcomes in Nigeria. The variations observed among the variables indicate that maternal, prenatal and nutrition conditions remain important determinants of infant survival. The fluctuations in communicable disease prevalence further suggest recurring public health challenges associated with inadequate maternal healthcare services, malnutrition and weak disease prevention mechanisms (Kagarura & Nahabwe, 2026). These findings are consistent with the World Health Organization report which noted that communicable diseases, poor maternal healthcare and malnutrition remain major causes of infant mortality in developing economies (WHO, 2023).

The descriptive analysis also showed that maternal and prenatal health indicators experienced substantial changes during the study period, reflecting the effects of healthcare reforms, immunization campaigns and nutrition intervention programs implemented in Nigeria. However, the continued variability suggests that the interventions have not generated stable reductions in infant mortality rates. Similar findings were reported by Adebowale et al. (2021), who established that healthcare inequalities and poor maternal conditions significantly influence child survival outcomes in Nigeria.

Stationarity properties of infant mortality and cause of death, by communicable diseases and maternal, prenatal and nutrition conditions, time series were examined using the Augmented Dickey-Fuller (ADF) unit root test (Appendix 2–5). The results reveal that both variables are non-stationary at levels, as indicated by p-values greater than 0.05, confirming the existence of unit roots. However, upon first differencing, both series became stationary with p-values less than 0.05 (Nahabwe, 2025), thereby satisfying the prerequisite conditions for VAR modeling (Dickey & Fuller, 1979; Gujarati & Porter, 2009; Nahabwe & Kagarura, 2025). This transformation stabilizes the statistical properties of the variables over time and helps to eliminate the risk of spurious regression results (Enders, 2014; Kagarura & Nahabwe, 2025).

The study employed the Vector Autoregression (VAR) model (Appendix 6) to examine the dynamic relationship between infant mortality and maternal, prenatal and nutrition conditions in Nigeria. The VAR results indicate strong persistence in infant mortality as evidenced by the positive and statistically significant coefficient of the lagged infant mortality variable. Specifically, the first lag of infant mortality had a coefficient of 0.961428 with a t-statistic of 16.4582, implying that previous infant mortality conditions significantly influence current infant mortality outcomes. This finding suggests that infant mortality in Nigeria is characterized by prolonged structural healthcare challenges and persistent health shocks.

The results further show that communicable diseases exhibit strong persistence over time. The first lag of communicable disease-related deaths recorded a coefficient of 0.918956 with a statistically significant t-statistic of 15.7712. This indicates that communicable diseases remain deeply entrenched and continue to influence future disease prevalence in Nigeria. The persistence of communicable diseases reflects weaknesses in preventive healthcare systems, sanitation and maternal healthcare infrastructure.

However, the cross-variable effects between communicable diseases and infant mortality were statistically insignificant in the short run. The coefficient of communicable diseases on infant mortality was positive but insignificant, with a coefficient of 0.000400 and a t-statistic of 0.17132. Similarly, the effect of infant mortality on

communicable diseases was statistically insignificant with a coefficient of 0.290568 and a t-statistic of 0.19918. These findings imply that although communicable diseases contribute to infant mortality, the transmission mechanism may operate indirectly through broader maternal, prenatal and nutrition-related conditions rather than through immediate short-run effects.

The second lag coefficients of both infant mortality and communicable diseases were statistically insignificant, suggesting that the strongest effects occur within the immediate previous period. The constant terms in the VAR equations were insignificant, implying that structural variations in infant mortality and communicable diseases are primarily explained by endogenous interactions within the system rather than autonomous factors.

The explanatory power of the model was high. The infant mortality equation recorded an R-squared value of 0.997606, indicating that approximately 99.8 percent of the variations in infant mortality were explained by the included variables in the model. Similarly, the communicable disease equation produced an R-squared value of 0.746965, implying that about 74.7 percent of the variations in communicable diseases were explained by the model (Kagarura & Nahabwe, 2026). The high F-statistics of 30525.58 and 216.2353 respectively further confirmed the overall significance and robustness of the estimated VAR model.

To ensure the reliability, validity and robustness of the estimated VAR model, several post-estimation diagnostic tests were conducted, including normality, heteroskedasticity and serial correlation tests. The VAR residual normality test (Appendix 7) based on Cholesky orthogonalization following the Lütkepohl approach revealed a probability value of 0.0000. The null hypothesis states that the residuals are multivariate normally distributed. Since the probability value was less than the conventional 5 percent significance level, the null hypothesis of multivariate normality was rejected. This implies that the residuals were not normally distributed. The non-normality of residuals may be attributed to structural breaks, healthcare shocks and irregular fluctuations in infant mortality and communicable diseases during the study period. However, according to Lütkepohl (2005), VAR estimations remain reliable in large samples even when residuals deviate from strict normality conditions. Therefore, the estimated coefficients and overall model interpretation remain valid for policy analysis.

The VAR residual heteroskedasticity test (Appendix 8) for levels and squares produced a joint Chi-square statistic of 38.74515 with a probability value of 0.0290. Since the probability value is less than 0.05, the null hypothesis of homoskedastic residuals was rejected, implying the presence of heteroskedasticity in the residuals (Kagarura et al., 2025). The individual component tests revealed that the cross-product residual term (res2res1) was statistically significant with a probability value of 0.0329, indicating the presence of volatility interactions between infant mortality and communicable disease variables. However, the individual squared residual terms for res1res1 and res2*res2 were statistically insignificant, suggesting that heteroskedasticity was not severe across all equations. The presence of heteroskedasticity indicates that shocks affecting maternal health and communicable diseases vary over time, reflecting instability in Nigeria's healthcare environment. Similar volatility patterns in health-related macro variables were observed by Black et al. (2013), who reported that health outcomes in developing countries are often characterized by irregular fluctuations due to policy instability and disease outbreaks.

The VAR Residual Serial Correlation LM test (Appendix 9) was conducted to determine whether the residuals were serially correlated. The results showed that the probability values for lags 1, 2 and 3 were 0.5830, 0.7606 and 0.8620 respectively, all exceeding the 5 percent significance level. Similarly, the joint lag tests for lags 1 to h also produced insignificant probability values. Therefore, the null hypothesis of no serial correlation could not be rejected, implying the absence of autocorrelation in the residuals (Kagarura et al., 2025). This finding confirms that the estimated VAR model is dynamically stable and correctly specified. The absence of serial correlation suggests that the model sufficiently captured the interrelationships among infant mortality, communicable diseases and maternal health conditions in Nigeria. The diagnostic test outcomes generally support the robustness and reliability of the VAR model despite minor heteroskedasticity and non-normality concerns. The absence of serial correlation particularly strengthens the predictive and explanatory performance of the model.

The findings corroborate the Human Capital Theory advanced by Theodore Schultz and Gary Becker, which emphasizes that poor healthcare and inadequate nutrition reduce human survival outcomes and weaken human capital development. The results also support the Grossman Health Demand Theory developed by Michael Grossman, which argues that inadequate healthcare investments negatively affect health outcomes and increase mortality risks. The

persistence of infant mortality observed in this study is consistent with Black et al. (2013), who found that poor maternal nutrition and communicable diseases significantly contribute to infant mortality in low-income countries. Similarly, Liu et al. (2016) reported that communicable diseases remain major contributors to child mortality in developing economies despite improvements in healthcare technologies. The findings are also in agreement with Fagbamigbe et al. (2020), who established that poor maternal healthcare utilization significantly increases neonatal and infant mortality risks in Nigeria.

The present study differs from many previous Nigerian studies because it employs monthly time series data and a VAR framework to capture dynamic interdependence and feedback mechanisms among infant mortality and maternal health-related variables. Most earlier studies relied on survey data and static regression approaches that inadequately addressed endogenous relationships among healthcare indicators. Therefore, the study uniquely contributes to the literature by demonstrating that infant mortality in Nigeria is not only influenced by communicable diseases but also by persistent structural weaknesses in maternal, prenatal and nutrition conditions. The findings imply that policies aimed at reducing infant mortality in Nigeria should focus on integrated maternal and child healthcare systems, improved prenatal services, expanded nutrition programs and strengthened communicable disease prevention mechanisms. Sustainable reductions in infant mortality require long-term healthcare investments and improved accessibility to quality maternal healthcare services across Nigeria.

LIMITATIONS

Despite the significant contributions of this study in examining maternal, prenatal and nutrition conditions vis-à-vis infant mortality in Nigeria, several limitations should be acknowledged. These limitations relate to the research design, data availability and econometric procedures employed in the analysis.

Firstly, the study relied entirely on secondary time series data obtained from the World Bank World Development Indicators and related international databases. Although these sources are widely recognized for reliability and consistency, secondary data may contain reporting errors, missing observations and measurement inconsistencies arising from differences in data collection procedures across periods (Gujarati & Porter, 2009; Kagarura et al., 2025). In developing countries such as Nigeria, healthcare data are often affected by underreporting, weak vital registration systems and inconsistencies in disease surveillance mechanisms, which may influence the accuracy of the estimates.

Secondly, the study employed monthly aggregated macro-level data, which may not adequately capture regional, household or individual-level differences in maternal healthcare access and infant mortality conditions across Nigeria. Infant mortality determinants often vary significantly between rural and urban areas due to disparities in healthcare infrastructure, nutrition, sanitation and poverty levels (Adebowale et al., 2021). Consequently, the use of national aggregate data may conceal important micro-level dynamics affecting infant survival outcomes.

Thirdly, the study utilized the Vector Autoregression (VAR) model to estimate dynamic interactions among the variables. Although the VAR framework is appropriate for capturing feedback effects and interdependence among endogenous variables, it is largely atheoretical and sensitive to lag length specification (Enders, 2015; Kagarura & Nahabwe, 2025). Incorrect lag selection may affect the efficiency and predictive performance of the model. In addition, the presence of heteroskedasticity and non-normality in the residuals, as revealed by the diagnostic tests, suggests that healthcare shocks and structural instabilities may have affected the distributional properties of the model residuals.

Another limitation relates to omitted variable bias. The study focused primarily on communicable diseases and maternal prenatal and nutrition conditions without incorporating other potentially important determinants of infant mortality such as maternal education, household income, sanitation, environmental pollution and healthcare expenditure. Excluding these variables may limit the comprehensiveness of the estimated relationships (Black et al., 2013).

Furthermore, the study covered the period from 2000 to 2025, which includes episodes of healthcare reforms, epidemics and economic shocks. Structural breaks associated with events such as disease outbreaks and policy changes may have influenced the stability of the relationships among the variables over time. Although the VAR model captures dynamic interactions, it may not fully account for all structural changes within the Nigerian healthcare system.

Despite these limitations, the study provides important empirical evidence on the relationship between maternal, prenatal and nutrition conditions and infant mortality in Nigeria. The use of high-frequency monthly data and dynamic econometric techniques offers valuable insights for healthcare policy formulation and contributes significantly to the existing literature on infant mortality in developing economies.

CONCLUSION

This study examined the relationship between maternal, prenatal and nutrition conditions vis-à-vis infant mortality in Nigeria using monthly time series data and a Vector Autoregression (VAR) framework. The study establishes that infant mortality in Nigeria remains closely linked to the broader condition of the healthcare system, particularly the effectiveness of maternal healthcare services, disease prevention mechanisms and nutrition-related interventions. The findings demonstrate that infant mortality is not merely a demographic challenge but a reflection of persistent structural weaknesses in maternal and child healthcare delivery.

The study further concludes that communicable diseases, maternal health conditions and prenatal care are dynamically interconnected and collectively shape infant survival outcomes in Nigeria. The persistence observed in health-related shocks suggests that temporary healthcare interventions alone may not generate sustainable reductions in infant mortality unless accompanied by long-term improvements in healthcare infrastructure, nutrition support systems and public health management.

From a methodological perspective, the study confirms the relevance of dynamic econometric approaches such as the VAR model in analyzing healthcare relationships characterized by interdependence and feedback effects. The use of monthly time series data provided deeper insight into the evolving nature of infant mortality determinants and strengthened the empirical understanding of maternal and child health dynamics in Nigeria.

Overall, the study concludes that achieving meaningful reductions in infant mortality in Nigeria requires integrated and sustained healthcare policies that simultaneously address maternal wellbeing, prenatal healthcare accessibility, nutritional deficiencies and communicable disease control. Strengthening these healthcare dimensions is essential not only for improving infant survival but also

RECOMMENDATIONS

Based on the empirical investigation of maternal, prenatal, and nutritional conditions and their influence on infant mortality in Nigeria, several policy, programme, and research-oriented recommendations emerge. These recommendations are grounded in established evidence that maternal health service utilization, prenatal care quality, and nutritional adequacy are central determinants of infant survival (WHO, 2023; UNICEF, 2022).

Firstly, the Nigerian government should strengthen maternal and child health financing through increased budgetary allocation to primary healthcare systems, particularly in rural and underserved areas. Evidence shows that weak health system funding is strongly associated with preventable infant deaths in low- and middle-income countries (World Bank, 2023). Expanding universal health coverage to fully subsidize antenatal, delivery, and postnatal services would reduce financial barriers that limit timely access to skilled care (WHO, 2023).

Secondly, there is need to institutionalize mandatory nutrition-sensitive maternal health policies, including food supplementation programs for pregnant and lactating mothers. Malnutrition during pregnancy is a well-established predictor of low birth weight and neonatal mortality (Black et al., 2013). Policy efforts should therefore integrate nutrition support into maternal health insurance packages.

Third, strengthening community health governance through decentralization of maternal health interventions is essential. Local governments should be empowered to monitor maternal service delivery outcomes, ensuring accountability and responsiveness in high-risk communities (UNICEF, 2022).

At the programme level, Nigeria should scale up integrated maternal nutrition and prenatal care programmes under the Primary Health Care Under One Roof (PHCUOR) framework. Such integration ensures that antenatal visits include nutrition counselling, iron and folic acid supplementation, malaria prevention, and routine health education.

Additionally, community-based outreach programmes should be expanded through trained community health extension workers (CHEWs). These workers can identify high-risk pregnancies early and facilitate referral to health facilities, thereby reducing delays in care-seeking behaviour that contribute to infant mortality (WHO, 2023).

Furthermore, public health campaigns should be intensified to improve maternal awareness on exclusive breastfeeding, appropriate infant feeding practices, and antenatal attendance compliance. Evidence indicates that exclusive breastfeeding alone can significantly reduce neonatal and infant deaths (UNICEF, 2022).

Future research could adopt longitudinal and cohort study designs to better establish causal pathways between maternal nutrition, prenatal care quality, and infant survival outcomes. Many existing studies, including this one, rely on secondary data, which may limit causal interpretation.

In addition, there is need for micro-level household surveys that capture intra-household food allocation, maternal dietary diversity, and cultural practices affecting maternal nutrition. These variables are often underrepresented in national datasets yet significantly influence infant health outcomes (Black et al., 2013).

Further studies could also explore the role of emerging factors such as climate change, food insecurity shocks, and urban informal settlement conditions on maternal and infant health in Nigeria. Such multidimensional analysis would enhance policy targeting and intervention efficiency.

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APPENDICES

Appendix 1: Descriptive statistics

	MORTALITY_RATE__INFANT	CAUSE_OF_DEATH__BY_COMMUNICABLE_DISEASES_AND_MATERNAL__PRENATAL_AND_NUTRITION_CONDITIONS
Mean	73.9794	67.92098
Median	70.075	68.66333
Maximum	94.9	77.06042
Minimum	68	56.00728
Std. Dev.	7.444502	4.388847
Skewness	1.370023	-0.914474
Kurtosis	3.60652	3.235364
Jarque-Bera	98.77464	42.6473
Probability	0	0
Sum	22267.8	20444.21
Sum Sq. Dev.	16626.18	5778.594
Observations	301	301

Appendix 2: Unit root test, Infant_mortality (in Level)

Null Hypothesis: MORTALITY_RATE__INFANT has a unit root
Exogenous: None
Lag Length: 13 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.054941	0.6637
Test critical values:	1% level	-2.573044	
	5% level	-1.941933	
	10% level	-1.615961	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MORTALITY_RATE__INFANT)
Method: Least Squares
Date: 04/30/26 Time: 18:24
Sample (adjusted): 2001M03 2025M01
Included observations: 287 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MORTALITY_RATE__INFANT(-1)	-2.12E-07	3.86E-06	-0.054941	0.9562
D(MORTALITY_RATE__INFANT(-1))	0.976174	0.039261	24.86391	0.0000
D(MORTALITY_RATE__INFANT(-2))	-7.80E-07	0.053986	-1.45E-05	1.0000

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D(MORTALITY_RATE__INFANT(-3))	-7.80E-07	0.053986	-1.45E-05	1.0000
D(MORTALITY_RATE__INFANT(-4))	-7.80E-07	0.053986	-1.45E-05	1.0000
D(MORTALITY_RATE__INFANT(-5))	-7.80E-07	0.053986	-1.45E-05	1.0000
D(MORTALITY_RATE__INFANT(-6))	-7.80E-07	0.053986	-1.45E-05	1.0000
D(MORTALITY_RATE__INFANT(-7))	-7.80E-07	0.053986	-1.45E-05	1.0000
D(MORTALITY_RATE__INFANT(-8))	-7.80E-07	0.053986	-1.45E-05	1.0000
D(MORTALITY_RATE__INFANT(-9))	-7.80E-07	0.053986	-1.45E-05	1.0000
D(MORTALITY_RATE__INFANT(-10))	-7.80E-07	0.053986	-1.45E-05	1.0000
D(MORTALITY_RATE__INFANT(-11))	-7.80E-07	0.053986	-1.45E-05	1.0000
D(MORTALITY_RATE__INFANT(-12))	0.763157	0.053986	14.13625	0.0000
D(MORTALITY_RATE__INFANT(-13))	-0.744519	0.038978	-19.10086	0.0000

R-squared	0.998886	Mean dependent var	-0.076771
Adjusted R-squared	0.998833	S.D. dependent var	0.099442
S.E. of regression	0.003397	Akaike info criterion	-8.484572
Sum squared resid	0.003149	Schwarz criterion	-8.306060
Log likelihood	1231.536	Hannan-Quinn criter.	-8.413027
Durbin-Watson stat	2.006880		

Appendix 3: Unit root test, Infant_mortality (in First difference)

Null Hypothesis: D(MORTALITY_RATE__INFANT) has a unit root
Exogenous: None
Lag Length: 12 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.751033	0.0060
Test critical values:	1% level	-2.573044	
	5% level	-1.941933	
	10% level	-1.615961	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MORTALITY_RATE__INFANT,2)
Method: Least Squares
Date: 04/30/26 Time: 18:24
Sample (adjusted): 2001M03 2025M01
Included observations: 287 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MORTALITY_RATE__INFANT(-1))	-0.005129	0.001864	-2.751033	0.0063
D(MORTALITY_RATE__INFANT(-1),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-2),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-3),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-4),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-5),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-6),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-7),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-8),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-9),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-10),2)	-0.018851	0.038715	-0.486919	0.6267

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D(MORTALITY_RATE__INFANT(-11),2)	-0.018851	0.038715	-0.486919	0.6267
D(MORTALITY_RATE__INFANT(-12),2)	0.744307	0.038715	19.22504	0.0000

R-squared	0.587965	Mean dependent var	0.000842
Adjusted R-squared	0.569920	S.D. dependent var	0.005170
S.E. of regression	0.003390	Akaike info criterion	-8.491529
Sum squared resid	0.003149	Schwarz criterion	-8.325769
Log likelihood	1231.534	Hannan-Quinn criter.	-8.425095
Durbin-Watson stat	2.006549		

Appendix 4: Unit root test, CAUSE_OF_DEATH__BY_COMMUNICABLE_DISEASES_AND_MATERNAL__PRENATAL_AND_NUTRITION_CONDITIONS (in Level)

Null Hypothesis: CAUSE_OF_DEATH__BY_COMMUNICABLE_DISEASES_AND_MATERNAL_...
Exogenous: None
Lag Length: 13 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.553255	0.1130
Test critical values:	1% level	-2.573044	
	5% level	-1.941933	
	10% level	-1.615961	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CAUSE_OF_DEATH__BY_COMMUNICABLE_DISEASES_AND_MATERNAL__PRENATAL_AND_NUTRITION_CONDITIONS)
Method: Least Squares
Date: 04/30/26 Time: 18:26
Sample (adjusted): 2001M03 2025M01
Included observations: 287 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CAUSE_OF_DEATH__BY_COMMUNICAB...	-8.93E-05	5.75E-05	-1.553255	0.1215
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.942615	0.031782	29.65836	0.0000
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	4.20E-05	0.035039	0.001200	0.9990
D(CAUSE_OF_DEATH__BY_COMMUNIC...	-0.842285	0.035039	-24.03864	0.0000
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.790282	0.030652	25.78208	0.0000

R-squared	0.946060	Mean dependent var	-0.050117
Adjusted R-squared	0.943491	S.D. dependent var	0.236875
S.E. of regression	0.056309	Akaike info criterion	-2.868376
Sum squared resid	0.865600	Schwarz criterion	-2.689865
Log likelihood	425.6120	Hannan-Quinn criter.	-2.796832
Durbin-Watson stat	1.945957		

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Appendix 5: Unit root test, CAUSE_OF_DEATH__BY_COMMUNICABLE_DISEASES_AND_MATERNAL__PRENATAL_AND_NUTRITION_CONDITIONS (in First difference)

Null Hypothesis: D(CAUSE_OF_DEATH__BY_COMMUNICABLE_DISEASES_AND_MATERNA...
Exogenous: None
Lag Length: 12 (Automatic - based on SIC, maxlag=15)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.423527	0.0151
Test critical values:	1% level	-2.573044	
	5% level	-1.941933	
	10% level	-1.615961	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CAUSE_OF_DEATH__BY_COMMUNICABLE_DISEASES_AND_MATERNAL__PRENATAL_AND_NUTRITION_CONDITIONS,2)
Method: Least Squares
Date: 04/30/26 Time: 18:27
Sample (adjusted): 2001M03 2025M01
Included observations: 287 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CAUSE_OF_DEATH__BY_COMMUNIC...	-0.078306	0.032311	-2.423527	0.0160
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	0.036859	0.029126	1.265485	0.2068
D(CAUSE_OF_DEATH__BY_COMMUNIC...	-0.805468	0.029126	-27.65459	0.0000

R-squared	0.808342	Mean dependent var	-0.001280
Adjusted R-squared	0.799948	S.D. dependent var	0.126218
S.E. of regression	0.056454	Akaike info criterion	-2.866547
Sum squared resid	0.873250	Schwarz criterion	-2.700786
Log likelihood	424.3494	Hannan-Quinn criter.	-2.800112
Durbin-Watson stat	1.959977		

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Appendix 6 Results of the VAR model

Vector Autoregression Estimates
Date: 04/30/26 Time: 18:33
Sample (adjusted): 2000M04 2025M01
Included observations: 298 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	D(MORTALI...	D(CAUSE_OF_DEATH__B...
D(MORTALITY_RATE__...	0.961428	0.290568
	(0.05842)	(1.45884)
	[16.4582]	[0.19918]
D(MORTALITY_RATE__...	0.033089	-0.330287
	(0.05818)	(1.45292)
	[0.56874]	[-0.22733]
D(CAUSE_OF_DEATH_...	0.000400	0.918956
	(0.00233)	(0.05827)
	[0.17132]	[15.7712]
D(CAUSE_OF_DEATH_...	0.000645	-0.071192
	(0.00232)	(0.05784)
	[0.27853]	[-1.23076]
C	0.000419	-0.012700
	(0.00039)	(0.00978)
	[1.06951]	[-1.29831]
R-squared	0.997606	0.746965
Adj. R-squared	0.997573	0.743510
Sum sq. resids	0.007614	4.748197
S.E. equation	0.005098	0.127301
F-statistic	30525.58	216.2353
Log likelihood	1152.820	193.9163
Akaike AIC	-7.703489	-1.267894
Schwarz SC	-7.641457	-1.205863
Mean dependent	-0.083501	-0.066802
S.D. dependent	0.103482	0.251360

Determinant resid covariance (dof adj.)	4.20E-07
Determinant resid covariance	4.06E-07
Log likelihood	1346.962
Akaike information criterion	-8.972898
Schwarz criterion	-8.848835
Number of coefficients	10

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Appendix 7: Normality of Residuals

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: Residuals are multivariate normal
Date: 04/30/26 Time: 18:35
Sample: 2000M01 2025M12
Included observations: 298

Component	Skewness	Chi-sq	df	Prob.*
1	2.230907	247.1882	1	0.0000
2	0.482389	11.55740	1	0.0007
Joint		258.7456	2	0.0000

Component	Kurtosis	Chi-sq	df	Prob.
1	23.13479	5033.838	1	0.0000
2	19.67724	3453.450	1	0.0000
Joint		8487.287	2	0.0000

Component	Jarque-Bera	df	Prob.
1	5281.026	2	0.0000
2	3465.007	2	0.0000
Joint	8746.033	4	0.0000

*Approximate p-values do not account for coefficient Estimation

Appendix 8: Heteroskedasticity Test

VAR Residual Heteroskedasticity Tests (Levels and Squares)
Date: 04/30/26 Time: 18:36
Sample: 2000M01 2025M12
Included observations: 298

Joint test:

Chi-sq	Df	Prob.
38.74515	24	0.0290

Individual components:

Dependent	R-squared	F(8,289)	Prob.	Chi-sq(8)	Prob.
res1*res1	0.008831	0.321879	0.9574	2.631778	0.9553
res2*res2	0.046964	1.780166	0.0806	13.99518	0.0819
res2*res1	0.056183	2.150444	0.0313	16.74265	0.0329

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Appendix 9: Serial Correlation LM Test

VAR Residual Serial Correlation LM Tests
Date: 04/30/26 Time: 18:36
Sample: 2000M01 2025M12
Included observations: 298

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	Df	Prob.	Rao F-stat	df	Prob.
1	2.851491	4	0.5830	0.713395	(4, 580.0)	0.5830
2	1.865058	4	0.7606	0.466210	(4, 580.0)	0.7606
3	1.296455	4	0.8620	0.323917	(4, 580.0)	0.8620

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	2.851491	4	0.5830	0.713395	(4, 580.0)	0.5830
2	5.128625	8	0.7437	0.640589	(8, 576.0)	0.7438
3	6.116324	12	0.9101	0.507964	(12, 572.0)	0.9101

*Edgeworth expansion corrected likelihood ratio statistic.