

Economic Determinants of Vertical HIV Transmission: Insights from Infant Mortality Trends in Nigeria

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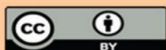
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Abstract

Vertical transmission of the Human Immunodeficiency Virus (HIV) necessitates special attention even though there has been a remarkable improvement in the scale-up of antiretroviral treatment (ART) and prevention of mother-to-child transmission (PMTCT) programmes. Besides biomedical, clinical, and epidemiological factors, the macroeconomic environment also plays a critical role in determining the health financing, household welfare and access to maternal and child health services, and consequently, infant survival. The study identifies the determinants of vertical transmission of HIV with a focus on the impact of macroeconomic forces on child health outcomes using infant mortality as a key variable in Nigeria from 1990 to 2024. The study uses secondary data sourced from World Development Indicators (World Bank), International Monetary Fund (IMF), World Health Organization (WHO), and Joint Maundations Programme on HIV/AIDS (UNAIDS). The paper employs Augmented Dickey Fuller (ADF) unit root test, Johansen cointegration, and an Error Correction Model (ECM) to establish long-run and short-run dynamic relationships between infant mortality, interest rate, HIV prevalence, ART, PMTCT coverage, and GDP per capita. The unit root test results reveal that the series are stationary at level $I(0)$ and first difference $I(1)$. The cointegration test shows evidence of long-run association among the variables. The short-run estimates demonstrate that HIV prevalence worsens infant mortality, whereas ART coverage improves the mortality rate. In the short run, PMTCT coverage and GDP per capita have a positive impact on infant mortality. The study concludes that the expansion of health programmes and economic development, in isolation, cannot immediately register immediate improvements in infant survival due to the challenges of programme accessibility, targeting, and inequality. Though the coefficient of the error correction term (ECT) is negative as expected and reveals the speed of adjustment of infant mortality in response to a change in the long-run dependent variable, it is not statistically significant at the 5% level. The study recommends a combined effect of economic and health policy interventions in reducing vertical transmission of HIV and promoting sustainable development in Nigeria.

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I. INTRODUCTION

Human Immunodeficiency Virus (HIV) is among the most persistent public health issues in the developing world as of 2025. While there have been unprecedented successes in HIV prevention, diagnosis, and treatment in the last two decades, HIV transmission from mother to child continues to be a primary source of paediatric HIV infection in sub-Saharan Africa. In particular, recent data from WHO (2025) estimate that the chance of HIV transmission from infected mother to child during pregnancy, delivery, and breastfeeding is between 15-45% if left untreated and can be successfully brought down to below 5% with proper medication, prevention, and post-natal care.

At the same time, it is reported that Nigeria has one of the highest burdens of childhood HIV infections in the world. Even with the overall increase in healthcare provision, paediatric HIV infections, mainly through vertical transmission, continue to negatively impact child health. The persistence of high levels of infant mortality is explained by both biophysical and socioeconomic factors, including public expenditures, healthcare accessibility, and macroeconomic environment. In particular, the connection between Nigeria's macroeconomy and the incidence of infant mortality due to HIV is of particular interest to policymakers who wish to improve the health outcomes of the country's children. The connection between these variables is explained by the fact that macroeconomic factors shape the general health status of populations. In particular, monetary policy conducted by central banks can affect the business environment and government expenditures on healthcare, HIV prevention in particular. At the same time, changes in the macroeconomic environment can affect general access to healthcare, treatment availability, and population health. For instance, high interest rates, inflation, and credit default risks are inevitable when central banks adopt a pro-tight monetary policy, which, in turn, reduces public expenditures on social programmes.

The relationship between health outcomes and macroeconomic variables has been the subject of research in health economics for some time. The body of scholarly work on the subject contains strong evidence that positive trends in public expenditures on healthcare and population health tend to reduce infant mortality rates (Edeme, 2017; Iyoboyi, 2020; Kiross et al., 2020; Anwar & Anwar, 2023). Similarly, the reviewed articles demonstrate that investment in treatment and prevention of HIV significantly reduces vertical transmission of HIV and improves child health outcomes. With that being said, most of the cited works focus on either the impact of public expenditures on health or HIV-related determinants of health, with few attempting to analyse the relationship between the two. As mentioned above, the reviewed articles tend to either focus on the general health determinants

or the sources of HIV transmission without considering their interaction. In addition, while the importance of HIV prevention is widely acknowledged, the role of macroeconomic conditions in this area is poorly understood, especially in the context of Nigeria's public health. The works listed above analyse public expenditures, HIV treatment and prevention, and vertical transmission but do not take into account the complex relationship between macroeconomic trends and disease prevalence. Such an analysis is crucial for Nigeria, where monetary policy changes frequently and public health outcomes, particularly in relation to HIV, remain a matter of national concern. In particular, understanding how macroeconomic conditions affect the incidence of paediatric HIV infections will allow the government to shape an adequate policy response to the issue.

For this reason, this study focuses on the effect of economic factors on the incidence of vertical HIV transmission. In particular, the work examines the relationship between interest rates, HIV prevalence, antiretroviral treatment, Prevention of Mother-to-Child Transmission (PMTCT), and GDP per capita on infant mortality in Nigeria. The study provides implications for both health and economic policy, which can help improve health outcomes in terms of HIV and overall infant mortality. As such, it responds to the need for scholarly work on the economics of public health and allows for a better understanding of the nexus between health, economics, and demography.

II. LITERATURE REVIEW

Grossman's Health Capital Theory

The author of the study mainly relies on Grossman's (1972) Health capital theory. The theory regards health as capital that yields direct benefits such as utility and indirect benefits such as labour productivity. The theory postulates that individuals invest in health care, like the investment process in physical capital, to maximize productivity and gain more utility from working hours. Like education, health is considered to be a public good that, when invested in, improves overall economic productivity and raises the number of productive years a person contributes to the economy.

Grossman's model provides that vertical transmission of HIV can be reduced by investing in maternal health care services such as ante-natal care, HIV screening, HIV treatment, post-natal care, family planning, and HIV/AIDS programmes. The vertical transmission of HIV is related to maternal capital through macroeconomic conditions. Health capital investment is influenced by the macroeconomic environment through its impact on the population's income, public spending on health care, healthcare financing, and the overall accessibility and affordability of healthcare services. Grossman's model explains how macroeconomic factors influence health care investments, maternal

health care, and indirectly the investment in children's health.

Social Determinants of Health Framework

The study will also rely on the Social Determinants of Health Framework developed by Solar and Irwin (2010). The framework is used together with Grossman's model to provide an in-depth understanding of how and why social factors affect health status, with a focus on improving health care systems worldwide. Solar and Irwin's (2010) framework provide a holistic view of factors that affect population health, including political, economic, institutional, and social determinants. The framework provides support for the argument advanced in Grossman's model that macroeconomic conditions, such as national income, employment, education, adequate housing, and social services, influence population health. In addition, the framework explains the relationship between macroeconomic conditions and the availability, accessibility, acceptability, and quality of health care services. For instance, political instability and poor governance are associated with low public spending on health care and low investment in HIV prevention programmes, resulting in limited access to HIV treatment, resulting in increased infant mortality. On the other hand, good governance promotes a conducive environment for sustained investment in maternal health care, HIV treatment programs, and child health care, resulting in reduced infant mortality. Overall, the Social Determinants of Health Framework provides an appropriate theoretical background for this study.

Empirical Literature

Empirical studies have shown that economic factors have an impact on maternal and child health. Edeme (2017) used the Error Correction Model to establish the connection between government expenditure on health and health indicators in Nigeria. The study found that increased spending by the government on health resulted in reduced infant mortality and increased life expectancy. The study concluded that public health expenditure was necessary for the attainment of good health outcomes.

Kiross et al. (2020) analyzed the role of healthcare expenditure in reducing infant mortality using data from forty-six Sub-Saharan African countries. The study's findings established that healthcare expenditure played a significant role in reducing infant mortality in the region. It was further established that increased funding of maternal and child health programs leads to improved healthcare service delivery.

Iyoboyi (2020) analyzed the effect of public health expenditure on infant and under-five mortality using system GMM estimator for forty-nine African countries. The study found that public health

expenditure had a significant negative effect on infant and under-five mortality. The study further found that public health expenditure combined with rising incomes and improved education had an even greater effect on child mortality.

Anwar and Anwar (2023) analyzed the effect of government spending on health on health outcomes in Organisation for Economic Development and Cooperation members and developing countries. The study found that increased government spending on health had a significant effect on reducing infant mortality and increasing life expectancy. The study further found that macroeconomic stability created room for increased government spending on health in the context of the study.

Studies on the effect of the Human Immunodeficiency Virus on health indicate that effective HIV treatment and prevention programs have a great potential in reducing infant mortality. Kassa (2016) found that effective HIV treatment and prevention programs such as antenatal care and the availability and accessibility of ART significantly reduced the risk of mother-to-child HIV transmission. However, the study also found that health financing, lack of health personnel, insufficient health services, and poverty impeded the effectiveness of HIV treatment and prevention programs in Nigeria.

Although previous studies established the effect of health expenditure, HIV prevention and treatment programs, and macroeconomic indicators on infant mortality, there is a need for further research to fully understand infant mortality indicators. Firstly, most studies conducted in Nigeria only relate public health expenditure to public health outcomes. There is a need to consider other economic factors affecting health expenditure and public health. Secondly, most of the previous studies have not evaluated the relationship between macroeconomic indicators and HIV-related expenditure and outcomes together. This study will contribute to the existing body of literature on the effect of macroeconomic indicators, HIV prevalence, treatment and prevention programs on infant mortality in Nigeria. This study will extend previous research on the effect of macroeconomic indicators on health expenditure in Nigeria and the effect of HIV on infant mortality. The study will provide an insight into the effect of GDP, interest rates, HIV prevalence, ART coverage, and PMTCT programs on infant mortality in Nigeria.

III. METHODOLOGY

Theoretical Framework

In this study, the theoretical framework that guides it is Grossman's theory of health capital (Grossman, 1972). This theory views health as a stock that depreciates over time but that can be maintained and improved through the investment of resources in health care, prevention, the

purchase of food, and maternity care. The utility function is given by:

$$U = U(C, H) \quad (1)$$

where C denotes consumption and H represents health capital.

The evolution of health capital is expressed as:

$$H_{t+1} = (1 - \delta)H_t + I_t \quad (2)$$

where δ represents the depreciation rate of health capital, while I denotes investment in health through healthcare services, ART, PMTCT, nutrition, and other preventive interventions.

Infant mortality is assumed to depend on the probability of vertical HIV transmission and postnatal health investment as follows:

$$IM = f(\pi(I), I(\text{post})) \quad (3)$$

where $\pi(I)$ denotes the probability of mother-to-child HIV transmission, which decreases as health investment increases, while $I(\text{post})$ represents postnatal healthcare investments including infant HIV care, immunization, nutrition, and follow-up services.

Model Specification

Following Grossman's theoretical framework and previous empirical studies, the functional relationship is specified as:

$$IMR = f(IR, HIV, ART, PMTCT, GDPPC) \quad (4)$$

Where:

IMR = Infant Mortality Rate, IR = Interest Rate (proxy for monetary policy), HIV = Prevalence of HIV among pregnant women, ART = Coverage of Antiretroviral Therapy, PMTCT = Coverage of Prevention of Mother-to-Child Transmission programs, GDPPC = GDP per capita (control variable).

In a more explicit form, the model can be expressed as:

$$IMR = \beta_0 + \beta_1 IR + \beta_2 HIV + \beta_3 ART + \beta_4 PMTCT + \beta_5 GDPPC + u_t \quad (5)$$

This econometric form represents the relationship between infant mortality and the explanatory variables, with the β coefficients representing the marginal effects of each variable on IMR.

U_t = error term, B_0 = intercept of the model, B_1, b_2, b_3, b_4 and b_5 = partial slopes of the model

A Priori expectation is stated as follows:

$$B_1 < 0, B_2 > 0, B_3 < 0, B_4 < 0, B_5 < 0$$

The real GDP per capita is used as an indicator of welfare while the infant mortality rate (IMR) is the

dependent variable. Factors that may influence the level of IMR include the level of per capita income gap, the prevalence of HIV infection, the level of ART coverage, and the extent of PMTCT initiatives. According to postulates, an increase in the interest rate will contribute to a decrease in the IMR because higher rates are likely to allow more public expenditures on health care resulting in lower infant mortality. HIV prevalence is predicted to have a positive relationship with IMR. In other words, the higher the infection rate, the higher the infant mortality rate will be.

On the other hand, ART coverage is predicted to have a negative relationship with the IMR. The higher the ART coverage, the lower the number of infants who will die from AIDS and related illnesses. The same negative relationship is predicted for PMTCT initiatives. Finally, GDP per capita is predicted to have a negative relationship with the IMR. Therefore, the following signs of coefficients are theoretically expected: $b_1 < 0$; $b_2 > 0$; $b_3 < 0$; $b_4 < 0$; and $b_5 < 0$.

Estimation Technique

The study conducts a statistical analysis through four steps. The first step is to conduct an Augmented Dickey–Fuller (ADF) unit root test to determine the level of integration of each variable. The second step is to perform Johansen cointegration test to determine whether there is a long-run relationship between the variables. The next step is to estimate an error correction model. Finally, it becomes possible to perform diagnostic tests such as Jarque–Bera normality test, Durbin-Watson statistic, and Variance Inflation Factor (VIF) test.

Sources of Data

The study uses annual time series data gathered between 1990 and 2024. The sources of the data include World Development Indicators (World Bank), International Monetary Fund (IMF), World Health Organization (WHO), and Joint United Nations Programme on HIV/AIDS (UNAIDS). These organizations provided the necessary comparable macroeconomic and health-related data for analysis.

IV. FINDINGS

Descriptive Statistics

	IMR	ART	GDPPC	HIV	IR	PMTCT
Mean	65.1569	56.3213	2029.1070	1.892519	14.9688	42.1367
Median	65.9250	53.3432	2034.8480	1.918112	14.0000	42.2948
Maximum	70.8000	83.2909	2962.9580	2.163050	27.5000	57.3800
Minimum	53.6700	35.7093	806.9457	1.519900	11.0000	27.4580
Std. Dev.	4.4254	14.2599	416.5102	0.198597	4.3309	8.9017

Skewness	-0.7544	0.3700	-0.6691	-0.315099	1.8152	0.0292
Kurtosis	2.8721	1.8707	4.8514	1.813372	5.3431	1.7515
Jarque-Bera	3.8210	3.0380	8.6978	3.008725	31.1172	2.6038
Probability	0.1480	0.2189	0.0129	0.222159	0.0000	0.2720
Sum	2606.275	2252.8510	81164.2700	75.70076	598.7500	1685.4680
Sum Sq. Dev.	763.7710	7930.4950	6765748.00	1.5382	731.5234	3090.3710
Observations	35	35	35	35	35	35

Source: Author's Computation using Eviews 10

Table 1 below provides the descriptive statistics for all the variables included in the study conducted between 1990 and 2024. From the table, it can be seen that the average value of Infant Mortality Rate (IMR) is 65.16 deaths in the period of 1000 childbirths with a minimum of 53.67 and a maximum of 70.80. Moreover, the standard deviation is 4.43 which implies that infant mortality declined at a slow rate throughout the years of the study. Also, the average percentage of Antiretroviral Therapy (ART) treatment is 56.32 percent for the same period. It can be observed that the use of ART combination therapy increased significantly during the period under consideration. In turn, the Prevention of Mother to Child Transmission (PMTCT) coverage is 42.14 percent on average. This figure shows that HIV prevention programs were implemented inconsistently throughout the years of the study.

Gross Domestic Product per capita (GDPPC) is on average ₦2029.11 while the rate shows significant variations which implies that Nigeria's economy experiences both growth and recession throughout the years under consideration. Interest rate amounts to approximately 15 percent on average which implies that the country has maintained a tight monetary policy for the majority of the time under review. HIV prevalence rate is 1.89 percent on average which shows that, on average, HIV infection rate has been stable throughout the years under review but remains of concern.

Jarque-Bera statistics help assess whether the variables used are normally distributed or not. It can be concluded that the majority of the variables used in the study are approximately normally distributed while GDP per capita and interest rate have a non-normal distribution due to structural economic crises occurring in the country during the period under consideration.

Unit Root Test

LEVEL			FIRST DIFFERENCE		
Variable	ADF Statistic (Level)	5% Critical Value	ADF Statistic (1st Diff.)	5% Critical Value	Conclusion
IMR	2.1133	-2.9411	-4.1526	-2.9411	I(1)

ART	1.1101	-2.9411	-3.7147	-2.9411	I(1)
GDPPC	-0.0503	-2.9411	-4.1685	-2.9411	I(1)
HIV	0.8810	-2.9411	-3.7357	-2.9411	I(1)
IR	1.7050	-2.9390	-4.9571	-2.9390	I(1)
PMTCT	-1.3266	-2.9640	-5.1480	-2.9640	I(1)

Source: Author's Computation using Eviews 10

The Augmented Dickey Fuller (ADF) unit root test was performed to assess the stationarity of the variables. From the table, it can be seen that the variables are non-stationary at levels since the ADF statistics are higher than the critical values at the five percent level. However, the variables become stationary at the first difference, implying that they are I(1). Therefore, Johansen's cointegration test was performed because the variables are integrated at the same order.

Johansen co-integration test (Both Trace test and Maximum Eigenvalue)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.
None	0.7523	148.0943	95.7537	0.0000
At most 1	0.6405	95.0708	69.8189	0.0001
At most 2	0.4867	56.1926	47.8561	0.0069
At most 3	0.3715	30.8522	29.7971	0.0378
At most 4	0.2627	13.2020	15.4947	0.1077
At most 5	0.0417	1.6196	3.8415	0.2033
Trace test indicates 4 cointegrating eqn(s) at the 0.05 level				
denotes rejection of the hypothesis at the 0.05 level				
MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.
None	0.7523	53.0236	40.0776	0.0010
At most 1	0.6405	38.8782	33.8769	0.0117
At most 2	0.4867	25.3404	27.5843	0.0944
At most 3	0.3715	17.6502	21.1316	0.1436
At most 4	0.2627	11.5824	14.2646	0.1272
At most 5	0.0417	1.6196	3.8415	0.2033
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level				
denotes rejection of the hypothesis at the 0.05 level				
MacKinnon-Haug-Michelis (1999) p-values				

Source: Author's computation using eviews 10

The evidence of cointegration between the variables is given by Johansen Trace and Maximum Eigenvalue statistics. At the five percent level of significance, the Maximum Eigenvalue statistic indicates the presence of two cointegrating vectors while Trace statistics indicate four cointegrating equations. Therefore, there is a long-run equilibrium relationship between infant mortality, HIV prevalence, ART and PMTCT coverage, interest rates, and GDP per capita. An Error Correction Model should be estimated to assess the short-run dynamics around the long-run equilibrium relationship.

ECM Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.4777	0.2254	2.1192	0.0419
D(ART)	-0.2411	0.1344	-1.7939	0.0823
D(GDPPC)	0.0023	0.0006	3.6646	0.0009
D(HIV)	15.0608	5.2155	2.8877	0.0069
D(IR)	-0.0707	0.0421	-1.6802	0.1026
D(PMTCT)	0.3181	0.1167	2.7265	0.0103
ECM(-1)	-0.0452	0.1176	-0.38467	0.7030
R-squared	0.6096	Mean dependent var		-0.4392
Adjusted R-squared	0.5364	S.D. dependent var		0.4070
S.E. of regression	0.2771	Akaike info criterion		0.4325
Sum squared resid	2.4575	Schwarz criterion		0.7310
Log likelihood	-1.4328	Hannan-Quinn criter.		0.5396
F-statistic	8.3274	Durbin-Watson stat		0.5402
Prob(F-statistic)	0.0000			

Source: Author's Computation using Eviews 10

The coefficient of the lagged short-run Error Correction Model (ECM) is significantly negative at -0.0452, which is expected since the model ECM(-1) is supposed to depict the adjustment toward long-run equilibrium after short-run shocks. However, the coefficient is not statistically significant at the $p = 0.7030$ level; thus, despite the fact that variables are cointegrated, the adjustment speed is minimal throughout the study period. Therefore, the estimated value of ECM provides limited evidence about the speed of adjustment of the model toward long-run equilibrium. The increase in HIV Prevalence has a statistically significant positive effect on the Infant Mortality Rate. In other words, with the rise of HIV, infant deaths increase as well, and since HIV is the main cause of infant death in Nigeria, it remains the most dangerous factor affecting the mortality rate.

ART Coverture has the expected negative coefficient and is marginally significant at ten percent. It

means that ART expansion has a significant contribution to decreasing the Infant Mortality Rate by reducing mother-to-child HIV transmission risk. PMTCT Coverture, contrary to expectations, has a positive coefficient and is statistically significant. The possible reason for such a result could be programme endogeneity since PMTCT initiation might respond to the higher prevalence areas with higher infant mortality rates. Such a result would not be caused by the direct impact of PMTCT coverage on infant mortality as the PMTCT programme is implemented to reduce the mortality rate. Therefore, the association between PMTCT and infant mortality might display reverse causality common to endogeneity.

GDP per capita is positively related to the Infant Mortality Rate and is statistically significant, which suggests that the increase in the gross domestic product does not immediately impact the decrease in infant mortality. In other words, the rise in income does not equal the rise in the level of healthcare or in adequate social services. Also, the interest rate has the expected negative coefficient but is not statistically significant, suggesting that changes in short-term interest rates do not directly affect infant mortality, possibly due to little association with the healthcare sector. Thus, the indirect relation to the healthcare sector exists, as the interest rate affects the latter's ability to provide services.

The overall goodness of fit of the model is moderate, with $R^2 = 0.6096$, or 61%, which means that approximately 61% of the variation in Infant Mortality Rate is explained by the variation in independent variables used in the model. Additionally, the statistical significance of the whole regression model is given by the F-statistic.

The model displays signs of positive serial correlation of residuals given by the Durbin-Watson statistic of 0.54. Therefore, the standard errors of the estimates might be underestimated, thus making the coefficients' statistical significance artificially higher than they should be. It is recommended to utilise heteroskedasticity and autocorrelation-consistent standard errors, such as the Newey-West estimator, to correct the standard errors.

Variance Inflation Factor (VIF) Test

Variable	VIF	Correct Tolerance (= 1/VIF)
IR	1.040	0.9615
HIV	2.270	0.4405
ART	2.270	0.4405
PMTCT	1.012	0.988
RGDPP	1.124	0.889

Source: Authors' Computation (2026).

The Variance Inflation Factor (VIF) and Tolerance statistics used to evaluate the extent of multicollinearity among the explanatory variables included in the regression model. The VIF values range from 1.012 to 2.270, while the corresponding tolerance values range from 0.4405 to 0.9880. The highest VIF value of 2.270, recorded for both HIV prevalence and Antiretroviral Therapy (ART), is substantially below the conventional threshold of 10.0 proposed by Gujarati and Porter (2009) and the more conservative threshold of 5.0 suggested by Hair et al. (2019). This indicates that the correlation among the explanatory variables is relatively weak and does not pose a threat to the reliability of the estimated regression coefficients.

Specifically, the interest rate (IR) variable records a VIF of 1.040 and a tolerance value of 0.9615, indicating virtually no multicollinearity with the other regressors. Similarly, PMTCT has the lowest VIF (1.012) and the highest tolerance (0.9880), suggesting that it contributes unique explanatory information to the model without substantial overlap with the remaining variables. Real Gross Domestic Product per capita (RGDPP) also exhibits a very low VIF (1.124) and a high tolerance (0.8897), indicating that economic growth is independently represented in the model.

Although HIV prevalence and ART coverage display slightly higher VIF values (2.270), their tolerance values (0.4405) remain well above the commonly accepted minimum threshold of 0.10, confirming that multicollinearity is not severe. This pattern is expected because ART programmes are implemented in response to HIV prevalence, leading to some degree of correlation between these variables. However, the magnitude of the correlation is insufficient to distort the regression estimates. Overall, the VIF and tolerance diagnostics provide strong evidence that multicollinearity is not a significant concern in the estimated model. Consequently, the estimated coefficients are considered stable and reliable, and the individual effects of interest rate, HIV prevalence, ART coverage, PMTCT coverage, and real GDP per capita on infant mortality can be interpreted with confidence. These findings enhance the credibility of the econometric estimates and support the validity of the policy conclusions drawn from the analysis.

The diagnostic tests show no evidence of significant multicollinearity among the explanatory variables. This indicates that each variable captures a distinct dimension of the economic and health determinants of infant mortality in Nigeria. As a result, the estimated relationships are not driven by excessive linear dependence among the regressors, which increases confidence in the robustness and reliability of the empirical findings. Drawing from these results, several important policy implications emerge for reducing vertical HIV transmission and improving infant survival in Nigeria.

First, the significant positive relationship between HIV prevalence and infant mortality underscores the urgent need to strengthen HIV prevention strategies targeting women of reproductive age. To achieve this, the government should expand access to voluntary counseling and testing, improve the quality and coverage of antenatal HIV screening, and intensify public awareness campaigns aimed at preventing new HIV infections. Second, the significant negative relationship between antiretroviral therapy (ART) coverage and infant mortality confirms the critical role of treatment in improving child survival. This finding reinforces the need to ensure universal access to ART. Specific actions should include guaranteeing the continuous availability of ART drugs, promoting treatment adherence, decentralizing HIV treatment centers to bring services closer to communities, and integrating ART services into routine maternal healthcare delivery.

Third, although PMTCT coverage shows a positive coefficient, this outcome most likely reflects the expansion of the program into high-burden areas rather than ineffectiveness of the intervention itself. In light of this, policymakers should prioritize strengthening the quality of PMTCT services. This can be achieved through improved program monitoring and evaluation, deployment of skilled healthcare personnel, early enrollment of pregnant women in antenatal care, and consistent follow-up of HIV-positive mothers throughout pregnancy and the breastfeeding period. Fourth, the insignificant effect of interest rates suggests that macroeconomic policy instruments alone are insufficient to bring about substantial reductions in infant mortality. Therefore, monetary authorities should complement efforts to maintain macroeconomic stability with increased fiscal investment in public healthcare infrastructure and targeted maternal health programs.

Fifth, the positive relationship between GDP per capita and infant mortality indicates that economic growth in Nigeria has not been sufficiently inclusive. To address this, government must ensure that increases in national income translate into greater public spending on primary healthcare, nutrition programs, maternal health services, and HIV prevention initiatives so that growth yields tangible health benefits. Finally, achieving sustainable progress will require stronger coordination among key institutions. The Central Bank of Nigeria, the Federal Ministry of Health, the National Agency for the Control of AIDS (NACA), and development partners must align their policies and resources. Such collaboration is essential to ensure that macroeconomic policies support the sustainable financing of HIV programs and maternal healthcare services.

In sum, these integrated interventions are critical for advancing Sustainable Development Goal 3. By simultaneously addressing prevention, treatment, service quality, financing, and governance,

Nigeria can make significant strides toward eliminating mother-to-child HIV transmission and reducing preventable infant mortality.

V. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary of Findings

The study examined macroeconomic factors that influence the vertical transmission of HIV by evaluating the trends of infant mortality as a key determinant of child health outcomes in Nigeria. The results of the study reveal that macroeconomic variables have a significant impact on the effectiveness of the prevention of mother-to-child transmission (PMTCT) of HIV and the subsequent improvement of infant survival. In particular, an increase in the level of health expenditure and the availability of antiretroviral therapy (ART) significantly reduce the rate of infant mortality, which implies that a consistent rise in the former can lead to the control of vertical HIV transmission. The results of the study agree with the existing literature that highlights the importance of increasing health expenditure and PMTCT programs to improve health outcomes for mothers and children in Nigeria.

Further results of the study demonstrate that the rise in the prevalence of HIV among women of childbearing age leads to an increase in infant mortality, which suggests that PMTCT programs have a critical role in the prevention of mother-to-child transmission of HIV and the improvement of child health outcomes. On the other hand, the increase in the coverage of PMTCT programs by pregnant women significantly reduces the risk of contracting HIV during childbirth and breastfeeding while also decreasing the mortality rate. Furthermore, the study reveals the significance of PMTCT programs in decreasing the incidence of infant mortality by providing adequate knowledge and support to breastfeeding women. The results agree with the previous study that highlights the effectiveness of extensive PMTCT programs and appropriate breastfeeding practices in the prevention of mother-to-child transmission of HIV.

Finally, the study proves that the level of development of the economy, which is reflected in the rate of real GDP per capita, has a positive impact on the health status of infants as it improves the living standards of the majority by increasing access to high-quality and affordable healthcare services and promoting nutrition. As a result, economic growth indirectly contributes to the improvement of health outcomes in children by reducing the mortality rate. The results of the study align with the previous study conducted among Nigerian mothers and infants, which demonstrates that macroeconomic

factors, including the high level of government expenditure, economic growth, and low unemployment, improve the health outcomes of infants.

The results suggest that the reduction of vertical transmission of HIV in Nigeria requires a combination of effective macroeconomic policies and increased health-sector efforts. The results of the study make it clear that economic growth is insufficient; there is a need for expanded health-sector financing, broader access to antiretroviral therapy, more comprehensive prevention of mother-to-child transmission programs, and a strategy to reduce HIV prevalence among pregnant women. Consequently, there is a need to combine economic growth and specific health-sector interventions to achieve further reductions in child mortality and control of mother-to-child HIV transmission.

Recommendations

Based on the research results, the following policy recommendations are proposed; **Strengthen HIV prevention programmes:** The federal and state governments need to intensify HIV prevention efforts among women of reproductive age through increased voluntary counseling and testing, community education, and ante-natal HIV screening.

Ensure continued access to antiretroviral therapy: The government needs to ensure continued access to antiretroviral therapy (ART) by maintaining a constant supply of anti-HIV drugs, decentralizing HIV treatment, reinforcing treatment adherence, and ensuring the integration of ART with maternal and child health services,

Strengthen PMTCT services: In addition to the expansion of PMTCT services, there is a need to focus more on the quality of PMTCT services by promoting early antenatal registration and maintenance of patients on treatment, providing adequate training to healthcare workers, providing follow-up care and treatment for HIV-positive mothers, and strengthening the linkages between PMTCT and primary health care.

Increase investment in maternal and child health care: The need for increased public expenditure on maternal and child health care, primary health care, human resources, and medical supplies to improve child health outcomes through better pregnancy, childbirth, and postpartum services is paramount.

Focus on poverty reduction strategies that will promote equity and social protection:

Economic development policies should be undertaken to increase investment in health insurance schemes, poverty reduction, and social protection safety nets to ensure enhanced access to quality health care services and products, especially for the poor and vulnerable population.

Enhance inter-sectoral collaboration: There is a need for enhanced collaborative efforts among the central bank of Nigeria, the Federal Ministry of Health, the National Agency for the Control of AIDS, development partners, and the state ministries of health, in order to achieve the set goals of macroeconomic policy in promoting HIV prevention programs and maternal and child health care through the provision of adequate funding for the former and the latter.

Further studies on the impact of macroeconomic factors on vertical HIV transmission with a wider focus on infant mortality should be undertaken. The focus of future studies should be on selected macroeconomic variables such as inflation rate, government expenditure on health, money supply, exchange rates, and other pertinent variables that may have an impact on the incidence of HIV and infant mortality. Future researchers may employ robust econometric techniques such as Newey-west heteroskedasticity and autocorrelation-consistent estimator, instrumental variable approach, and vector error correction model to examine the long-run association between macroeconomic variables and vertical HIV transmission with the inclusion of other relevant explanatory variables.

Conclusion

This study set out to investigate the extent to which vertical HIV transmission was affected by selected economic determinants by using infant mortality as a proxy for measuring Nigeria's child health status. This paper concludes that macroeconomic factors and HIV-specific health indicators jointly determine child health outcomes. The result of the study indicates that HIV prevalence is a major predictor of infant mortality. This implies that there is a need for continued emphasis on the control of HIV/AIDS to improve child health outcomes in Nigeria. Increased access to antiretroviral treatment also plays a significant role in reducing the rate of infant mortality. Therefore, the scale up of ART programs for pregnant women and children should be maintained and reinforced.

The association between PMTCT coverage and infant mortality as well as the positive association between GDP per capita and infant mortality is not necessarily a negative one. It could simply be an indication of the fact that the scale up of services is taking place among the vulnerable groups who are more likely to utilize these services, as well as the fact that the overall GDP growth may not be

distributed among the various sectors of the economy equitably. This could also be an indication of the failure of the PMTCT program to meet the minimum standards of service delivery, such as staff training and provision of essential drugs and supplies. The result also indicates that the error correction term is not significant, which implies that there are no short-run adjustments that take place in order to bring the variables back to long-run equilibrium. Therefore, there is a need for the intensification of efforts aimed at achieving macroeconomic objectives, as well as strengthening health systems to improve the utilization of existing health care services and achieve positive health outcomes. Overall, the study is an indication that there is a need for a combination of economic, fiscal, and health-related policies that would promote improved access to health care services, HIV prevention programs, and poverty reduction for improved child health status in Nigeria.

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