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MALARIA, POVERTY AND CHILD HEALTH IN NIGERIA: ANY NEXUS?

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Abstract. Infant mortality rates remain high in many African countries, despite global lowering trends. These high rates are alarming, therefore, this study attempt to examine the effect of malaria and poverty on infant mortality a proxy for child health in Nigeria using a data for the period 1990-2021. Auto-regressive distributed lag model (ARDL) was used as the estimation technique. The study's findings showed that both in the short and long run, poverty rate has a negative non-significant effect on infant mortality while malaria has a positive and significant effect on infant mortality. Government expenditure on health both in the short run and long run is positive and nonsignificant on child health. The current values of primary school enrolment (PSE) and number of physician (NOP) have a negative (-0.014 and -0.0002) non-significant effect on infant mortality in the short, and also negative (-0.501 and -1.654) but significant in the long run. The study recommends that policies that will improve child health and promote poverty reduction should be put in place and well implemented in Nigeria. Also, the government should take measures that will eradicate malaria in Nigeria.

Keywords: *malaria, poverty, child health, infant mortality, ARDL*.

Rezumat. Ratele mortalității infantile rămân ridicate în multe țări africane, în ciuda tendințelor globale de scădere. Studiul încearcă să examineze efectul malariei și a sărăciei asupra mortalității infantile, un proxy pentru sănătatea copiilor în Nigeria, folosind date pentru perioada 1990-2021. Drept tehnică de estimare a fost utilizat modelul de întârziere distribuită auto-regresiv (ARDL). Concluziile studiului au arătat că atât pe termen scurt, cât și pe termen lung, rata sărăciei are un efect negativ nesemnificativ asupra mortalității infantile, în timp ce malaria are un efect pozitiv și semnificativ. Cheltuielile guvernamentale pentru sănătate, atât pe termen scurt, cât și pe termen lung, sunt pozitive, dar nesemnificative pentru sănătatea copilului. Valorile actuale ale înscrierii în școala primară (PSE) și ale numărului de medici (NOP) au un efect negativ (-0,014 și -0,0002) nesemnificativ asupra mortalității infantile pe termen scurt, dar negativ (-0,501 și -1,654) și semnificativ pe termen lung. Studiul recomandă, ca politicile care vor îmbunătăți sănătatea

copiilor și vor promova reducerea sărăciei să fie puse în aplicare și bine implementate în Nigeria. De asemenea, guvernul ar trebui să ia măsuri pentru eradicarea malariei în Nigeria.

Cuvinte cheie: *malarie, sărăcie, sănătatea copilului, mortalitatea infantilă, ARDL*.

1. Introduction

Well-being and wealth are key drivers of any economy to bring about positive change. It as a known fact that developing economies like Nigeria is characterized with different diseases both communicable and non-communicable, malaria inclusive. Malaria poses a great threat to the development of any nation, including Nigeria. The prevalence of malaria is extremely high in Nigeria, given the weather condition of Tropical rain forest. Malaria is not only a national concern, but it is also a global concern. No wonder that Target 3.3 of Sustainable Development Goals (SDGs) is to fight malaria [1]. The target aims to eradicate malaria in at least 35 countries and cut death rates by at least 90 % by 2030 [2]. Malaria has to be taken seriously because the economic burden is very high and more importantly, it results in elevated rates of morbidity and mortality in both children and expectant mothers. Malaria goes as far as reducing the immune system of people [3, 4]. Malaria is a disease that is caused by protozoan parasite of the plasmodium genus which is usually spread by the female mosquito called anopheles. This type of mosquito usually attacks the red blood cells. According to [5], malaria is preventable and curable even though it is very deadly. Malaria in human is caused by five different parasite species, of which Plasmodium falciparum and Plasmodium vivax are the two most harmful. Even though both national and international, governmental and nongovernmental organisations have rolled out policies and programmes to curb the prevalence of this disease, it has not given an expected and desired result. Some of these programmes include distribution of mosquito-treated nets, and awareness about keeping the environment clean to prevent the breeding of mosquitoes. Most times malaria affects the poor because poor people usually live in an environment that breeds mosquitoes. Failure to eradicate malaria in most developing countries is because of poverty and places where malaria prospers, the people in such places also have the least prosperity [6]. Poverty can encourage the spread of malaria, yet malaria can also create poverty by hindering a nation's ability to prosper economically. The two case scenarios can happen having a case of two-way causality.

Africa's Sub-Saharan region is most burdened of the incidence of malaria [7]. There are about 300 million to 500 million cases across the globe annually, more than 1 million deaths recorded, most of these deaths occurred among under-five children. Also, 96% of most of the mortality cases occur in sub-Saharan Africa. The two leading causes of childhood fatalities are anemia and cerebral malaria. Poverty and malaria have a number of intricate relationships. According to [8], Nigeria's growth has been adversely impacted by malaria by roughly 3.8 %. Aside from the detrimental impact on economic growth, the incidence of malaria can discourage foreign trade and investment even at the national level. As a result, the economic burden of malaria is higher in sub-Saharan Africa, Nigeria inclusive. Sub-Saharan Africa continues remains the region with the highest rate of mortality for children under five despite the fact that globally, a reduction in child mortality has occurred. Nigeria and India alone accounted for about a third of mortality cases of under five children in 2019 [9].

In Nigeria, malaria is a critical public health concern. This is because families are kept in a cycle of illness and financial hardship by the condition and the expense of

treatment. Even though, using mosquito net coated with insecticides has increased to about 61%, yet the prevalence of malaria is still high in the country [10]. The level of poverty is also high in Nigeria many people are faced with little or on financial opportunities, the level of unemployment is high making many people not to have a regular income [11]. A person is considered to be below the poverty line in Nigeria if the person id having less than 213 US Dollars in a year at least to feed, this is according to the Nigerian National Standards. There are about 40.1% of Nigerians that are living in poverty [12]. Furthermore, [13] stated that more than 50% of people living in Nigeria live below poverty line. Similarly, child poverty is very high in Nigeria. It has been stated that one of the dreadful outcomes of high level of poverty in the Nigeria is the child poverty. According to the 2011 Multiple Indicator Cluster Survey (MICS), over 70.31% of Nigerian children live in overall child poverty, and about 23.22% of children live in extreme poverty [14].

Although, across the globe, there is an appreciable decrease in the deaths of under-five, yet sub-Saharan Africa continues to be the area with the highest global under-five death rates, with one out of many children dying before turning five. More importantly, Nigeria topped the list of under-five mortality in 2019 with about 858 deaths per thousand [9]. Malaria and malnutrition have been part of diseases that cause these child deaths. In fact, European Alliance Against Malaria, (2007) stated that in Nigeria the primary cause of mortality for children is malaria. Nigeria cannot afford to continue to record high child mortality because better health for children would allow them to live longer, in order to get educated and eventually earn income in the future this would likely contribute to the productivity of a country. Hence, good health has both direct and indirect impact on an economy [13].

Even though a link has been found between poverty and malaria [6], its yet unknown how strong of a correlation this is and in what direction. Most of the existing studies have captured the links at the individual or household level but the wider societal level has not been fully captured. It is also important to raise these questions to put this study in the right perspective; is there any relationship among malaria, poverty and child mortality is Nigeria? If there are, what type of association exists among them? Have malaria and poverty contributed to the high child mortality in Nigeria? If yes, what is the magnitude? Therefore, this study aims to investigate the level of association among malaria, poverty and child mortality. With the intention of looking into 1the effects of both malaria and poverty on child health in Nigeria from 1990 to 2021.

The impact of poverty and other economic factors on the treatment of malaria among residents of Zamfara State, Northwestern Nigeria, was studied by [4]. They discovered through semi-structured interviews that the high rate of malaria in that state was a result of poverty. The impoverished are unable to pay for their own malaria treatment. Similarly, using the cost of illness approach with the Harmonized National Living Survey (HNLSS) [13]. They examined how the monetary expenditure among households affect the treatment of malaria in Southern Nigeria. Their study revealed that the economic burden in the treatment of malaria is high in the Southern states of Nigeria. Malaria has been explained to be the disease of the poor. Studies have emphasized the two-way causality between poverty and malaria, especially in the area of micro study. This is in the sense that poverty could make people sick such that they are unable to afford the necessary medical care when they are sick. On the other hand, sickness fosters poverty. That is, when people are sick, they cannot go to work which leads to loss of income and hence, poverty.

According to [15], malaria is endemic in Nigeria and they also examined the possibility of two-way causality between presumptive malaria and household poverty level in rural areas of Southwest Nigeria. They used the multi-stage sampling technique and structured questionnaires on about 395 respondents from 35 villages. They employed the Foster-Greer-Thorbecke (FGT) model and two-stage probit least square method to analyse the data and they found a two-way causality between poverty and malaria.

The willingness to pay method was used by [3] to analyze the malaria load. They employed linear regression analysis and a structured questionnaire with roughly 1600 responses. Their findings demonstrated a high degree of public readiness to pay for the treatment of malaria. They discovered that poverty and health are closely related, and that a large portion of the population bears a heavy financial burden due to malaria. In the Similar vein, a study by [16] estimated the cost of malaria to rural households in Western Ethiopia's Oromia Regional State's Chewaka District. The research was a cross-sectional study conducted in a community. With a sample size of about 765 households, using the multivariate logistic regression analysis, they found that there is high economic burden in that district in Western Ethiopia. Most households spend more than 5% of their yearly revenue due to malaria. Furthermore, a study by [17] also examine the links between households' poverty level and malaria in Uganda. They looked into the association between the socioeconomic standing, its determinants and malaria among children in rural area Nagongera, Uganda. Information on socioeconomic position was collected for about 318 children from 100 households, who were followed up for 36 months. The age bracket of the selected children was between 6 months and 10 years of living. Investigating the causal pathways through mediation analysis, they found out that the children from the lowest socioeconomic backgrounds had an average of twice the odds of contracting malaria indicating that socioeconomic factors influence malaria transmission in Uganda. Similarly, [18] reviewed several previous studies between 2020 and 2022 that examined the socioeconomic pathways between poverty and malaria. Their study suggested in sub-Saharan Africa, the housing, food security and the use of antimalaria drugs are mediations in the link between poverty and malaria.

In another vein, using secondary data in Nigeria, [19] investigated the burden of malaria economically on labour productivity. This study covered the period of 31 years from 1987 to 2017. A long-term correlation between malaria and labor productivity was discovered using Engel-Granger Cointegration Test. Their ECM results showed that malaria impacted negatively on labour productivity in Nigeria. Using the Vector Error Correction Model for 37 years to examine the influence of health shock on the poverty level in Nigeria, [20] they found out that health shocks induce poverty in Nigeria. Also with a balanced panel of 100 countries that are endemic with malaria from 1985 to 2001, [21] focused on the two-way causality between malaria and economic well-being. They used the OLS, Two Stage Least Squares and Three Stage Least Squares Method to analyse the data. Their result indicated that malaria had a negative and significant effect on income per capita. They stated that high economic growth leads to reduction in malaria, but that economic development cannot be brought about by reduction in malaria alone. In a more recent study, using a multivariable logistic regression to find malaria correlates in a facility-based cross-sectional study with 585 children under five who visited public health facilities in the northwest Ethiopian Wogera district, [22] investigated the prevalence of malaria in children under five years old and its contributing factors. They discovered that there was a high

frequency of malaria in the study population and that malaria of course is one of the major causes of worsened health of children.

Furthermore, studies also abound on the influence of poverty on child health. For instance, [23] in their study on how poverty affects a child's development and health, found that in a number of dimensions, there is evidence that poverty has a detrimental impact on children's development and health. A similar study by [24] also examine the effects of poverty on children's health in Canada, both now and in the future. They discovered that children who grow up in low-income households or areas typically have poorer health outcomes. Furthermore, poverty affects children's health not just when they are young but also throughout their lives. Another study by [25] on poverty and child health in the UK discovered that child poverty is currently at high levels in the UK, thus Children's potential and development are limited by the poor health associated with child poverty, which results in poor health and life chances as adults. Using National Centre for Health Statistics (NCHS) birth-infant death files from the 2013 timeframe cohort to evaluate the relationship among Poverty, urban-rural classification and infant mortality in United State, [26] concluded that `infant mortality was still linked to high poverty and extremely rural counties, regardless of the specific sociodemographic, health, and obstetric characteristics of each mother.

From the above, it can be gathered that most studies on malaria have focused on households hence, making use of micro study. The few macro studies have not really linked the malaria, poverty and child deaths together especially in Nigeria. Therefore, this study sets to bridge this gap in the literature.

2. Materials and Methods

To examine the effect of malaria and poverty on child health in Nigeria, this paper is guided by the model specified by [27]. The model is specified as:

$$IMR = f(POV, MAL, PSE, GEXH, NOP), \quad (1)$$

In a simple linear equation and log form, model "Eq. (1)" becomes:

$$LnIMR = \alpha_0 + \alpha_1 LnPOV + \alpha_2 LnMAL + \alpha_3 LnPSE + \alpha_4 LnGEXH + \alpha_5 NOP + \mu, \quad (2)$$

where: IMR is infant mortality a proxy for child health; POV is poverty rate; MAL is incidence of malaria; PSE is primary school enrolment; GEXH is Government Expenditure on Health; NOP is Number of physician; μ is the error term, α_0 is the intercept, and α_1, α_2 ... α_5 represent the parameter estimates. The apriori expectation is expressed mathematically as $\alpha_1 > 0$, $\alpha_2 > 0$, $\alpha_3 < 0$, α_4, < 0, and $\alpha_5 < 0$.

This study employed the Autoregressive Distributed Lag (ARDL) model to determine how malaria and poverty affect child health. This model is fundamentally important because it enables us to investigate both short- and long-term relationships simultaneously using the same framework, irrespective of "whether all variables are I(1), I(0), or a combination of I(1) and I(0) variables," i.e., in the same sequence. The error correction version of autoregressive distributed lag (ARDL) is specified in "Eq. (3)" A variant of the error-correction model (ECM) can explain the long-run relationship among the variables [28]. This clarifies the relationship between changes in the infant mortality proxy for child health and any changes caused by changes in other dependent variables, as well as the disequilibrium and divergence in the previous period. The ARDL model is derived as follows:

$$\Delta IMR_t = \beta_0 + \sum_{j=1}^{n} \partial_j \Delta POV_{t-1} + \sum_{J=1}^{P} \alpha_j \Delta MAL_{t-1} + \sum_{J=1}^{p} \varphi_j \Delta PSE_{t-1} + \sum_{J=1}^{p} \Phi_j \Delta GEXH_{t-1} + \sum_{j=1}^{P} \theta_j \Delta NOP_{t-1} + \beta_1 POV_{t-1} + \beta_2 \mathrm{MAL}_{t-1} + \beta_3 PSE_{t-1} + \beta_4 GEXH_{t-1} + \beta_5 NOP_{t-1} + \tau ECT_{t-1} + \mu_t \quad (3)$$

In "Eq. (3)" β_{1-5} represent the convergence of short-run dynamic coefficients to long-run equilibrium while τ is the error correction model and speed of adjustment parameter derived from the predicted equilibrium relationship. The aforementioned ECM could be considered as including both short-term transient effects and long-term consequences.

Definitions and Measurement of variables

Based on the literature, the measurements of the different variables of the model for the study are described briefly and stated as follows.

Infant Mortality rate proxy for Child health

The number of deaths of children under five years old, expressed per 1,000 live births, is known as the infant mortality rate. *A proxy for child health [25, 26]*. The World Development Indicator (WDI) was the source of this data.

Poverty

In line with the [29] definition, which defines poverty as "the inability to attain a minimal standard of living." Using fundamental consumption needs as a benchmark, this definition calculates poverty. It has also been maintained that per capita household spending is a more constant indicator of poverty than per capita income [30, 31]. This data was obtained from the World Development Indicator (WDI).

Incidence of Malaria

Following [32] and [33] on their findings which indicate that the degree to which victims have been made immobile or unable to carry out their regular productive activities needs to be reflected in an acceptable measure. Therefore, the number of reported cases of malaria per 1,000 people (Incidence of malaria (per 1,000 population at risk) serves as the study's malaria index. Because it is predicted to be order-preserving, this should serve as a good proxy for the severity of malaria attacks, including cases that go unreported. The data on incidence of malaria was obtained from WDI and National Bureau of Statistics (NBS).

Furthermore, **Primary school enrollment** is the gross enrollment ratio, calculated as the proportion of all enrolled individuals, aged or not, to the age group population that formally corresponds to the shown degree of education. And **Government expenditure on** health as a proportion of total government spending - This metric shows the %age of total government spending that goes toward general health care. It illustrates the proportion of public health spending to the overall value of operations in the public sector. While **No of Physicians** is the number of physicians, including generalists and specialists, in medical professions per 1,000 people. Data on these variables are also sourced from WDI.

3. Results and Discussion

Gaining a sense of the data set is crucial in order to understand the information in the sample before conducting any regression analysis. Descriptive statistics therefore enables a researcher to have a glimpse of the data used in the study thereby gaining a more precise idea of the distribution of the variables employed. However, the result of the descriptive statistics is presented in Table 1. Table 4.1 shows that the average value of

Infant mortality rate (IMR) between 1990 and 2021 is 159.45, with a maximum of 209.3 and a minimum of 110.8. In addition, the average value of the poverty (POV) in Nigeria during the study period is about 65.20, ranging from 35.78 to 86.92. Concerning Incidence of malaria (MAL), the study revealed that the average value is 342.5, and it varies between the range of 294.1 and 415.7. However, on Primary school Enrolment (PSE), the table shows that this ranges from 78.66 to 102.1 (minimum and maximum respectively) with an average value of 90.78.

Also, government expenditure on health (GEXH) average value is 1673.3, with a maximum value of 5185.3 and a minimum of 9.51 and the mean value of No of physician (NOP) is 0.313, ranging from 0.18 to 0.315.

Table 1

Descriptive Statistics

	IMR	POV	MAL	PSE	GEXH	NOP
Mean	159.4563	65.2039	342.5345	90.78721	1673.333	0.313031
Median	152.6500	66.20931	310.6279	90.38740	1277.875	0.315000
Maximum	209.3000	86.91956	415.7665	102.1081	5185.320	0.451000
Minimum	110.8000	35.78851	294.1107	78.66348	8.518700	0.185000
Std. Dev.	34.18290	13.79981	50.01407	6.584192	1530.854	0.082909
Skewness	0.204051	-0.326837	0.458113	-0.000881	0.886885	-0.076505
Kurtosis	1.521882	2.223549	1.359676	1.995830	2.619225	1.614250
Jarque-Berra	3.135176	1.373554	4.706847	1.344480	4.388330	2.591620
Prob.	0.208548	0.503195	0.095043	0.510564	0.111452	0.273676
Obs	32	32	32	32	32	32

Source: Author's Computation, 2024.

Note: IMR - Infant mortality rate; POV – poverty; MAL- Incidence of malaria; PSE- Primary school Enrolment; GEXH- government expenditure on health; NOP- No of physician.

Furthermore, the series appears to be widely scattered from the mean values as captured by the values of their standard deviations in Table 1 except for GEXH which somewhat clustered around its mean value. The skewness shows how spread the data is from their means. It measures the asymmetry of the series distribution around the mean. The statistics in table 4.1 reveal that variables IMR, MAL and GEXH are positively skewed, implying that these distributions have long right tails while POV, PSE and NOP skewed negatively depicting a long left tail. In addition, the kurtosis measures the series distribution's flatness or peakness (height). Distributions with kurtosis values of less than three are said to be platykurtic while values greater than three are said to be leptokurtic. Hence, all the variables (IMR, POV, MAL, PSE, GEXH and NOP) are platykurtic with 1.52, 2.223, 1.359, 1.995, 2.619 and 1.614 respectively, indicating that the distributions are flat relative to normal.

Lastly, the Jarque-Bera (JB) statistic measures whether the series is normally distributed or not. All variables have p-values larger than 0.05. With regard to all the variables, the null hypothesis of a normal distribution at 5% was thus approved.

3.1 Correlation Test

Correlation matrix is needed to observe the degree of association between a model's explanatory variables and dependent variable(s). Table 2 presents the correlation matrix between the dependent and explanatory variables of the model used in the study.

Table 2

Correlation Matrix

	IMR	POV	MAL	PSE	GEXH	NOP
IMR	1.000000					
POV	-0.538990	1.000000				
MAL	0.019149	0.001335	1.000000			
PSE	-0.006618	-0.145578	0.512148	1.000000		
GEXH	-0.478935	0.635243	0.402535	0.014412	1.000000	
NOP	-0.634150	0.466159	0.036749	-0.152910	0.621311	1.000000

Source: Authors Computation, 2024.

Note: IMR - Infant mortality rate; POV – poverty; MAL- Incidence of malaria; PSE- Primary school Enrolment; GEXH- government expenditure on health; NOP- No of physician.

Table 2 specifically indicated the strength of the correlation between the dependent variable (IMR) and independent variables (POV, MAL, PSE, GEXH and NOP). The results demonstrates that there is no multi-collinearity in the variables because the values are less than 0.8. Specifically, the correlation matrix's coefficients fall between 0.001 to 0.63. Hence, according to the findings, the variable's correlation coefficients are moderate and allow for coexistence in the same model.

3.2 Stationarity Test (Unit Root Test)

It became necessary to ascertain the stationarity or non-stationarity of the variables using augmented Dickey-Fuller (ADF) unit root tests. By comparing the ADF test statistics with the critical values in Table 3, it was discovered that most of the variables were non-stationary at levels (IMR, POV, MAL, GEXH and NOP). However, it became stationary at first, differencing I(1) except for PSE which is stationary at level I(0). Having demonstrated that all variables were stationary at levels and at first difference, we applied the Johansen and bounds test for cointegration analysis in the model.

Table 3

Augmented Dickey-Fuller (ADF) Unit Root Test

Variable	Level ADF	Level 5%	1st Diff	1st Diff @ 5%	Decision
IMR	-0.289137	-2.967767	-3.029754*	-2.967767	1(1)
POV	-2.816156	-2.960411	-6.984395*	-2.963972	I(1)
MAL	-1.156492	-2.960411	-4.620562*	-2.953972	I(1)
PSE	-3.549460*	-2.967767	-4.342530	-2.976263	I(0)
GEXH	-2.134425	-2.986225	-3.670429*	-2.991878	I(1)
NOP	-1.323258	-2.960411	-4.197282*	-2.963972	I(1)

Source: Authors Computation, 2024.

Note: * 5% significance level. All variables are in log form except NOP

3.3 Cointegration Test

Consequently, a cointegration test is conducted in order to determine the variables' long-term relationship. The Johansen and ARDL bound Cointegration results are however presented in Tables 4 and 5 below.

Table 4

Result of Unrestricted Co-integration Rate Test (Trace)

Hypothesized No of CEs	*Eigen value*	*Trace statistic*	*0.005 critical valu*	*Prob* **
None *	0.909562	152.9063	83.9371	0.0000
At most 1	0.700694	80.81352	60.06141	0.0004
At most 2	0.521791	44.62485	40.17493	0.0167
At most 3	0.337386	22.49361	24.27596	0.0825
At most 4	0.266867	10.14671	12.32090	0.1126
At most 5	0.027412	0.833846	4.129906	0.4167

Note: Trace test indicates 3 co-integrating equation(s) at the 0.05 level *denotes rejection of the hypothesis at the 0.05 level. **Mackinnon-Haug-Michelis (1999) p-values.

From Table 4, the null hypothesis of no cointegration among the variable is rejected as the trace test indicates 3 co-integrating equation at 5% significance level. Thus, there is cointegration among the variables. This suggests that the variables in Nigeria have long-term relationships with one another.

Also corroborating the Johannsen cointegration results above, arising from the estimated bounds F-statistics results presented in Table 5, we conclude that the three key variables (i.e. Infant mortality, poverty and incidence of malaria, co-move in the long run and have long run relationships. The F-statistics (7.0096) exceed the critical values of both lower and upper bounds at all levels. Hence, it is implied that there is a long-term co-integration relationship among the variables in this model thus the null hypothesis of no co-integration is rejected.

Table 5

ARDL Bounds Test for co-integration Relationship

Model	**Computed F-Statistic**	
F-Statistic	7.0096	
Bounds Level	I(0)	I(1)
10 %	2.26	3.35
5 %	2.62	3.79
2.5 %	2.96	4.18
1 %	3.41	4.68

Source: Author's Computation, 2024.

3.4 Auto Regressive Distributed Lag Model (ARDL)

Table 6 contains both the short run and long run ARDL estimates of poverty rate (POV), incidence of malaria (MAL), government expenditure on health (GEXH), primary school enrolment (PSE) and number of physician (NOP) on infant mortality (IMR) proxy for child health in Nigeria.

Table 6 provides information about the regression estimate that captures the long and short run analysis. It indicates that the explanatory variables jointly explain approximately 99% of the variations in infant mortality in Nigeria, with the F-statistics (60301.26; P=0.000)

being highly significant at all levels. This confirms the model's applicability, and the Durbin Watson statistics of 2.2292 show that there is no serial auto-correlation in the short- and long-term estimates. Additionally, the short run regression estimate demonstrates that the ECM's coefficient of the error-term satisfies its basic criteria of less than 1, negative and statistically significant. Going by the p-value of 0.0036 which is significant at 5% level, demonstrates the rapidity of change (speed of adjustment) from the short to the long term. i.e. if there exists any disequilibrium in the system, it takes just 2 % to adjust back from the short run to the long run.

In addition to the above, the ARDL result revealed that poverty rate (POV) has a negative non-significant effect on infant mortality (IMR) a proxy for child health both in the short and long run in Nigeria. This implies that a rise in poverty level may worsen the health of an infant thus resulting in poor health outcome for the child as children's health generally suffers when they are raised in low-income households or communities, thus an increase in the chances of sudden unexpected death in infancy (SUDI) in Nigeria. This finding is in line with [23-26]. It was also observed that the coefficients of malaria (MAL) have a positive and significant effect on infant mortality both in the short and long run. Meaning that a rise in incidence of malaria would result in higher death rate in infancy. Thus, Malaria contributes to increased worsened health of children**.** This also corroborates the submission of [22] and Roser [34].

Also, it was further revealed that the coefficient of government expenditure on health both in the short run and long run is positive and nonsignificant on child health in Nigeria. This implies that child health outcome is unaffected both in the short run and long run even in the face of the perceived increased in government expenditure on health. Implying that with increased government expenditure on health, child health neither deteriorate nor improve. The reason for the non-significant result in the short and long run may be as a result of high rate of corruption which makes government expenditure on health ineffective. This finding runs contrary to the findings of [35] and [36].

Table 6

Estimated Short and long run coefficients using ARDL approach (Dependent Variable *ln*IMR)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
		SHORT-RUN		
LNPOV	-0.002656	0.004101	-0.647607	0.5270
LNMAL	0.010710	0.002106	2.307207	0.0252*
LNMAL(-1)	0.002231	0.007752	0.287737	0.7775
LNMAL(-2)	0.015769	0.005752	2.741600	0.0151*
LNPSE	-0.014036	0.006844	-2.050875	0.0582
LNPSE(-1)	0.012893	0.005912	1.865306	0.0818*
LNPSE(-2)	-0.009726	0.005441	-1.787498	0.0941*
LNGEXH	0.000255	0.000344	0.739456	0.4710
LNGEXH(-1)	0.001465	0.000984	1.488723	0.1573
LNGEXH(-2)	-0.001285	0.001176	-1.093069	0.2916
NOP	-0.000270	0.016321	-0.016542	0.9870
NOP(-1)	-0.039078	0.017721	-2.205186	0.0435*
CointEq(-1)	-0.024026	0.006984	-3.440173	0.0036
R-Square	0.999982			
Adjusted R-Square	0.999966			
D-WATSON	2.229289			

Continuation Table 6

	LONG-RUN			
LNPOV	-0.121133	0.170697	-0.709640	0.4875
LNMAL	1.199657	0.275406	4.355957	0.0004*
LNPSE	-0.501848	0.225608	-2.224426	0.0400*
LNGEXH	0.011741	0.011167	1.051418	0.3078
NOP	-1.654220	0.368985	-4.483160	0.0003*
C	1.460561	2.037389	0.716879	0.4832

Source: Authors Computation, 2024.

Note: * 5 % and 10 % significance level respectively.

Furthermore, the current values of primary school enrolment (PSE) and number of physician (NOP) has a negative (-0.014 and -0.0002) non-significant effect on infant mortality in the short, and also negative (-0.501 and -1.654) but significant in the long run. This implies that 1 % increase in primary school enrolment and number of physicians will reduce the infant mortality by 1.4 % and 0.02% and also 5.1% and 16.5% in the short and long run respectively. Implying that an increase in level of education and number of physician results in a decline in infant mortality in Nigeria. These findings suggest that a well-educated spouse can make thoughtful decisions to improve the health of their newborn and children.

4. Conclusion

Compared to the rest of the globe, the African continent has greater rates of infant mortality. This study attempts to explore the effect of malaria and poverty on child health in Nigeria using data for the period 1990–2021. This is the first macro study of its kind that uses advanced econometric techniques to examine the effect of poverty and malaria on child health in Nigeria. The results revealed the existence of long-run co-integrating relationship among poverty rate (POV), incidence of malaria (MAL), government expenditure on health (GEXH), primary school enrolment (PSE) and number of physician (NOP) on infant mortality (IMR) proxy for child health in Nigeria. The study revealed that children's health typically deteriorates when they are raised in low-income households or communities thus rising levels of poverty may exacerbate an infant's health and lead to a poorer outcome for the child. The study further showed that an increase in malarial incidence would translate into a greater infant mortality rate as malaria has a positive and significant effect on infant mortality. Also, government expenditure on health neither improves nor worsens child's health as the coefficient shows a positive and nonsignificant effect on child's health. The study further revealed that an increase in level of education and number of physician results in a decline in infant mortality in Nigeria.

This study thus recommends the implementation of laws and policies that strengthen efforts to reduce poverty and promote children's health, like the child right act. Focus on measures that consider the needs of the parent should also be investigated and improved upon, especially improved literacy level and alleviation of poverty. Significant efforts should also be made by the government and development partners to completely eradicate mosquito-borne malaria in Nigeria.

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