MEASLES OUTBREAKS AND UNDER-FIVE MORTALITY IN NIGERIA: ISSUES AND POLICY OPTIONS

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ABSTRACT
Nigeria's under-five mortality is one of the highest in Sub-Saharan Africa region comparatively. Perhaps this is related to the rising outbreaks of measles. Therefore, this study investigated the effect of measles outbreaks on under-five mortality in Nigeria between 1986 and 2021. Findings from the co-integration technique employed shows a positive effect of measles outbreaks on under-five deaths in Nigeria. Based on the results of the findings, the study recommends need for government at all levels, stake-holders in the private sectors and NGOs to focus on reducing measles attacks on under-five children by promoting children related health policies and vaccinations that will halt the menace of under-five deaths in Nigeria.

Keywords: Measles, Under-five Mortality, Johansen's Co-Integration Methodology, Nigeria.

***JEL CODES*:** H51, H52, H53 and H75.

1. INTRODUCTION
Several of the thirteen health targets of Sustainable Development Goal 3 are related to reduction of under-five deaths. In spite of this, Nigeria's under-five deaths reduced from 135.7 to 110.8 per 1,000 live births between 2010 and 2021 (World Bank, 2023). However, the averages of under-five mortality for global and Sub-Saharan Africa (SSA) region were 105.5 and 53.3 per 1, 000 live births in 2010, and 73 and 38.1 per 1, 000 live births in 2021. While these imply that there is 22 percentage-points mere reduction in under-five deaths in Nigeria, the figures for global and SSA reduced by 45 and 40. These reveal that under-five health in Nigeria needs a considerable attention from preventable child mortality diseases. Theoretically, Grossman (2017) noted that under-five health is predicted by various factors, and their health status depreciates overtime particularly with health shocks, such as, measles outbreaks. But public spending and poverty reduction improve children's health outcomes (Abubakar *et al.* 2022; Onah & Ugwuibe, 2022; Okonkwo *et al.*, 2019, 2023; Oyedele, 2023).

According to World Health Organization (WHO, 2022 & 2023a), measles is one of the major factors accounting for under-five deaths in developing countries. In fact, more than 140,000 deaths from measles were recorded in 2018 worldwide, while about 95% of these deaths occurred in developing countries (WHO, 2023b). It is also known as one of the most contagious diseases, and a viral infection that is against the survival of children, typically from high fever, coughing, running nose, and watery-eyes. It can also lead to life-threatening or life-changing complications for the children. Between January and April, 2023 in Nigeria; 7,305 and 1,134

cases of measles were reported in Borno and Yobe states, respectively (Health Sector Bulletin, 2023). Perhaps this is connected with the high population growth, high fertility rate per woman and low per capita income in the country.

Empirically, there is an expansive literature indicating that measles outbreaks have a direct, deleterious effect on under-five deaths (Abdul-Kuddus & Mohiuddin, 2023; Tsegaye & Berhanu, 2022; Nomhwange & Jean-Baptiste, 2022; Walekhwa & Mulogo, 2021). However, this study established the short-run and long-run links between measles and under-five deaths while earlier studies that modelled this relationship ignored these effects. Second, rather than adopting only descriptive analysis as used by Nomhwange & Jean-Baptiste (2022) or focusing only on one segment of an economy as carried out in the study of Tsegaye & Berhanu (2022). This research conducted both descriptive and inferential statistical analyses. This has been adjudged to be a superior measure of empirical impacts (Gujarati, 2004).

For the appropriate formulation of under-five health policies that will mitigate the rate of measles attacks on under-five children in Nigeria, the research questions for this study are:

i. What is the effect of measles on under-five deaths in Nigeria in both short- and long-run?
ii. What other factors are responsible for high under-five mortality in Nigeria?

An understanding of these issues can help policy makers in formulating health policies that will avert the high under-five mortality rate in Nigeria. Therefore, the central focus of this research is to estimate the effects of measles outbreaks on under-five mortality in Nigeria. The study was then organized into five sections, namely; introduction, review of related literature, methodology, findings and discussion of results, and conclusion with policy recommendations.

2. LITERATURE REVIEW

Several studies have been conducted on measles across domestic and international countries, but the appropriate policy response against measles outbreaks in developing countries still remains an ongoing debate among development experts. However, Abdul-Kuddus, Rahman & Mohiuddin (2023) employed mathematical modelling framework to explore the different interventions scenarios for programmatic measles control in Bangladesh from 2000 and 2019. The study concluded that scenario which combines enhanced treatment for exposed and infected population, first and second doses of vaccine is the most effective at rapidly reducing the total number of measles incidence and under-5 mortalities in Bangladesh.

Further, Tsegaye, Gezahegn & Berhanu (2022) equally used descriptive as well as logistic regression to model measles outbreaks in Guradamole District of Bale Zone, South Eastern Ethiopia. The study found that overall, 98 cases were identified with an overall attack rate of 12/1000 population and a case fatality rate (CFR) of 7%. The highest attack rate (38/1000 population) and a case fertility rate CFR (57%) were among children aged <59 months while vaccination efficacy was considered ineffective in controlling the menace of measles in the study location.

Nomhwange, Jean-Baptiste & Masresha (2022) employed retrospective research method and descriptive statistics to assess measles outbreaks response immunization during the COVID-19 pandemic in Borno State, Nigeria. The study found that a total of 181,634 children aged 9 months were vaccinated against measles with 27,961 receiving the measles vaccine for the first time. Their study reported that prior to the interventions, 20 COVID-19 and measles cases were reported in the study locations while sixteen suspected cases were reported with 14 confirmed in one of the study areas four weeks after the ORI. Also, Gignoux, Polonsky, Ciglenecki, Bichet, Coldiron, Lwiyo, Akonda, Serafini, & Porten (2018) used spatial and univariate linear

regression to examine the risk factors for measles mortality and the importance of decentralized case management during an unusually large measles epidemic in Eastern Democratic Republic of Congo. The research showed that younger children that did not receive care, and those living farther away from health facilities in the epidemic had a higher risk of measles related deaths. The study also found that vaccination coverage prior to the outbreak was low (76%), and a delayed reactive vaccination campaign contributed to the high attack rate in the study locations.

Further, Walekhwa, Ntaro & Mulogo (2021) adopted a retrospective unmatched case-control study to investigate Measles outbreak in Western Uganda**.** However, the research shows that 34 facility-based measles cases were documented to have had maculopapular rash, and cough. The study found that majority of under-5 children under measles infection had fever (97%), coryza (94.1%), lymphadenopathy (76.5%), arthralgias (73.5%) and Koplik Spots (91.2%) as documented in the clinical registers. In addition, Donadel, Stanescu, Pistol, Stewart, Butu, Jankovic, & Zimmerman (2021) used logit regression to examine risk factors for measles deaths among children during a nationwide measles outbreak in Romania. The study employed the Romanian national surveillance data to identify hospitalized cases of laboratory-confirmed or epidemiologically linked measles in infants and children aged < 59 months with rash onset in the study location. The study found that ninety-three percent of case-patients and controls had not received a valid dose of a measles-containing vaccine; only 5 % received Vitamin A supplementation once diagnosed with measles.

Again, Aworabhi-Oki, Numbere & Olorukooba (2020) used quasi-secondary data to analyze measles case-based surveillance data for the period of January 2014 to December 2018 obtained in Microsoft Excel from the State Ministry of Health to depicts styled facts and trends in measles cases in Bayelsa state, Nigeria. The study found that a total of 449 cases of measles were reported from 2014 to 2018. There were 245(54.6%) males and the most affected age group was 1–4 years with 288(64.1%) cases. Of all cases, 289(9.35%) were confirmed and 70 (48.27%) had received at least one dose of measles vaccine. There was an all-year transmission with increased cases in the 4th quarter of the year. The study found that Yenegoa Local Government Area had the highest number of measles cases. Timeliness of specimen reaching the laboratory and the proportion of specimens received at the laboratory with results sent to the national level timely were below WHO recommended 80% respectively. The study reported that predictors of measles infection in the study area were, age less than 5 years and residing in an urban area.

In another development, Byberga, Fisker & Griffiths (2017) adopted clustered randomized methodology and descriptive statistics to investigate cost-effectiveness of providing measles vaccination to all children in Guinea-Bissau. The study found that measles vaccination at 36 months was 97% in measles vaccination-for-all clusters and 84% in restrictive measles policy clusters. The finding of the study indicated that 90% wastage of measles vaccination under the measles vaccination-for-all policy and 40% under the restrictive measles vaccination policy. In addition, Basumatary & Basumatary (2020) equally employed Vector Autoregressive (VAR) model and granger causality test to study the relationship between Health and economic development in Egypt. The study found that lagged of living in urban areas, household population and malnutrition granger-cause under-five mortality in Egypt.

Empirically speaking, a significant weakness of the studies reviewed above on the effects of measles on under-five deaths is that they do not account for the impact of measles outbreaks on under-five deaths in the short- and long-run scenarios as it is being examined in this study. Thus, given the high level of exposure of under-five children to the vulnerability of preventable killer diseases and Nigeria's weak health system, it is essential to evaluate the short- and long-run dynamic nexus between measles and under-five deaths. Yet, from the reviewed studies,

other factors influencing under-five deaths were not clearly accounted for; only the relationship between the proxy of measles outbreaks and risk factors was outlined. To fill this gap, this study, therefore, incorporates other factors influencing under-five deaths in Nigeria.

Besides, a large chunks of the studies reviewed in the literature employed descriptive statistics while only a few of these studies adopted logistic regression, granger causality and VAR model to analyze the impact of measles outbreaks on under-five deaths. But this study incorporating both descriptive statistics and Johansen's co-integration. The adoption of the model for this study is due to its ability to adequately capture the interaction scenarios (trace and eigenvalue tests) between short- and long-run effects of measles outbreaks and under-five deaths.

3. METHODOLOGY

3.1 Description of Variables and Sources of Data

This research examined the nexus among measles outbreaks, population growth rate, fertility rate per woman of child-bearing age and under-five deaths in Nigeria using annual time series datasets spanning 1986 to 2021. The datasets used for this study were all sourced from the World Development Indicators (WDI). Table 1 contains additional information on the annual time series datasets used for this study.

Table 1: Description of Variables and Sources of Data

Variables	Description
Measles outbreaks (MS)	A suspected case of measles that has been confirmed positive by testing in a proficient laboratory.
Under-5 deaths (mortality) (UD5)	This is the probability a newborn death before reaching exactly 5 years of age, expressed per 1,000 live births.
Population growth rate (PGR)	It is the change in the number of individuals over a specific period of time.
Fertility rate per woman of child-bearing age (FR)	The number of children born to a woman if she were to live to the end of her child-bearing years and bear children.

Source: Authors' Compilations (2023)

3.2 Model Specification

This study employed the modified version of the Johansen's cointegration models developed by Bigili and Faik (2018), Adedoyin (2021) and Farouk (2020) to capture the dynamic nexus between measles outbreaks and under-five deaths in Nigeria. Bigili and Faik (2018), Adedoyin (2021) and Farouk (2020) studies investigated the interaction of vaccines dosage and measles outbreaks in the health sectors of Bangladesh, Egypt and Mali using measles outbreaks as an endogenous variable and vaccines dosage as an exogenous variable. This study augments theirs by incorporating under-five deaths (U5D) as an endogenous variable while population growth rate (PGR), fertility rate per woman of child-bearing age (FR) and per capita income (RGDP) form the exogenous variables. Therefore, the econometric model for this study is specified below:

$$\boldsymbol{U5D_t = \alpha_o + \beta_1 MS_t + \beta_2 PGR_t + \beta_3 FR_t + \beta_4 RGDP_t + \mu t} \qquad \textbf{(1)}$$

Where U5D is under five deaths rate, MS denotes measles outbreaks, PGR is the population growth rate while FR denotes fertility rate per woman of child-bearing age, and RGDP is the per capita income, while $\boldsymbol{\mu t}$ stands for white noise. A positive (negative) and significant interaction term will indicate the complementarity (substitutability) of measles outbreaks on

under-5 deaths. The literature has shown that control variables also influence measles outbreaks (Bigili & Faik, 2018, Adedoyin, 2021 & Farouk, 2020). Meanwhile, population growth rate (PGR) and fertility rate per woman of child-bearing age are the control variables in the model.

3.3 Unit Root Tests

The seasonality, trend and structural breaks that characterized time series datasets have prompted Granger (1966) and Pesaran et al. (2001) to recommend that macro time series datasets should pass through unit root test analysis in order to avoid spurious regression. In addition, unit root test analysis also plays a significant role in determining the appropriate econometric methodology to be adopted in research (Pesaran et al., 2001). Therefore, to test the stationarity of the variables in this research, the study employed the Augmented Dickey-Fuller (ADF) test. The ADF test of stationarity is used for this study because it is considered the most efficient approach among other methodologies for testing stationarity of annual time series data and it is also appropriate for a large and complex set of data as we have in this study (Bigili & Faik, 2018). The ADF test estimation procedure is expressed as follows:

$$\Delta Y_t = \lambda + \delta t + \beta Y_{t-i} + \varphi_i \sum_{i=1}^{n} \Delta Y_{t-1} + \mu_t \qquad (2)$$

Where ΔY_t denotes the lag difference of the variable of interest, λ is the constant term, n is the number of lag, t is the time trend, and μ_t is a white noise. The unit root analysis is important as it will indicate the appropriate co-integration technique to be adopted (Bigili & Faik, 2018).

Based on the outcome of the unit root test conducted in this study, the research employed the Johansen's co-integration econometric technique to analyze the long-run and short-run relationships among measles outbreaks, population growth rate, fertility rate per woman of child-bearing age and under-5 deaths in Nigeria. The technique was considered appropriate for this research because it allows variable integrated of the same level to be jointly analyzed (Bigili & Faik, 2018; Adedoyin, 2021 & Farouk, 2020).

3.4 The Johansen's Cointegration Methodology

The Johansen's cointegration test is a test for cointegration of several I(1) time series datasets. "Cointegration" is the property of two-time series data where both share common stochastic drift. Stochastic drift is the change in average value of the random or stochastic process (Gujarati, 2004). The advantage of the Johansen cointegration test comes from its ability to handle several time series variables integrated at I(1) (as observed in this study); in contrast, the Engle-Granger cointegration test could handle only one cointegration relationship (Adedoyin, 2021). However, the Johansen cointegration test relies on two types of tests: (i) the trace test and (ii) the maximum eigenvalue test (Bigili & Faik, 2018; Adedoyin, 2021 & Farouk, 2020).

In Johansen's maximum likelihood estimation of cointegration vectors, the null hypothesis is, for any r $\leq$p, H_0 : rank$(\Phi) \leq$ r or $\Phi = \alpha\beta'$ where α and β are pxr matrices. If there is cointegration among variables, X_t is cointegrated with the cointegration vector β $(\Phi = \alpha\beta')$. The coefficient P has a reduced rank $r < n$; thus, there exists $n \times r$ matrices α and β with rank r such that $\mathbf{P} = \alpha\beta$ and βX_t is stationary. Recall that r is the number of relationships. The null hypothesis of the Johansen's cointegration test in this study states that there are no cointegrating equations among under five deaths, measles outbreaks, fertility rate per woman

of child-bearing age, population growth rate and per capita income while the alternative hypothesis states that the null hypothesis is not true.

However, one cannot estimate the parameters of α and β but can estimate the space spanned by β. In the estimation of space spanned by β, *Johansen's theorem states that the maximum likelihood estimator of the space spanned by* β *is the space spanned by the r canonical variates corresponding to the r largest squared canonical correlations between the residuals of* X_{t-p} *and* ΔX_t *corrected for the effect of the lagged differences of the* X_t *process* (Bigili & Faik, 2018; Adedoyin, 2021 & Farouk, 2020). The elements of α is known as the adjustment parameters in the vector error correction model (VECM), β is the vector column of cointegrating vectors while X_t *is the vector of cointegrating variables*. The objective is to show that for a given r the likelihood estimator of β defining the combination vector X_{t-p} that produces r the largest conanical correlations of X_t with X_{t-p} is to estimate the trace test and eigenvalue test. Therefore, for the purpose of this study, we calibrate the largest canonical correlation in the Johansen's cointegration test as follows:

After determining the order of p, regress:

$$\Delta X_t \text{ on } \Delta X_{t-1} + \Delta X_{t-2} + \Delta X_{t-3} + \ldots + \Delta X_{t-p+1} \quad \textbf{(3)}$$

$$\text{Regress } \Delta X_{t-p} \text{ on } \Delta X_{t-1} + \Delta X_{t-2} + \Delta X_{t-3} + \ldots + \Delta X_{t-p+1} \quad \textbf{(4)}$$

Let n_t be residuals from equation 3 and v_t be residuals from equation 4

Compute squares of the canonical correlations between n_t and v_t as:

$$\Omega_1^2 \succ \Omega_2^2 \succ \Omega_3^2 \succ \ldots \succ \Omega_p^2 \quad \textbf{(5)}$$

Maximal eigenvalue test that uses $(r+1)^{th}$ largest squared canonical correlation is calibrated as follows:

$$\Omega max(r, r+1) = -T \ln\left(1 - \Omega_{r+1}^2\right) \quad \textbf{(6)}$$

While, one can generate the trace test as follows:

$$\Omega trace(r) = -T \sum_{i=r+1}^{n} \ln\left(1 - \Omega_i^2\right) \quad \textbf{(7)}$$

Ω trace and Ω max tests depict the number of eigenvalues r that are statistically different from zero: For instance, in the five-variables (measles outbreaks, under-5 deaths, population growth rate, fertility rate per woman of child-bearing age and per capita income) case like we have in this study, n = 5, Ω, trace tests the hypothesis that there is no cointegration among measles outbreaks, under-five deaths, population growth rate, fertility rate per woman of child-bearing age and per capita income against the alternative hypothesis that cointegration vector does exist among the aforementioned variables. If H_0: r = 0 is rejected against H_1: r > 0, then H_0: r < 1 is tested against hypothesis r = measles outbreaks, under-5 deaths, population growth rate, fertility rate per woman of child-bearing age and per capita income. The Ω max is more specific than the Ω trace test, whose null hypothesis is that there are no cointegrating vectors against the hypothesis that there is one cointegrating vector. Or in Ω max tests; H_0: r = measles outbreaks vs H_1: r = under-five deaths, H_0: r = under-five deaths vs H_1: r = population growth

rate H_0: r = population growth rate vs H_1: r = fertility rate per woman of child-bearing age, H_0: r = fertility rate per woman of child-bearing age vs H_1: r = per capita income.

4. FINDINGS AND DISCUSSION OF RESULTS

Table 2 shows the summary of preliminary results for under-five deaths, and measles outbreaks in Nigeria. It also includes the characteristics of the control variables, such as population growth rate, fertility, and real GDP in Nigeria.

Table 2. Descriptive Statistics of the Variables (Obs=36)

	$U5D_t$	$Measles_t$	PGR_t	FR_t	$RGDP_t$
Mean	164.96	40.81	2.60	6.02	US$1,338.41
Standard Dev.	35.84	11.59	0.09	0.36	US$918.05
Maximum	210.00	63.00	2.76	6.56	US$3,200.95
Minimum	110.80	21.00	2.41	5.23	US$270.02

Source: Authors' Computation (2023)

Table 2 illustrates that the average under-five mortality in Nigeria is 165 per 1,000 live births every year with the maximum deaths of 210 per 1,000. This is particularly high compared to the recommended average reduction of 73 per 1,000 live births of under-5 deaths in Sub-Saharan African countries (World Bank, 2023). It further shows that the proportion of under-five children in Nigeria with access to immunization against measles is nearly 41%. This is quite low comparatively.

Table 3: Stationarity Result

Variables	*At level*	*At first difference*	*Remarks*
$U5D_t$	-1.8686	-3.5781	I (1)
$Measles_t$	-1.7917	-6.3509	I (1)
PGR_t	-1.2841	-3.1182	I (1)
FR_t	-1.0953	-3.1596	I (1)
$RGDP_t$	-0.6715	-4.0845	I (1)

Source: Authors' Computation (2023)

Table 3 depicts the unit root test conducted. It was established that all variables are stationary at I (1). This suggest the application of Johansen's co-integration test.

Table 4. Trace Statistics for Co-integration test

Hypothesized	*No of CEs*	*None**	*At most 1**	*At most 2*	*At most 3*	*At most 4*
Eigen value		*0.7611*	*0.5949*	*0.3978*	*0.2279*	*0.0592*
Trace statistics		*107.5157*	*58.8411*	*28.1158*	*10.8695*	*2.0746*
0.05 Critical value		*69.8188*	*47.8561*	*29.7971*	*15.4947*	*3.8415*
*Probability***		*0.0000*	*0.0033*	*0.0772*	*0.2196*	*0.1498*

Source: Authors' Computation (2023)

Trace test indicates 2 co-integrating equations at 5%; and *Reject H_o at 5%

Table 5. Maximum Eigenvalue Co-integration test

Hypothesized	*No of CEs*	*None**	*At most 1**	*At most 2*	*At most 3*	*At most 4*
Eigen value		*0.7611*	*0.5949*	*0.3978*	*0.2279*	*0.0592*
Max-Eigen statistics		*48.6745*	*30.7253*	*17.2463*	*8.7949*	*2.0745*
0.05 Critical value		*33.8768*	*27.5843*	*21.1316*	*14.2646*	*3.8415*

*Probability***	*0.0005*	*0.0191*	*0.1607*	*0.3036*	*0.1498*

Source: Authors' Computation (2023)
Trace test indicates 2 co-integrating equations at 5%; and *Reject H_o at 5%

Table 6. Co-integration of the Normalized Equation (Long-run Results)

	Coef.	Standard Error	t-statistics	Remarks
$Measles_t$	1.04	0.12	8.82***	Positive and significant at 1% level
PGR_t	248.53	29.91	8.31***	Positive and significant at 1% level
FR_t	-125.27	12.98	-9.64***	Negative and significant at 1% level
$RGDP_t$	-0.0089	0.0045	-1.97*	Negative and significant at 10% level

Source: Authors' Computation (2023)

There are two statistics generated by Johansen's co-integration. These are known as trace and maximum Eigenvalue statistics as reported in Table 4 and 5, respectively. Both results shows that there is long-run relationship between measles outbreaks and under-five deaths in Nigeria. This result corroborates the studies conducted by Bigili & Faik (2018), Adedoyin (2021) and Farouk (2020) in Bangladesh, Egypt and Mali who found long-run relationship between routine immunization and measles outbreaks. Therefore immunization will prevent the spread of grave diseases, including measles, as it creates antibodies in their body (WHO, 2022). It would also reduce measles outbreaks and under-five deaths in the nearest future in Nigeria.

Table 6 is the normalized long-run result. It show that immunization against measles outbreaks (the proxy for measles) have positive effect on under-five deaths, and it is significant at 1% level. The result implies that children's immunization against measles outbreaks at 12 to 24 months cannot permanently reduce under-five deaths, in fact this can results to more mortality in the long-run. This is because there are two shot of vaccine against measles: under-five should get one shot between 12 and 15 months. However, the second shot should be taken between 4 and 5 years (WHO, 2023). Therefore, any under-five that misses the second shot could experience measles attack that can results to under-five deaths. This finding is consistent with the study conducted by Abdul-Kuddus, Rahman & Mohiuddin (2023).

For the control variables, increase in population growth rate associated with higher under-five mortality in Nigeria. However, in the long-run, higher per capita income from economic growth related with fewer under-five deaths.

Table 7. Short-run Results

	Coef.	Standard Error	t-statistics	Remarks
$Measles_t$	-0.227	0.115	-1.96*	Negative and significant at 10% level
PGR_t	-116.79	15.99	-7.30***	Negative and significant at 1% level
FR_t	85.37	6.14	13.89***	Positive and significant at 1% level
$RGDP_t$	-0.0065	0.002	-2.67**	Negative and significant at 5% level
α	-26.49	30.23	-0.87	Negative and significant at 10% level

Source: Author's Computation (2023)

Table 7 depicts the short-run effect of measles outbreaks on under-five deaths. It indicates that immunization against measles outbreaks have inverse effect on under-five deaths. This statistic is also statistically significant at 10% level. By implication, immunization of children against measles at 12 to 24 months can constrain under-five deaths in Nigeria. This is in line with the

study of Abdul-Kuddus *et al.* (2023) for Bangladesh. Overall, this study conclude that measles outbreaks related with more under-five deaths in Nigeria in both short- and long-run extents.

5. CONCLUSION AND RECOMMENDATIONS FOR POLICY

Our study estimated the effect of measles outbreaks on under-five deaths in Nigeria between 1986 and 2021. Its unit root test result shows that all variables are stationary at first difference, with need for Johansen co-integration test. Both trace and maximum eigenvalue statistics of co-integration show that there is long-run relationships between the variables in Nigeria. The implications of the findings is that immunization of children against measles outbreaks at 12 to 24 months might not permanently limit under-five deaths, in fact this can upshots deaths in the long-run. Also, the short-run effects of measles outbreaks on under-five deaths was found to be inverse. These implies that as immunization of under-fives against measles increases, their deaths reduces in Nigeria significantly. Other factors such as fertility rate, population growth rate and per capita income are also critical to determining under-five deaths in Nigeria.

Thus, government should focus on reducing measles attacks on under-fives by rolling out effective health policies that will halt the upward trajectory in Nigeria. Again vaccinations for children should be prioritized in Nigeria. Specifically, government at all levels, stakeholders in the private sector and NGOs through the Ministry of Health should improve access to immunization against measles, while the government should articulate and implement policies that will reduce population growth in order to halt the menace of under-five deaths in Nigeria.

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