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ENVIRONMENTAL POLLUTION AND MATERNAL MORTALITY IN NIGERIA

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Abstract

This study examines the consequences of environmental pollution on maternal mortality in Nigeria with emphasis on the proliferation of pollutants in most nooks and cranes of the country. Data for the study are generated from secondary sources of World Development Indicator and Central of Nigeria Statistical Bulletin of various issues. The data is analyzed using the Toda-Yamamoto estimation technique for the analysis. The study used maternal mortality rate as the dependent variable while carbon dioxide, nitrous oxide and particulate matter are used as the main explanatory variables for environmental pollution, whereas government expenditure on health is used as check or control variable. The finding reveals that carbon dioxide, nitrous oxide and particulate matter do not have causal effect on maternal mortality in Nigeria within the period of study. Implying that environmental pollution do not contribute to maternal deaths in Nigeria within the period of study. Although the impact of environmental pollution considering the status of the result is not the focal cause of maternal mortality in Nigeria in the period of study, the study recommends the following in order to achieve a better and healthier environment. Tree planting is one of the best means of mitigating the impact of environmental pollution because of its absorptive nature. On this premise, tree planting should be made a priority in the local, state and federal levels. Also, products that utilize solar energy, wind energy, hydro energy and other renewable product should be made tax free in order to encourage mass production.

Keywords: Environment Pollution, Maternal Mortality.

Introduction

Environmental pollution is not a new phenomenon yet it remains the world's greatest problem facing humanity and the leading environmental cause of morbidity and mortality (Ukaogo, 2010). The impact of environmental pollution is traumatic such that the World Health

Organization (WHO) estimates that 8.9million persons die each year of diseases caused by pollution, 8.4 million (94 percent) of them in poor countries (WHO, 2014a,b). By comparison, HIV/AIDS causes 1.5 million deaths per year (WHO, 2014c), and malaria and tuberculosis cause fewer than 1 million deaths each (WHO, 2014d).Nigeria is one of the countries in Sub-Saharan Africa where maternal mortality has remained a problem. The country's progress towards cutting the number of maternal deaths has been largely insufficient. Maternal mortality persists in Nigeria despite strategies like the promotion of institutional deliveries, training and deploying new skilled health workers. It is also among the top six countries in the world that contribute to more than 50percent of all global maternal deaths. In 2008, Nigeria had the second largest recorded number (50,000) of maternal deaths with an estimated maternal mortality rate of 840/100,000 live births (Meh et al, 2019).

Nigeria accounts for about 10 percent of all maternal deaths globally, with maternal mortality ratio of 545 deaths per 100,000 live births and has second highest maternal mortality rates in the world after India with maternal ratio of 658 deaths per 100,000 live birth (Nigeria Demographic and Health Survey, 2008). Basically, the issue of environmental pollution manifest in various forms in Nigeria. The activities of illegal oil bunkering result to black soot in the southern part of the country. The eastern part is characterised with inappropriate disposal of solid waste, the west and northern Nigeria are prone to deforestation, erosion and desertification.

Given the problem posed by environmental pollution in developed and undeveloped counties, this study specifically examines environmental pollution impact on maternal mortality in Nigeria. The rest of the paper is delineated into four sections as follows; section two discusses the literature review, section three takes care of the methodology, section four is data analysis and discussions of findings while conclusions and recommendation are taken care of in section five.

Literature Review

Conceptual Clarification

Environmental pollution is one of the most serious problems facing humanity and other life forms on the planet today. Holdgate (1979) defined environmental pollution as the introduction by man into the environment of substances or energy liable to cause interference with legitimate uses of the environment. Environmental pollution is defined as "the contamination of the physical and biological components of the earth/atmosphere system to such an extent that normal environmental processes are adversely affected.

Pollutants can be naturally occurring substances or energies, but they are considered contaminants when in excess of natural levels. Any use of natural resource at a rate higher than nature's capacity to restore itself can result in pollution of air, water and land. Maternal death or maternal mortality is defined by the World Health Organization (WHO) as "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management.

Maternal mortality refers to deaths due to complications from pregnancy or childbirth. From 2000 to 2017, the global maternal mortality ratio declined by 38 per cent – from 342 deaths to 211 deaths per 100,000 live births. This translates into an average annual rate of

reduction of 2.9 per cent. Being substantive, this is less than half the 6.4 per cent annual rate needed to achieve the sustainable development global goal of 70 maternal deaths per 100,000 live births. Also, United Nations Independent Children Emergency Fund (UNICEF, 2021) affirms that though the maternal mortality ratio declined by 37 per cent between 2000 –2015, there were an estimated 303,000 maternal deaths worldwide in 2015 due to complications in pregnancy and childbirth. Almost all (99 per cent) occurred in developing regions, with the highest level (546 per 100,000 live births) in sub-Saharan Africa, followed by South Asia (182 per 100,000 live births).

Theoretical Literature

This work reviewed three theories namely; Pollution Haven theory, environmental kuznet theory and pollution prevention theory.

Pollution Haven Theory

The Pollution Haven Hypothesis (PHH) was first postulated by Copeland and Taylor in 1994. The pollution haven theory or hypothesis posits that when large industrialized nations seek to set up factories or offices abroad, they will often look for the cheapest option in terms of resources and labour that offers the land and material access they require. However, this often comes at the cost of environmentally unsound practices.

Developing nations with cheap resources and labour tend to have less stringent environmental regulations, and conversely, nations with stricter environmental regulations become more expensive for companies as a result of the costs associated with meeting these standards. Thus, companies that choose to physically invest in foreign countries tend to relocate to the countries with the lowest environmental standards or weakest enforcement.

Thus, the assumptions of the theories emphasize that; pollution costs have an impact on the margins, where they exert some effect on investment decisions and trade flows. Pollution control costs are important enough to measurably influence trade and investment. Countries set their environmental standards below socially-efficient levels in order to attract investment or to promote their exports.

The formula of Pollution Haven Theory is given as; $Yi = \alpha Ri + Xi\beta I + \varepsilon i$

In the above formula, Y is economic activity, R is regulatory stringency, X is an aggregate of other characteristics that affect Y and ε is an error term.

Theoretically, by changing the value of R, analysts will be able to calculate the expected effect on economic activity. According to the Pollution Haven Hypothesis, this equation shows that environmental regulations and economic activity are negatively correlated, because regulations raise the cost of key inputs to goods with pollution-intensive productions and reduce jurisdictions' comparative advantage in these goods. This lack of comparative advantage causes firms to move to countries with lower environmental standards, decreasing Y.

The Environmental Kuznets Theory

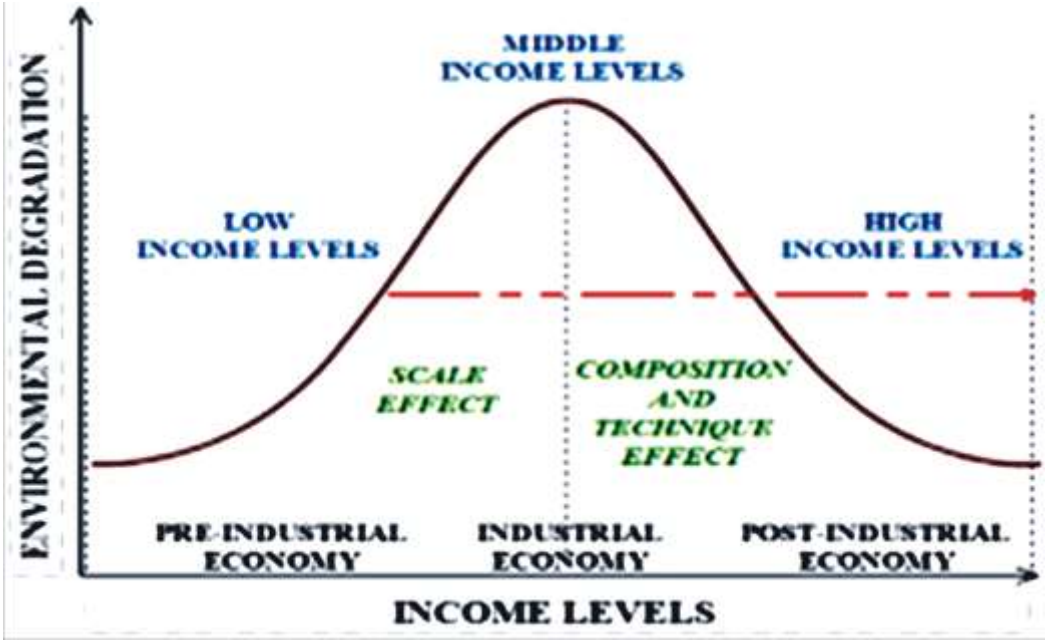
The Environmental Kuznet Theory also known as Environmental Kuznet Curve **(**EKC) follows the name of Nobel Laureate Simon Kuznets who had remarkably hypothesized an inverted 'U' income-inequality relationship (Kuznets, 1955). According to this hypothesis, as an economy develops market forces first increase and then decreases economic inequality. In the

1990s economists detected this relationship between economic growth and environmental degradation. Since then this relationship is known as Environmental Kuznets Curve.

According to the EKC theory, as a country develops, the pollution increases, but after reaching a specific level of economic progress pollution begins to decrease. The EKC hypothesis suggests that environmental degradation is something unavoidable at the first stage of economic growth, so a developing country is forced to tolerate this degradation in order to develop.

In a graphical representation the x-axis symbolizes economic growth which is measured by GDP per capita and the y-axis represents the environmental degradation which is measured by many different pollution indicators such as carbon dioxide, sulfur dioxide, nitrogen oxide, deforestation etc.

Below is the Environmental Kuznet curve diagram.



The Environmental **Kuznets Curve** (**EKC**) diagramme explains an inverted U-shaped relationship between economic growth and environmental degradation. Environmental pressure increases in the early stages of economic growth due to the increased release of pollutants and is extensive and intensive. It is a hypothesized relationship between different indicators of environmental degradation and income per capita. At the first stages of economic growth degradation and pollution increase, but further than some levels of income per capita. The movement reverses, so that at high-income levels economic growth leads to environmental improvement. This means that the impact of environmental indicator is an inverted U-shaped function of income per capita (Stern, 2003).

Pollution Prevention Theory

However, the theoretical framework for this study is the Pollution Prevention theory also known as *Pollution Prevention Act which was propounded or established by* the United States Congress in 1990.The United State Environmental Protection Agency (EPA)

developed a formal definition of pollution prevention and a strategy for making pollution prevention a central guiding mission. Under Section 6602(b) of the Pollution Prevention Act, the assumptions of the theory emphasize that pollution should be *prevented* or *reduced* at the source whenever feasible. Pollution that cannot be prevented or recycled should be *treated* in an environmentally safe manner whenever feasible and disposal released into the environment that should be employed only as a last resort and should be conducted in an environmentally safe manner (Habicht, 1992).

Below is the pollution prevention hierarchy as established by the United State Congress in 1990.

POLLUTION PREVENTION HIERARCHY

As established by congress in the

Pollution Prevention Act of 1990

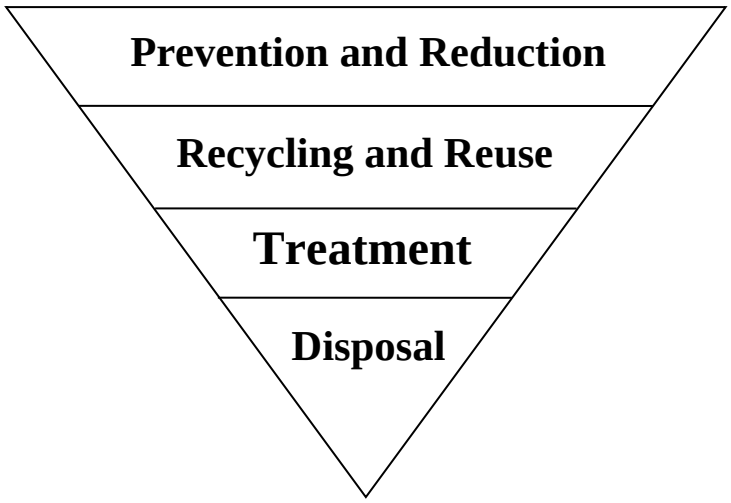


Figure 1. Pollution Prevention Hierarchy (source: Phipps, 1995).

Consequently, this is the hierarchy of preferred options for dealing with environmental pollution. Officially, it places prevention at the top of the list. According to the Environmental Protection Agency (EPA, 1992), pollution prevention theory emanates from the Pollution Prevention Act of 1990 (PPA) in the United States. It created a national policy to have pollution prevented or reduced at the source wherever possible. “The Pollution Prevention Act” focused on industry, government, and public attention on reducing the amount of pollution through cost-effective changes in production, operation, and raw materials used. Opportunities for source reduction are often not realized because of existing regulations, and the industrial resources required for compliance, focus on treatment and disposal.

Consequently, amongst the theories reviewed, pollution prevention theory founded in 1990 also regarded as the pollution prevention act of the United State Congress is the theory that is in tandem with the concept “Environmental Pollution” and maternal mortality in Nigeria. This is obviously displayed because the assumption of the theory under section 6602(B) emphasize that pollution should be prevented or reduced at the source and that pollution that cannot be prevented should be recycled in a safe manner whenever feasible. This is pertinent because pollution prevention will help prevent fatalities.

Empirical Literature Review

Hackley, Feinstein and Dixon (2007) carried out a study on air pollution impact on maternal and pre-natal environmental health in the United States. The study involves the two types of data that are used for regulating air quality and tracking variations over time and by location. First, the national emissions inventory includes information about emissions based on engineering estimates of the total tonnage of air pollutants released annually from major point sources of air pollution such as industrial sites and power plants.

Emission trends are based on many factors, including the level of industrial activity, technology developments, type, and quantity of fuel consumption. Secondly, the air quality system database contains information about concentrations of criteria pollutants derived from actual measurements of ambient air at air quality monitoring stations. The study discovered that fetal physiology is thought to affect the impact that pollutants have on the developing fetus. Exposures in early pregnancy at a time of high oxygen demand and rapid cellular turnover may lead to structural or genetic damage. Exposures later in pregnancy are more likely to result in functional changes. The study further recommends that women can also follow simple nutritional advice that may protect against lead exposures. Meeting the recommended daily intake of calcium can help maintain maternal skeletal homeostasis and minimize the release of lead from bony stores.

Kenneth, H., Kevin, T., Carla, A., Neff, W., Lale, S., Suzuki, M. (2007) studied the estimates of maternal mortality worldwide between 1990 and 2005: an assessment of available data. The study developed and used a range of methods, depending on the type of data available, to produce comparable country, regional, and global estimates of maternal mortality ratios for 2005 and to assess trends between 1990 and 2005. The findings reveal that there were 535,900 maternal deaths in 2005, corresponding to a maternal mortality ratio of 402 (uncertainty bounds 216–654) deaths per 100,000 livebirths. Most maternal deaths in 2005 were concentrated in sub-Saharan Africa (270 500, 50% percent) and Asia (240 600, 45%). For all countries with data, there was a decrease of 2·5% percent per year in the maternal mortality ratio between 1990 and 2005 ($p<0·0001$). However, there is no evidence of a significant reduction in maternal mortality ratios in sub-Saharan Africa in the same period.

Courage, M., Carlowin, C., Tawanda, Z. (2013). Carried out an investigation of the causes of maternal mortality in Zimbabwe, The study to investigate the main causes of maternal mortality in Zimbabwe. Maternal mortality has been recognized as a public health problem in developing countries. Among the developing countries that have not been making progress in reducing maternal death is Zimbabwe. Since 1990 there has been a large and significant increase in maternal mortality in Zimbabwe and this erases any potential gain in maternal survival achieved by safe motherhood programmes during the preceding decade.

This shows that there is a need to investigate the causes of maternal death in Zimbabwe so that solutions can be put in place. Efficient services to improve maternal health in Zimbabwe need policies that are informed by reliable and valid data. This study contributes to the accurate assessment of maternal mortality in Zimbabwe. The study investigated the main cause of maternal mortality at Mpilo hospital. The study used interviews to investigate the causes of maternal mortality in Zimbabwe. Findings from the study show that haemorrhage causes most

of the deaths. Other major causes are abortion, hypertension and sepsis. The study also offers some practical recommendations based on the research findings.

Owili, Lein, Muga and Lin, (2017) examined the associations between types of ambient $PM_{2.5}$ and under-five and maternal mortality in Africa. The spectral derivate of aerosol optical depth (AOD) from moderate resolution imaging spectroradiometer (MODIS) products from 2000 to 2015 were employed to determine the aerosol types before using Generalized Linear and Additive Mixed-Effect models with Poisson link function to explore the associations and penalized spline for dose-response relationships.

Four types of $PM_{2.5}$ were identified in terms of mineral dust, anthropogenic pollutant, biomass burning and mixture aerosols. The results demonstrate that biomass $PM_{2.5}$ increased the rate of under-five mortality in Western and Central Africa, each by 2percent, and maternal mortality in Central Africa by 19percent. Anthropogenic $PM_{2.5}$ increased under-five and maternal deaths in Northern Africa by 5percent and 10percent, respectively, and maternal deaths by 4percent in Eastern Africa. Dust $PM_{2.5}$ increased under-five deaths in Northern, Western, and Central Africa by 3percent, 1percent, and 10percent respectively. The findings that indicate the types of ambient $PM_{2.5}$ are significantly associated with under-five and maternal mortality in Africa where the exposure level usually exceeds the World Health Organization's (WHO) standards. Appropriate policy actions on protective and control measures are therefore suggested and should be developed and implemented accordingly.

Lin (2017) carried out a study on the impacts of air pollution on maternal stress during pregnancy in Shanghai. The aim of the study is to investigate the association of air pollution with maternal stress during pregnancy. The study enrolled 1,931 women during mid-to-late pregnancy in Shanghai in 2010. Air pollution data were collected for each district where pregnant women lived during pregnancy. The stronger associations and higher levels of pollutants were observed in the cool season than in the warm season. SO_2 increases on the recruitment day are also associated with an increased risk of high depression scores (P75-P100). The result supports a dose-dependent association between air pollution and emotional stress during pregnancy.

Franklin (2019) evaluated maternal exposure to indoor air pollution and birth outcomes in Nigeria. The study investigated if indoor air pollutants are associated with poor birth outcomes. Pregnant women were recruited prior to 18 weeks gestation. The study completed a housing questionnaire and household chemical-use survey. Indoor pollutants, formaldehyde (HCHO), Nitrogen Dioxide (NO_2) and Volatile Organic Compounds (VOCs) were monitored in the women's homes at 34 weeks gestation. Gestational Age (GA), Birth Weight (BW) and Head Circumference (HC) were collected from birth records.

The associations between measured pollutants, and pollution surrogates were analyzed using general linear models controlling for maternal age, parity, maternal health, and season of birth. Only Formaldehyde (HCHO) is associated with any of the birth outcomes. There is a 0.044 decrease in BW z-score ($p = 0.033$) and 0.05 decrease in HC z-score ($p = 0.06$) for each unit increase in HCHO. Although HCHO concentrations are very low, the finding is consistent with other studies of formaldehyde and poor birth outcomes.

Meh, Thind and Ryan (2019) studied the levels and determinants of maternal mortality in northern and southern Nigeria. The study aimed to assess differences in the levels and

determinants of maternal mortality in women of childbearing age (15–49 years) in the North and South of Nigeria. The Nigeria Demographic and Health Surveys (2008 and 2013) were used. The association between maternal mortality (outcome) and relevant sociocultural, economic and health factors were tested using multivariable logistic regression in a sample of 51,492 living or deceased women who had given birth.

The result reveals that there are variations in the levels of maternal mortality between the two regions. Maternal mortality is more pronounced in the North and increased in 2013 compared to 2008. For the South, the levels slightly decreased. Media exposure and education are associated with maternal mortality in the North while contraceptive method, residence type and wealth index were associated with maternal death in the South. In both regions, age and community wealth are significantly associated with maternal mortality.

Mekonnen, Oehlert, and Eskenazi, (2021) studied the relationship between air pollutants and maternal socioeconomic factors on preterm birth in California urban counties. Prenatal birth is the leading cause of perinatal morbidity and mortality in the U.S. and disparities among racial and ethnic groups persist. While etiologies of preterm birth have not been fully elucidated, it is probable that environmental and social factors play a role. The study hypothesized that there is an interactive association between exposure to fine particulate matter ($PM_{2.5}$) or ozone (O_3) and neighborhood socioeconomic factors that increase the risk of preterm birth. The study conducted a retrospective finding using geocoded birth certificate data between 2007 and 2011, daily ambient air quality data on $PM_{2.5}$ and O_3, and American Community Survey (2007–2011 5-year estimates) data to assess census tract-level socioeconomic factors in California urban counties. The result of the study found a small positive association between maternal exposures to $PM_{2.5}$ and O_3 and preterm birth that varied by gestational exposure period. In mixed-effects models, the study found an increase in the risk of preterm birth for a one-unit change in $PM_{2.5}$averaged across the entire pregnancy (AOR = 1.02, 95% CI: 1.01, 1.02) and O_3during 3-months pre-pregnancy (AOR = 1.03, 95% CI: 1.02, 1.04). Interaction between census tract-level factors and air pollutants shows an increase in the risk of preterm birth among mothers living in higher socioeconomic areas, though, a fixed cohort bias sensitivity analysis shows that these associations are not significant.

Boyles (2021) investigated environmental factors involved in maternal morbidity and mortality in North Carolina United State. The study adopted mechanistic study model system and reveals that non-genetic and environmental factors contribute to maternal morbidity and mortality through chemical exposures via air, water, soil, food, and consumer products. And that pregnancy represents a particularly sensitive window of susceptibility during which physiological changes to every major organ system increases sensitivity to chemicals that can impact a woman's long-term health. Nonchemical stressors, such as low socioeconomic status, may exacerbate the effects of chemical exposures on maternal health.

Again, those racial/ethnic minorities are exposed disproportionately to both chemicals and nonchemical stressors, which likely contribute to the observed health disparities for maternal morbidities and mortality. Boyles (2021) further stated that epidemiological studies linking exposures to adverse maternal health outcomes underscore the importance of environmental health impacts, and how chemicals perturb biological pathways and processes. The study reveals that environmental stressors are associated with a variety of immediate

maternal health impacts, including hypertensive disorders of pregnancy, fibroids, and infertility, as well as long-term maternal health impacts, such as higher risk of breast cancer and metabolic disorders.

Research Methodology

The concern here is to examine the method adopted in carrying out this research work.

Nature and sources of data

The data used for this study are annual time series data on Carbon dioxide emission (CO_2), Nitrous oxide (N_2O), Particulate Matter ($PM_{2.5}$) representing variables for environmental pollution and Maternal Mortality Rate (MMR) in Nigeria for a period of 38 years spanning from 1981 to 2020. The data are obtained from secondary sources such as NNPC annual statistics; various indicators and World Development Indicators (WDI).

Technique of data analysis

The basic technique of data analysis used for this study is Toda-Yamamoto estimation technique. However, because of the peculiar challenges posed by time series analysis (such as non-stationarity and spurious regression), the Toda-Yamamoto is preceded by the unit root test. Hence, the Augmented Dickey-Fuller (ADF) unit root test is used to test for the stationarity of the series. Also, a confirmation is done using Kwiatkowski – Phillips – Schonidt – Shin (KPSS) unit root test to ensure accuracy.

Model Specification

The model specification of this study is in line with the work of Odusanya (2014) with a slight modification. Odusanya (2014) examined the effect of environmental quality on health care spending in Nigeria within 1960-2011. While this study specify as follows;

$MMR=f(CO_2, N_2O, PM_{2.5}, GXH)$

Where:

MMR = Maternal Mortality Rate.CO_2 = Carbon dioxide, N_2O = Nitrous oxide, $PM_{2.5}$ = Particulate Matter, GXH = Government Expenditure on Health, MMR = Maternal Mortality Rate.

Econometrically, $MMR= \alpha_0+ \alpha_1 Co_2+ \alpha_2 N_2O + \alpha_3 PM_{2.5}+ \alpha_4 GXH +\mu$

$\alpha 1$-$\alpha 4$. Thus, a priori expectation are β_1-β_3 and $\beta_4 < 0$

Presentation of Result and Discussion of Findings

Table 1: represent the result of descriptive statistics of variables employed in the study

	MMR	**CO_2**	**N_2O**	**$PM_{2.5}$**	**GXH**
Mean	362.7275	0.627523	22203.50	72.92477	73.58668
Median	360.1830	0.673985	16131.27	74.50545	16.63877
Maximum	393.7390	0.874309	37938.31	122.4784	388.3671
Std. Dev.	17.92101	0.174144	9819.546	17.64341	103.1706
Skewness	-0.433563	-0.535557	0.621843	0.762062	1.386098
Kurtosis	2.864290	2.008642	1.496877	4.278001	3.887616

Jarque-Bera	1.251778	3.461372	6.184970	4.945300	13.76852
Probability	0.534786	0.177163	0.045389	0.084361	0.001024
Sum	14146.37	24.47340	865936.5	2187.743	2869.881
Sum Sq. Dev.	12204.18	1.152388	3.66E+09	9027.403	404478.4
Observations	39	39	39	39	39

The result of the descriptive statistics shows that the mean value of the variable MMR, CO_2, N_2O, $PM_{2.5}$ and GXH are 362.775, 0.627523, 22203.05, 72.92477 and 73.58668 respectively. From Table 1, the standard deviation of N_2O with the figure 9819.546 is the most volatile variable in the series, while CO_2 with 0.174144 was the least volatile variable. The skewness statistics shows that MMR and CO_2 are negatively skewed; suggesting that their distribution has a long tail, while $PM_{2.5}$ and GXH are positively skewed meaning that their distribution has a right tail.

Also, the Kurtosis statistics shows that MMR, CO_2 and N_2O variables are platykurtic suggesting that their distribution are flat relative to normal distribution, except for $PM_{2.5}$ and GXH that are leptokurtic, suggesting that its distribution is peaked relative to a normal distribution. Based on these observations, it indicates that the series are non-stationary. However, this indication is not surprising since the data are time series in nature. In sum there is no unit root (non-stationary) in the series. On this note, it is therefore necessary to test for stationary of variable.

This lead to the unit root test to be conducted so as to make the variables stationary. The study adopts the Augmented Dickey Fuller (ADF) and Kwiatkoski-Phillips Schmidt-Stim (KPSS) unit root test procedure.

Empirical Analysis for Maternal Mortality Rate (MMR). Table 2 and 3 below present result of stationary test for each of the variables used for Maternal Mortality Rate (MMR) using ADF and KPSS test.

Table 2: ADF Unit Root Test

Variables	ADF at level	ADF at 1st	ADF at 2nd differences	Status	Remark
MMR	-1.407393	-1.426357	-6.416521	1(2)	Stationary
CO_2	-2.173144	-6.810304		1(1)	Stationary
N_2O	-0.533224	-5.661445		1(1)	Stationary
$PM_{2.5}$	-3.239679			1(0)	Stationary
GXH	2.994850	2.034424	-3.924636	1(2)	Stationary
CRITICAL VALUES					
1%	-3.621023	-3.621023	-3.626784		
5%	-2.943427	-2.943427	-2.945842		
10%	-2.610263	-2.610262	-2.611531		

Source: Author's Computation (2022)

Table 3: KPSS Unit Root Test

Variables	KPSS at level	KPSS at 1st	KPSS at 2nd differences	Status	Remark
MMR	0.250861			1(0)	Stationary

CO_2	0.129624			1(0)	Stationary
N_2O	0.644024	0.104490		(1)	Stationary
$PM_{2.5}$	0.161337			1(0)	Stationary
GXH	0.650704	0.687235	0.312066	1(2)	Stationary
CRITICAL VALUES					
1%	0.739000	0.739000	0.739000		
5%	0.463000	0.463000	0.463000		
10%	0.347000	0.347000	0.347000		

Source: Author's Computation (2022)

The outcome of the ADF unit root test result in table 2 for Maternal Mortality Rate (MMR) reveals that Maternal Mortality Rate (MMR) and Government Expenditure on Health (GXH) are stationary at second difference I(2). Carbon dioxide emission (CO_2) and Nitrous Oxide (N_2O) are stationary at first difference I(1), while, Particulate Matter ($PM_{2.5}$) is stationary at level. Hence, that study concludes that the variables used in the model are integrated of different order of integration, that is, I(2), I(1) and I(O).

The result of the KPSS presented in table 3 reveals that Maternal Mortality Rate (MMR), Carbon dioxide emission (CO_2) and Particulate Matter of less than 2.5 diameters are stationary at level, Nitrous Oxide (N_2O) is stationary at first differences 1(1) and Government Expenditure on Health (GXH) is stationary at second differences 1(2).

Hence, this study conclude that the variable used in the KPSS model are integrated of different order of integration, that is, 1(O), 1(1), 1(2). However, since the ADF and the KPSS results indicate that the series are of different order of integration, the study proceeds to conduct the Toda-Yamamoto modeling techniques.

Table 4: VAR Granger Causality/Block Exogeneity Wald Tests

Date: 07/07/21 Time: 09:01
Sample: 1981 2020
Included observations: 24

Dependent variable: MMR

Excluded	Chi-sq	df	Prob.
CO2	2.315026	2	0.3143
N2O	0.553819	2	0.7581
PM25	0.209876	2	0.9004
GXH	0.106944	2	0.9479
All	4.972272	8	0.7605

Dependent variable: CO2

Excluded	Chi-sq	df	Prob.
MMR	4.052930	2	0.1318
N2O	1.090950	2	0.5796
PM25	0.221560	2	0.8951
GXH	1.392552	2	0.4984

All	9.865233	8	0.2746

Dependent variable: N2O

Excluded	Chi-sq	df	Prob.
MMR	0.796002	2	0.6717
CO2	0.374338	2	0.8293
PM25	1.243167	2	0.5371
GXH	0.046386	2	0.9771
All	6.564167	8	0.5843

Dependent variable: PM25

Excluded	Chi-sq	Df	Prob.
MMR	1.788057	2	0.4090
CO2	0.810432	2	0.6668
N2O	0.060680	2	0.9701
GXH	0.516668	2	0.7723
All	3.987583	8	0.8582

Dependent variable: GXH

Excluded	Chi-sq	Df	Prob.
MMR	0.150215	2	0.9276
CO2	2.441246	2	0.2950
N2O	0.523932	2	0.7695
PM25	25.86071	2	0.0000
All	41.80052	8	0.0000

Source: Authors Computation 2022

Discussions of Findings

From the result of the Toda-Yamamoto causality test the study reveals that there is no causal relationship between Carbon dioxide (CO_2) and Maternal Mortality (MMR) with direction from Carbon dioxide (CO_2) to maternal mortality in Nigeria within the period of study. This is

shown by the chi-square value of 2.315026 and probability value of 0.3143. This implies that Carbon Dioxide (CO_2) do not contribute or result to Maternal Mortality Rate (MMR) in Nigeria within the period of study. Also, on the relationship between Maternal Mortality Rate (MMR) and Nitrous Oxide (N_2O),: the result of the Toda-Yamamoto causality test reveals that there is no causal relationship between Nitrous Oxide (N_2O) and Maternal Mortality Rate (MMR) with direction from Nitrous Oxide (N_2O) to maternal mortality in Nigeria within the period of study. This is shown by the chi-square value of 0.553819 and probability value of 0.7581. This implies that Nitrous oxide (N_2O) does not contribute or result to Maternal Mortality Rate (MMR) in Nigeria within the period of study.

The correlation between Maternal Mortality Rate (MMR) and Particulate Matter ($PM_{2.5}$) result of the Toda-Yamamoto causality test reveals that there is no causal relationship between Particulate Matter ($PM_{2.5}$) and Maternal Mortality (MMR) with direction from Particulate Matter ($PM_{2.5}$) to maternal mortality in Nigeria within the period of study. This is shown by the chi-square value of 0.209876 and probability value of 0.9004. This implies that Particulate Matter ($PM_{2.5}$) does not contribute or result to Maternal Mortality Rate (MMR) in Nigeria within the period of study.

The result of the Toda-Yamamoto causality test between Maternal Mortality Rate and Government Expenditure on Health (GXH) reveals that there is no causal relationship between Government Expenditure on Health (GXH) and Maternal Mortality (MMR) with direction from Government Expenditure on Health (GXH) to maternal mortality in Nigeria within the period of study. This is shown by the chi-square value of 0.06944 and probability value of 0.9479. This implies that Government Expenditure on Health (GXH) does not contribute or result to Maternal Mortality Rate (MMR) in Nigeria within the period of study.

Conclusion

Environmental pollution is a source of burden to countries all over the world. This study centers on how environmental pollution impact**s** on maternal mortality in Nigeria. Carbon dioxide, Nitrous oxide and particulate matter are used to capture the explanatory variables of environmental pollution, while Maternal Mortality Rate as the dependent variable.

The result of the Toda-Yamamoto technique reveals that Carbon dioxide, Nitrous Oxide and particulate matter do not have a causal effect on Maternal Mortality in Nigeria. Implying that environmental pollution do not contribute to maternal mortality in Nigeria during the period of study. This finding is in line with the findings of United Nation Climate change conference (COP26) in 2021 held in Glasgow which reveals that Nigeria emission rate is 0.026percent compared to China with 26percent of global emission.

Recommendation

Environmental pollution can be alleviated through the following recommendations;

- Renewable product such as solar energy, wind energy, and hydro energy should be made tax free to encourage mass production
- Tree planting which is absorptive in nature should be encouraged to mitigate environmental pollution
- Government should sensitize the public on the dangers of pollutants.
- Gas flaring prohibition act should be enforced

- The ministry of health should be very articulate about Atmospheric Particulate Matter ($PM_{2.5}$) and should sensitize the public through the Ministry of health on its pros and cons.

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