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Environmental Pollution and Maternal Mortality among Female Entrepreneurs

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Abstract

Purpose

This study examines environmental pollution and maternal mortality among female entrepreneurs in Nigeria from 1981 to 2023.

Methodology/Approach

The study projected the future trend of the post Covid-19 Era from 2020 to 2023 using review analysis about implications on the female entrepreneurs in order to achieve the stated objectives using annual time series data were obtained from secondary sources and analyzed using the Toda-Yamamoto estimation technique of analysis. The study used maternal mortality as response variable to capture health implications on the after-math of Covid-19 prospects among female entrepreneurs with Carbon dioxide, Nitrous Oxide, and Particulate Matter as the main explanatory variables. The findings reveal that Carbon Dioxide, Nitrous Oxide and Particulate Matter reveal no causality with Maternal Mortality during the period of study. Implying that Carbon dioxide emission, Nitrous oxide emission and Particulate Matter do not contribute or result to Maternal Mortality in Nigeria during the period of study (1981-2023).

Findings

However, further finding reveals that increase in maternal mortality result a causal effect on carbon dioxide emission, implying that increase in maternal maternity leads to a continuous pollution of the environment especially the Carbon dioxide emission in the period of study.

Research Implications/ Practical Implications

Thus, Nigeria maternal mortality rate for 2020 was 1,047.00, a 6.68% decline from 2019. However, maternal mortality rate decline with steady rate from 2019 (1,122.00) to 1,047.00 in 2020 and 2023 concurrently. The study recommended that clean and renewable energy sources such as solar energy, wind energy and Hydro energy to replace the fossil fuel energy in the country. 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. This is in a bid to cut down the rate of emission in the country. The study further recommends females' entrepreneurs should be educated highly on prevalence and prevention of maternal mortality. Special environmental policy and restrictions need to be done for the female entrepreneurs' people, planet and profit.

KEYWORDS: *Environmental Pollution, Health Outcomes, Green Entrepreneurship, Female Entrepreneurs, Maternal Mortality, Post Covid-19*

1. CONTEXT OF THE PROBLEM

The dependency of the male counteract in most countries has create a driving motion on the micro economies. But, much attention has been drawn to the necessity of female economic resource value in the macro economics. The contribution on female entrepreneurs on economic growth and development, employment opportunities, national income, gross domestic product (GDP) and new venture creation cannot be over emphasizes (Schumpeter, 2020; Rosenbaum, 2023).. In antecedent to growth and development of nations micro and macro economy, female entrepreneurs support should be discussed on daily basis for sustainability, survival and success (Noor, Isa & Shafiq, 2022; Owalla & Al Ghafri, 2020). Kostiantyn, Kostiantyn and Poddubna, (2023) argued that in the 21st century humanity faced challenges related to its sustainability and survival which the female entrepreneurs are not excluded. Laxmi and Gochhait (2023) ascertained that women are seen as successful and sustainable entrepreneurs because of their burning passion, enthusiasm and self motivation in order to drive robust economic development in their respective countries. This shows how women's significantly contribution to economic growth and development on enterprise success globally (Ahunanya *et al*, 2022a, 2022b).

Female entrepreneurs have unique talent and untapped potential that needs to be utilized for future business opportunities in the business environment. Strategic and tactical competitive intelligence with the application modern technology in machine learning, data science, artificial intelligence, business intelligence and emotional intelligence are what females needs to augment the business world to achieve high climax. Also, the lean start-up entrepreneurship and light entrepreneurship is a viable remedies for future climax on the female entrepreneurs momentum (Ovharhe, 2023,a,b,c).

Despise the several environmental obstacles female entrepreneur has an edge in the society because of the special consideration on her in the business climax. Ovharhe and Woko (2024a) strongly believe that with the bottlenecks and pitfalls on environmental degradation and pollution issues the female entrepreneur strength on application of market intelligence, sale intelligence, production intelligence, strategic intelligence, tactical intelligence and operational intelligence will boost proficiency in the business environment (Ovharhe & Woko, 2024b).

Beato (2024) from Babson College, the renowned entrepreneurship institute with champiopreneurship trait laid emphasis on resilience and allyship for female champiopreneur, leadership applying business intelligence, creativity and innovation to achieve enterprise excellence. Breato (2024) and Ovharhe (2024) inclined that these factorial elements are expected to augment vital proceedings in empowering, proliferating and advancing infant-childhood, women, youth entrepreneurs in beyond now and SDG towards champiopreneurship.

One of the critical issues that call for urgent concerns is the proliferation and prevalence of maternal mortality among potential and prospective female entrepreneurs (Ovharhe, 2021; 2022;

2023). The negation of maternal mortality erupt from the inadequate medical attention and low inefficient technology in the environment with brain drain in the health sector the environment posses a lot of threat to the livelihood of potential female entrepreneurs (Chibuike & Ovharhe, 2022; Chibuike et al, 2022). In Africa generically, female entrepreneurs lose their life during negligence factor due to poor health facilities. These have affected the growth of Small Medium Scale entrepreneurs supply chain management operationally and strategically. It is important to note that there are petty trade and business development specially branded for women like in Nigeria such as Nichers in Restaurant business, edible food items, fruits garden shop, bake beans (Akara), among others (Ovharhe et al. 2021; 2022; 2023). The rate of maternal mortality has made these goes down the drain.

The resultant negation effect might be like pandemic, wars, global climate change and pollution in the enterprise environment. Irrespective of the numerous environmental laws enacted to protect the environment, environmental pollution continues unabated (Kalu, 2009). The issue of gas flaring, oil spillage, inappropriate waste disposal, carbon monoxide emission, land degradation etc. heightens the rate of pollution in the environment.

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 50% 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 (MMR) of 840/100,000 live births (Mehet al, 2019). Thus, Nigeria maternal mortality rate for 2020 was 1,047.00**,** a 6.68% decline from 2019. However, maternal mortality rate decline with steady rate from 2019 (1,122.00) to 1,047.00 in 2020 and 2023 concurrently (WHO, 2023).

Consequently, with respect to the human health impacts of oil spills in the Niger Delta part of Nigeria, the United Nations Environment Program (UNEP, 2011) in 2011 carried out a comprehensive environmental impact assessment to determine the level of oil pollution and hydrocarbon concentration in Ogoni land and environs. The study, reported a significantly high level of contamination in Ogoni land, which poses adverse health hazards. The soils, rivers and dams, farm crops, vegetables, and seafood were extremely contaminated with hydrocarbons, leading to an increase in health problems, such as liver damage, cancer, acute respiratory infections, and reproductive health problems. Over 4,000 samples were drawn and analyzed from drinking water sources in the region, from wells, ground and surface water. Soil samples were extracted from 780 boreholes. In addition, the UNEP project team examined more than 5,000 medical records. The assessment reports that considering the Niger Delta is a high intensity rainfall region, oil spills have the tendency to flow and disperse quickly into farmland and streams and may infiltrate underground water (Mlambo et al, 2023).

However, 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. According to Ghorani-Azam et al (2016) exposure to high levels of pollution cause a variety of adverse health outcome. It increases the risk of respiratory, infectious heart disease and lung

cancer. Implying that both short and long term exposure to pollutants negatively impacts on human health. Recently, diabetic diseases have been linked to environmental pollution. Infertility and pregnancy loss have also been attributed to air pollution. Consequently, the impacts 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 %) 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).

Obviously, the subject environmental pollution and health outcomes has not received the desired attention or received much research publications from researchers internationally and locally. However, there are few studies that are environmental pollution centered. According to Kampa and Castanas (2008), health effects of air pollution affirms hazardous chemicals escape to the environment by a number of natural anthropogenic activities and may cause adverse effects on human health and the environment. Increased combustion of fossil fuels in the last century is responsible for the progressive change in the atmospheric composition. Air pollutants, such as carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_2), volatile organic compounds (VOCs), ozone ($O_(3)$), heavy metals, and irrespirable particulate matter ($PM_{2.5}$ and PM_{10}), differ in their chemical composition, reaction properties, emission, time of disintegration and ability to diffuse in long or short distances. Air pollution has both acute and chronic effects on human health, affecting a number of different systems and organs. It ranges from minor upper respiratory irritation to chronic respiratory and heart disease, lung cancer, acute respiratory infections in children and chronic bronchitis in adults, aggravating pre-existing heart and lung diseases, or asthmatic attacks.

Also, Odusanya et al (2014) examined the effect of per capita carbon dioxide emission on real per capita health expenditures in Nigeria from 1960 to 2011. The study tends to investigate that as carbon dioxide emission increases, health expenditures significantly increase both in long and short-run. It is therefore necessary to appeal to empirical evidence holistically to consider environmental pollution impacts on maternal mortality in Nigeria specifically.

2. CONCEPTUAL/THEORETICAL PARADIGM

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, according to United Nation (UN) inter-agency estimates. 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) 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).
The maternal mortality ratio can be calculated by dividing recorded (or estimated) maternal deaths by total recorded (or estimated) live births in the same period and multiplying by 100,000. Measurement requires information on pregnancy status, timing of death (during pregnancy, childbirth, or within 42 days of termination of pregnancy), and cause of death. Maternal mortality ratio = (Number of maternal deaths / Number of live births) X 100,000 the maternal mortality ratio can be calculated directly from data collected through vital registration systems, household surveys or other sources. However, there are often data quality problems, particularly related to the underreporting and misclassification of maternal deaths. Therefore, data are often adjusted in order to take into account these data quality issues. Adjustments for underreporting and misclassification of deaths and model-based estimates should be made in the cases where data are not reliable. Because maternal mortality is a relatively rare event, large sample sizes are needed if household surveys are used. This is very costly and may still result in estimates with large confidence intervals, limiting the usefulness for cross-country or overtime comparisons.
To reduce sample size requirements, the sisterhood method used in the DHS and MICS (round 4 and 5) surveys measures maternal mortality by asking respondents about the survival of sisters. It should be noted that the sisterhood method results in pregnancy-related mortality: regardless of cause of death, all deaths occurring during pregnancy, birth, or the six weeks following the termination of the pregnancy are included in the numerator of the maternal mortality ratio.

Pollution Prevention Theory

Pollution prevention theory or also known as *Pollution Prevention Act was propounded or established by* the United States Congress in 1990.The pollution haven 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 labor 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 labor 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 (Singh *et a*l., 2012).

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 should be recycled in an environmentally safe manner whenever feasible.

Pollution that cannot be prevented or recycled should be *treated* in an environmentally safe manner whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.

In other words, Pollution Prevention Theory emanate 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 industry, government, and public attention on reducing the amount of pollution through cost-effective changes in production, operation, and raw materials use. Opportunities for source reduction are often not realized because of existing regulations, and the industrial resources required for compliance, focus on treatment and disposal (Romanus *et al*., 2020).

Some efforts the Environmental Protection Agency makes to build prevention practices include permitting, regulations, technical assistance, and enforcement. The agency also encourages business to reduce pollution at the source. The agency makes efforts to link pollution prevention to public information about chemicals (Zhang *et al*., 2020).

The Pollution Prevention Act of 1990 broadens the Toxic Release Industries (TRI stands for toxic Release Industry) TRI role in reducing chemical source pollution. The Act makes pollution prevention reporting mandatory by requiring each TRI-regulated facility to file, beginning July 1, 1992, a source reduction and recycling report with its TRI reporting form. This source reduction and recycling report details the amount of source reduction achieved for each TRI chemical, as well as the pollution prevention methods employed.

Conclusively, pollution prevention theory is an approach that combines substitutability of inputs in the twice-differentiable neoclassical production function and the discreteness of linear activity analysis (Emeka & Babatunde, 2019). The polluting firm's emissions, which result from its use of a toxic input, can be reduced by substituting other inputs for the toxic input or by switching to a nonpolluting process. The strengths of the model are that zero emissions are achievable at a finite marginal cost, the non-convexity that may occur in conventional activity analysis does not occur in this model, and there is a range of output levels at which polluting and nonpolluting firms in the same industry realistically coexist (Agboola, 2019). In this tail, the study analyses how environmental pollution affects maternal mortality among female entrepreneurs.

3. METHODOLOGY

The study adopts the quasi-experimental research design for the study. This design is chosen because it is an empirical study of the association between environmental pollution and maternal mortality among female entrepreneurs from 1981 to 2023 in Nigeria. Thus, the 1981-2019 was based on time series empirical. Whereas, from 2020-2023 was based on review analysis. The study employs descriptive statistics and Toda-Yamamoto estimation technique as the main analytical tool.

This study Environmental Pollution and Maternal Mortality in Nigeria captures the following variables namely; Maternal Mortality Rate (MMR), Nitrous Oxide (N2O), Carbon Dioxide (CO_2) Particulate Matter ($PM_{2.5}$) and Government Expenditure on Health (GXH). These

variables are elaborated below.

Dependent variables

Maternal Mortality Rate (MMR) is the dependent variables which are explained below.

Maternal death or maternal mortality is defined by World Health Organization (WHO) as the death of a woman while pregnant or within 42 days termination of pregnancy, irrespective of the duration and site of pregnancy from any cause related to or aggravated by the pregnancy or its management. The maternal mortality ratio can be calculated by dividing recorded maternal deaths by total recorded (or estimated) live birth in the same period and multiplying by 100,000.

Independents Variables

In this study, Carbon dioxide emission (Co_2), Nitrous oxide (No_2), Particulate Matter ($PM_{2.5}$) and Government Expenditure on Health (GXH) filled in as the informative factors in the model.

(i) Carbon Dioxide (CO_2)

Carbon dioxide molecules consist of one (1) carbon atom and covalently double bonded two (2) oxygen atoms, it is a colourless gas with a density about 53 higher burning of carbon containing power and other plant matter. The measure of Co_2 at the atmosphere his expended since individuals started consuming a lot of coal and oil in the nineteenth century (Abaje *et al*., 2020; Aborisade *et al*, 2020; Davies *et al*., 2019).

It is expected that an expression in carbon dioxide in Co_2 emanation will diminish life expectancy (LEX).

Therefore, δ LEX, / δ $Co_2 < 0$

(ii). **Nitrous Oxide (N_2O)** Nitrous Oxide, commonly known as laughing gas or nitrous, is a chemical compound having an oxide of nitrogen with the formula in No_2at room temperature. It is colourless non-inflammable gas, with a slight metallic scent and taste. At elevated temperatures nitrous oxide is a powerful oxidizer similar to molecular oxygen (Bezverkhyi & Poddubna, 2023).

It is expected that an expansion in No_2 outflow will diminish Maternal Mortality Rate (MMR). Therefore $\delta MMR/ \delta No_2 < 0.$

Particulate Matter (($PM_{2.5}$)
The term fine particles or Particulate Matter (($PM_{2.5}$), refers to tiny particles or droplets in the air that are two and one half microns or less in width. Like inches, meters and miles, a micron is a unit o measurement for distance. The worth's of the larger particles in ($PM_{2.5}$) size range would be thirty times smaller than human hair. The smaller particles are so small that several thousand of them could fit on the period at the end of this sentence. The United State Environmental Protection Agency (EPA) established National Ambient Air Quality standards for ($P_{m2.5}$) in 1997 and revised them in 2006 and 2012. National Ambient Air Standards are established to be protective public health.

It is expected that an expansion in $PM_{2.5}$ outflow will diminish Maternal Mortality Rate (MMR). Therefore $\delta MMR/ \delta PM_{2.5} < 0.$

(iii). **Government Expenditure on Health**

General government (excluding social security) expenditure on health refers to expenditures incurred by central, state/regional and local government authorities, excluding social security schemes. Included are non-market, non-profit institutions that are controlled and mainly financed by government units (OECD Health Data 2001). General government (excluding social security) expenditure on health refers to expenditures incurred by central, state/regional and local government authorities, excluding social security schemes. Included are non-market, non-profit institutions that are controlled and mainly financed by government units.It is expected that expansion in Government Expenditure on Health (GXH) will diminish infant mortality.

Model Specification

The study adopts Auto Regressive Distributive Lag (ARDL) bound testing approach to investigate the effects of environmental quality (proxied by CO_2 emission) on health care spending in the long and short run period. The line model states that; MMR = f(CO2 , FFC, TEPC, EH).

Where: MMR is Maternal Mortality Rate, CO_2 is an emission of carbon dioxide (in kiloton) from consumption of solid, liquid, and gas fuel or burning of bushes, construction industry, manufacturing activities etc. On its turn, FFC is energy consumption from fossil fuels, measured as a percentage of total energy consumption. TEPC represents the total electric power consumption, calculated as the total net consumption of the generating units and measured as in kilowatt-hours (kWh) per capita. EH is used to capture government health expenditure and is measured as the proportion of total government expenditure spent on healthcare.

The point of emphasis was the nexus between real per capita health expenditure and per capita Co_2 emissions in Nigeria. But this study deviates from this scholars by designing three models, while the former is a single model. In this investigation the present study disaggregated health outcome into maternal mortality.

Model

Maternal mortality is a function of carbon dioxide (CO_2), nitrous oxide (N_2O) Particulate Matter ($PM_{2.5}$) and Government Expenditure on Health (GXH)

Thus the functional form of the models are as follows:

Model (maternal mortality model)

$MMR=f(CO_2\ N_2O,\ PM_{2.5},\ GXH)$…….. equ (a)

Where;

CO_2= Carbon dioxide

N_2O = Nitrous oxide
$PM_{2.5}$= Particulate Matter
GXH=Government Expenditure on Health
MMR=Maternal Mortality Rate
Econometrically, equation (3.1) is specified as

Model

$MMR= \alpha_0+ \alpha_1 Co_2+ \alpha_2 N_2O + \alpha_3 PM_{2.5}+ \alpha_4 GXH +\mu$…… equ (b)

Where;

MMR, CO_2, N_2O, $PM_{2.5}$ and GXH are as earlier defined.

β_0=intercept

β_1- β_4, $\alpha 1$-$\alpha 4$ and $\pi 1$-$\pi 4$ are coefficient of the independent variable

$\mu 1$, $\mu 2$ and $\mu 3$ are stochastic term /error term and CO_2, N_2O, $PM_{2.5}$, GXH and MMR remained as defined above. It is expected that these variables will reduce maternal mortality. Thus, a priori expectation are β_1-β_3 AND $\beta_4 < 0$

The study adopts descriptive statistics and unit root test to estimate the link between environmental pollution and health outcomes in Nigeria. The study applied Toda-Yamamoto estimation technique due to the result of the unit root test.

4. Results and Discussion

4.1 Presentation of data.

The E-view analysis was focused on 1981-2019, whereas, the review analysis capture from 2020-2023.
The trend of Nigerian's Maternal Mortality Rate (IMR), Carbon dioxide emission (CO_2), Nitrous oxide (N_2O) Particulate Matter ($PM_{2.5}$) and Government Expenditure on Health (GXH) are presented in table below.

Table 4.1: Data on the variables- MMR, CO_2, N_2O, PM2.5 and GXH (1981-2019).

	MMR	CO_2	N_2O	PM2.5	GXH
1981	362.405	0.87430925	12780.45	-	0.0844575
1982	358.816	0.84727766	13501.08	-	0.0959464
1983	358.977	0.75464209	13395.68	-	0.0827864
1984	359.137	0.85483601	13538.73	-	0.1015487
1985	359.298	0.83641324	13298.3	-	0.1320247
1986	359.459	0.85703744	13570.2	-	0.1341245
1987	359.62	0.67398509	13732.02	-	0.0413145
1988	359.761	0.78264527	13736.39	-	0.4228
1989	359.901	0.45740662	14471.62	-	0.5753
1990	360.042	0.41167477	15542.51	81.46689	0.5007

1991	360.183	0.43282688	14410.89	81.46689	0.6182
1992	360.324	0.46539645	15448.26	81.46689	0.1501607
1993	363.801	0.43950119	15623.45	81.46689	3.8716009
1994	367.277	0.33429857	15488.74	81.46689	2.0939837
1995	370.754	0.31201403	15799.47	77.88861	3.3207
1996	374.231	0.33479508	15706.91	77.88861	3.0237074
1997	377.707	0.36379871	15980.87	77.88861	3.8910988
1998	380.914	0.326916	16325.98	77.88861	4.7422667
1999	384.12	0.3341685	16131.27	77.88861	16.638773
2000	387.326	0.64704259	16230.62	74.50545	15.218082
2001	390.532	0.69395568	17581.17	74.50545	24.522272
2002	393.739	0.73553254	16007.71	74.50545	40.621417
2003	389.439	0.76055829	15776.91	74.50545	33.267982
2004	385.14	0.7315821	16738.24	74.50545	34.198484
2005	380.84	0.76419041	16555.54	59.98227	55.662997
2006	376.541	0.68921072	26531.11	59.98227	62.253622
2007	372.241	0.64827779	37938.31	59.98227	81.909366
2008	368.101	0.63876777	31494.46	59.98227	98.219319
2009	363.961	0.49298093	33,571	59.98227	90.2
2010	359.82	0.72017502	35475.2	51.52977	99.1
2011	355.68	0.80885464	35829.9	53.37225	231.8
2012	351.54	0.71165279	36184.7	50.09322	197.9
2013	346.913	0.72383244	35829.93	46.39325	179.98693
2014	342.287	0.73768261	35948.18	41.60273	195.97678
2015	337.66	0.64000315	35987.6	115.124	257.7
2016	333.034	0.64728484	35921.9	122.4784	200.82399
2017	328.407	0.6749902	35953.56	93.07	245.18802
2018	324.961	0.65409273	35954.35	72.8555891	296.44279
2019	321.483	0.65878926	35943.27	72.0078815	388.36714

Note: MMR = Maternal Mortality rate
CO_2 = Carbon dioxide Emission
N_2O = Nitrous oxide
$PM_{2.5}$ = Particulate matter
GXH = Government Expenditure on Health

Source: World Development Indicators (2019) and CBN statistical bulletin (2019).

Figure 4.1: Trend of Maternal Mortality Rate (IMR) in Nigeria. (1981-2019).

Figure 4.1 show the value of Nigeria's Maternal Mortality rate (MMR) per 1000 female adult in Nigeria. The figures continue to fluctuate slightly up and down from 358.816 in 1982 to 380.914 in 1998. The Maternal Mortality Rate (MMR) maintained a steady increase from 384.12 in 1999 to 393.739 in 2002 indicating the highest rate of Maternal Mortality Rate (MMR) from the period under study. However, from 2002 where the peak figure of 393.739 per 1000 adult female

was recorded. The maternal mortality rate maintained a study decrease in figures from 389.439 in 2003 to 321.483 in 2019 per 1000 female adult in Nigeria. However, maternal mortality rate decline with steady rate from 2019 (1,122.00) to 1,047.00 in 2020 and 2023 concurrently

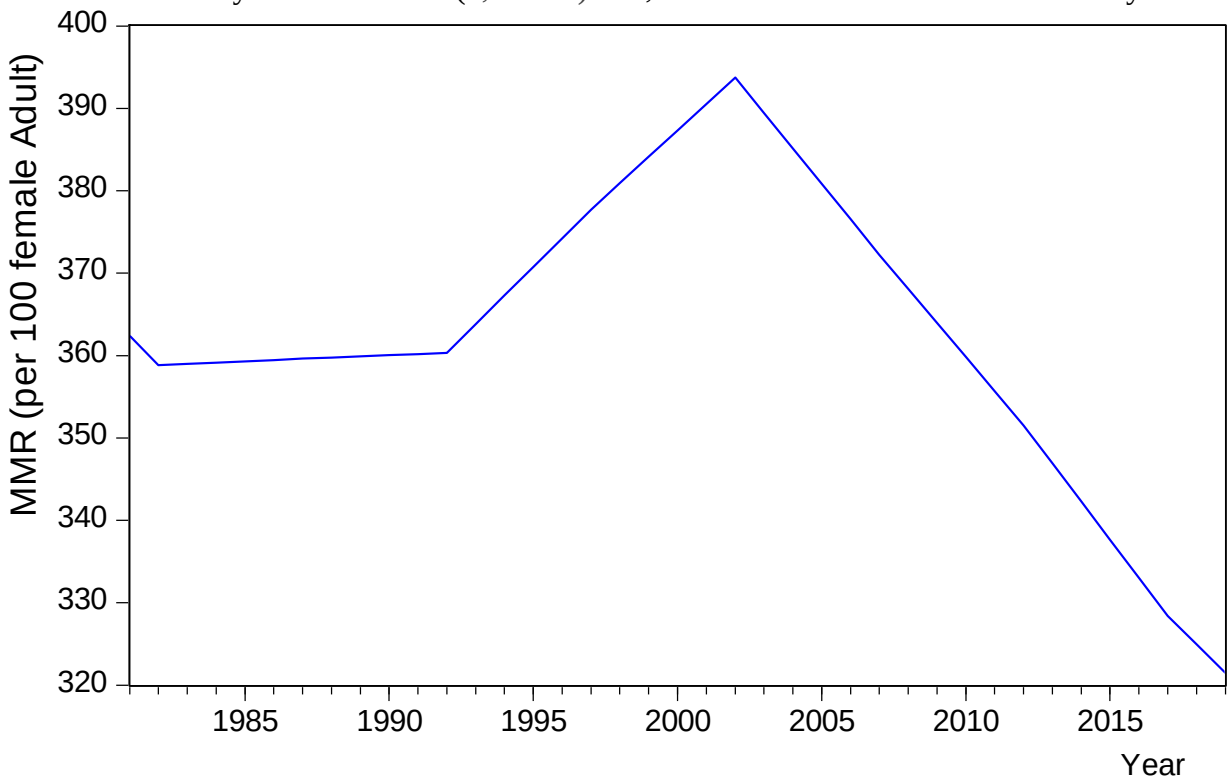

Figure 4.1. Time series plot of Maternal Mortality Rate (MMR) 1981-2019

Figure 4.2. Trend of Carbon dioxide emission (CO_2) in Nigeria. (1981-2019).

Figure 4.2 indicate that the figures of carbon dioxide emission (CO_2) in Nigeria are in puzzle form with strong up and down spike during the period chosen for this study. The figure of 0.87430925 in metric tones, per capital in 1981 indicate the highest in the period of study, while 0.312.01403 in 1996 reveals the smallest in figure of carbon dioxide emission.

Figure 4.2. Time series plot of Carbon dioxide (CO_2) 1981-2019

Figure 4.3 Trend of Nitrous oxide emission (N_2O) in Nigeria (1981-2019).

Figure 4.3 indicate a slight fluctuation in figures of Nitrous oxide emission (N_2O). 12780.45 in metric tonnes in 1981 to 16555.54 in 2005. From 2006 there is a spike of 26531.1, to 37938.31 metric tonnes in 2007. The figures then puzzle down to 31494.40 in 2008 and ended up to 35943.27 metric tonnes in 2019.

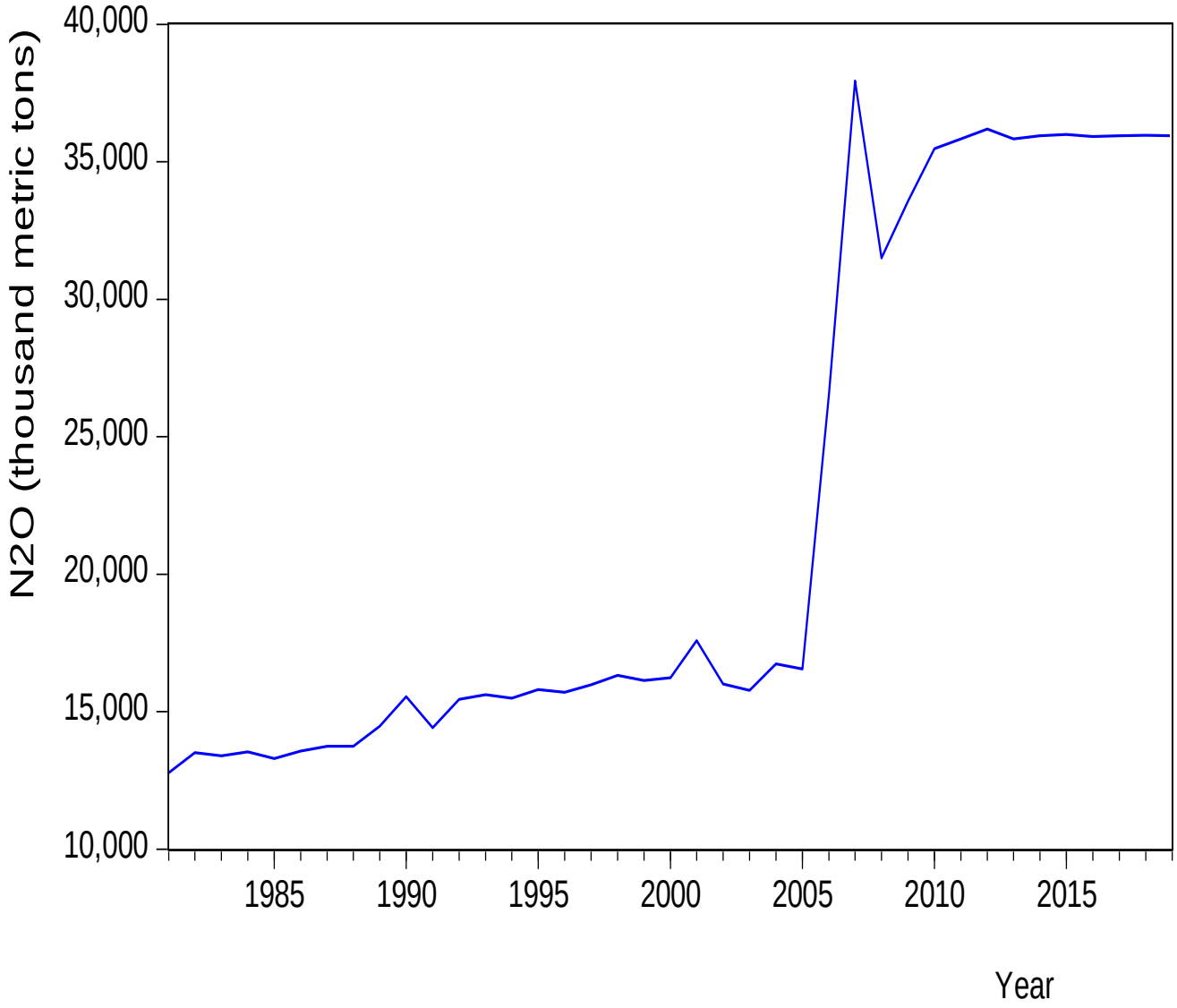

Figure 4.3 Time series plot of Nitrous Oxide (N_2O) 1981-2019

Figure 4.4: Trend of Nigeria's particulate Matter ($PM_{2.5}$) microgram (1981-2019).

Figure 4.4 show the value of Particulate Matter ($PM_{2.5}$) fluctuating in a puzzle form. It shows a steady and continuous decrease of 81.46689 in 1990 to a minimum level of 41.60273 on 2014. The values of 115.124 in 2015 depict the highest level of particulate matter in the period of study. However, in 2019 the value is 72.0078815 in micrograms per cubic meter.

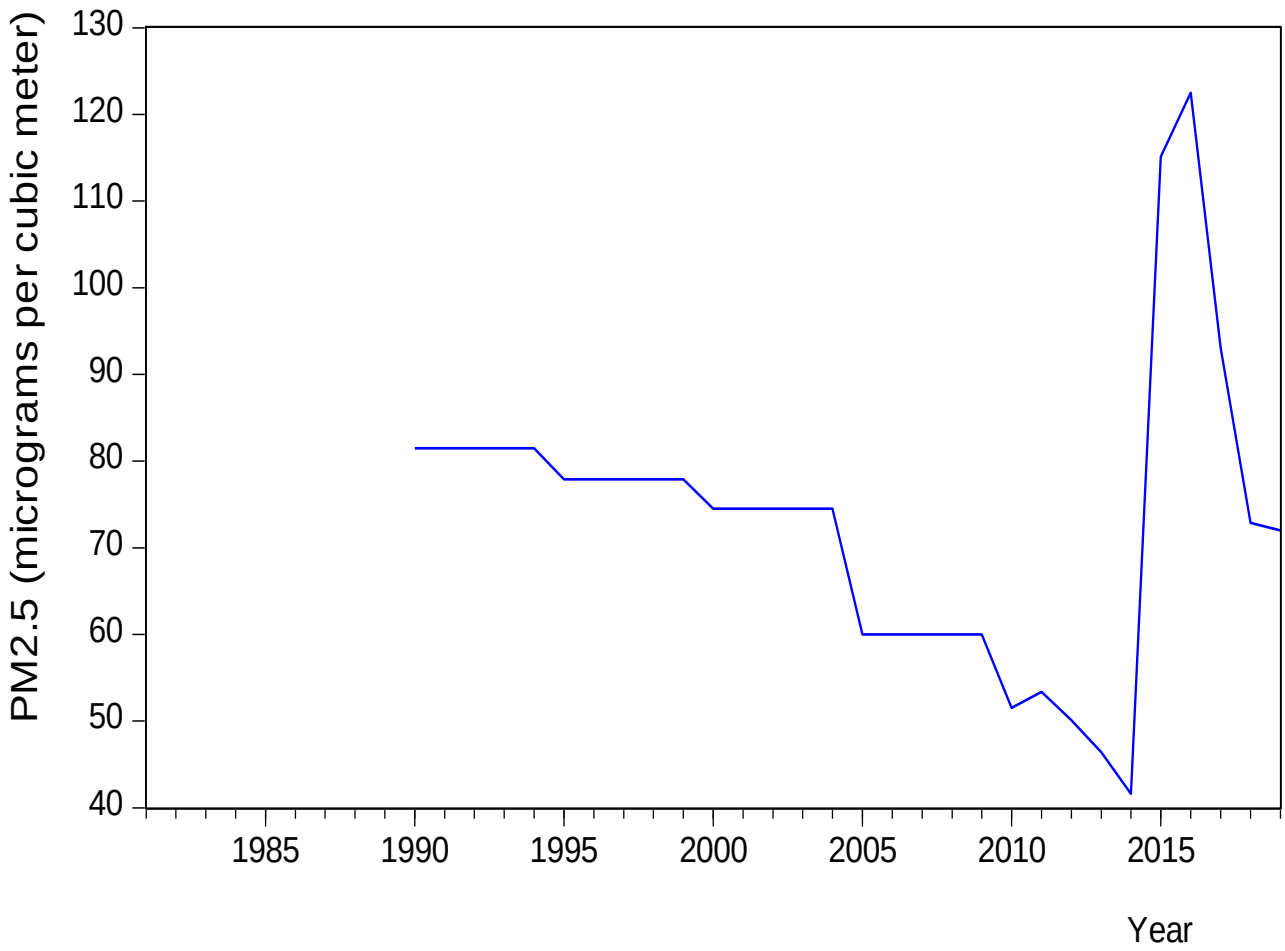

Figure 4.4 Time series plot of Particulate Matter($PM_{2.5}$) 1981-2019

Figurer 4.5: Trend of Nigeria's Government Expenditure on Health (1981-2019).
Figure 4.5 shows the value of Nigeria's government expenditure on health in Billions of Naira. Government expenditure health in Nigeria have been in a fluctuating state but the figures indicate more of increase then decrease. In 1981 0.0844575 was allotted for expenditure on health, the value of 0.041315 in 1987 was the least figure. However, considering the period under study the highest amount of government expenditure on health is 388.36714 in 2019.

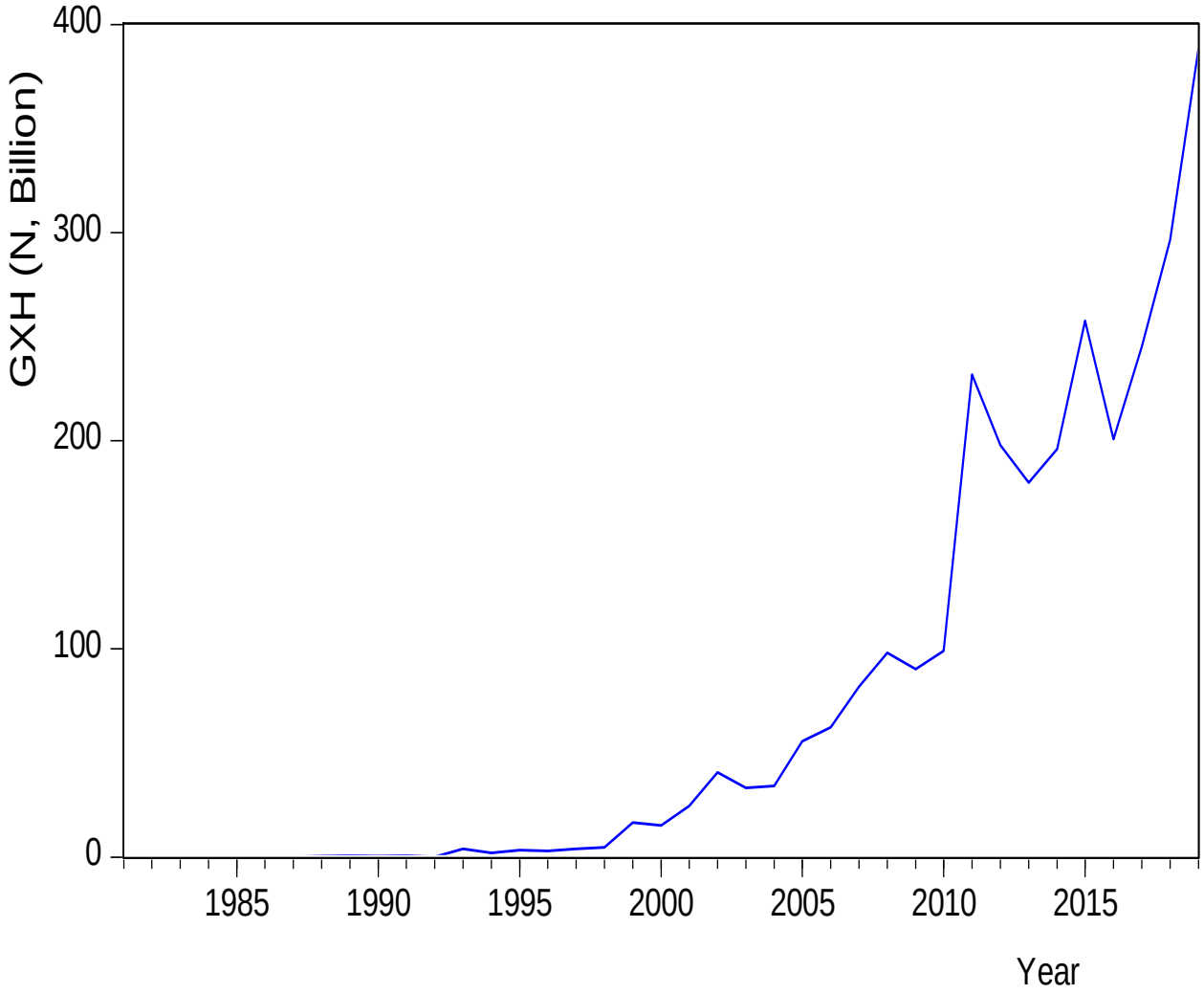

Figure 4.5 Time series plot of Government Expenditure on Health (GXH) 1981-2019

4.2 Data Analysis

The analyses of the data were done in phases. The first phase is the descriptive statistics to ascertain the stationarity of the variables. Secondly, the analyses of further results were done based on each of the models. That is the Maternal Mortality Rate (MMR) model.

4.2.1. Empirical Analysis for Maternal Mortality Rate (MMR) Model

The table below present result of stationarity test for each of the variables used for Maternal Mortality Rate (MMR) using ADF and KPSS test.

Table 4.1: Unit Root test for Maternal Mortality Rate (MMR) model two

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

Table 4.2: KPSS unit root test for Material Mortality Rate (MMR) model two

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

The outcome of the ADF unit root test result in table 4.6 for Maternal Mortality Rate (MMR) model two(2) reveals that Maternal Mortality Rate (MMR) and Government Expenditure on Health (GXH) were stationary at second difference I(2). Carbon dioxide emission (CO_2) and Nitrous Oxide (N_2O) were 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 were integrated of different order integration, that is, I(2), I(1) and I(O).

The result of the KPSS presented in table 4.7, model two 2, reveals that Maternal Mortality Rate (MMR), Carbon dioxide emission (CO_2) and Particulate Matter of less than 2.5 diameter were stationary of 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 two were integrated of different order 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, we proceed to conduct the Toda-Yamamoto modeling techniques.

Table 4.3. Toda-Yamamoto Estimation result for Maternal Mortality model (MMR) model is offered in table of below.

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

Discussion of result for Maternal Mortality Rate (MMR) Model two 2

From table the result of the Toda-Yamamoto causality test shows that CO_2, N_2O, $PM_{2.5}$ and GXH show no causality with MMR; MMR, N_2O, $PM_{2.5}$ and GXH show no causality with CO_2; MMR, CO_2, $PM_{2.5}$ and GXH show no causality with N_2O; MMR, CO_2, N_2O and GXH show no causality with $PM_{2.5}$; MMR, CO_2, and N_2O show no causality with GXH. However, the study find that there is a unidirectional causality which run strictly from $PM_{2.5}$ to GXH depicting that causality exist form $PM_{2.5}$ to GXH.

Relationship between Carbon dioxide (CO_2), Nitrous Oxide (N_2O) Particulate Matter ($PM_{2.5}$) and Government Expenditure on Health (GXH) on Maternal Mortality Rate (MMR) in Nigeria

(i) Carbon dioxide CO_2) and Maternal Mortality Rate (MMR) in Nigeria. 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) does not

contribute or result to Maternal Mortality Rate (MMR) in Nigeria within the period of study.

(ii) Nitrous oxide (N_2O) and Maternal Mortality (MMR) in Nigeria

From the result of the Toda-Yamamoto causality test the study reveals that there is no causal relationship between Nitrous oxide (N_2O) and Maternal Mortality (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.

(iii) Particulate Matter ($PM_{2.5}$) and Maternal Mortality (MMR) in Nigeria

From the result of the Toda-Yamamoto causality test the study 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.

(iv) Government Expenditure on Health (GXH) and Maternal Mortality (MMR) in Nigeria.
From the result of the Toda-Yamamoto causality test the study 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.

(v)Maternal Mortality Rate (MMR) and Carbon dioxide (CO_2) Emission in Nigeria.

The result of the Toda-Yamamoto causality test reveals that there is no causal relationship between maternal mortality and Carbon dioxide emission in Nigeria during the period of study. This is shown by the chi-square value of 4.052930 and probability value of 0.1318. Consequently, since the probability value of 0.1318 is greater than 0.05% percent, it implies that maternal mortality does not contribute to carbon dioxide (CO_2) emission in Nigeria during the period of study.

(vi) **Nitrous Oxide (N_2O) and Carbon dioxide (CO_2) Emission in Nigeria**

The result of the Toda-Yamamoto casualty test reveals that there is no causal relationship between Nitrous oxide (N_2O) and carbon dioxide (CO_2) emission in Nigeria during the period of study. This is shown by the chi-square value of 1.090950 and probability value of 0.5796. However,since the probability value of 0.5796 is greater than 0.05%percent, it implies that Nitrous oxide (N_2O) does not contribute to carbon dioxide (CO_2) in Nigeria during the period of study.

(vii) **Particulate Matter ($Pm_{2.5}$) and Carbon dioxide (CO_2) Emission in Nigeria**.

The result of the Toda-Yamamoto Causality test reveals that there is no causal relationship between Particulate Matter ($PM_{2.5}$) and carbon dioxide (CO_2) emission in Nigeria during the period of study. This shown by the chi-square value of 0.221560 and probability value of 0.8951. Consequently, since the probability value of 0.8951 is greater than 0.05% percent. The implication is that particulate matter does not contribute or result to carbon dioxide (CO_2) emission in Nigeria during the period of study.

(viii) **Government Expenditure on Health and Carbon dioxide (CO_2) Emission in Nigeria**

The result of the Toda-Yamamoto causality test reveals that there is no causal relationship between Government Expenditure on Health (GXH) and Carbon dioxide (CO_2) emission in Nigeria during the period of study. This is shown by the chi-square value of 1.392552 and probability value of 0.4984. However, since the probability value of 0.4984 is greater than 0.05% percent. This implies that Government Expenditure on Health (GXH) does not contribute to carbon dioxide CO_2 emission in Nigeria during the period of study.

(ix) **Maternal Mortality Rate (MMR) and Carbon dioxide (CO_2) in Nigeria**

The result of the Toda-Yamamoto causality test reveals that there is no causal relationship between Maternal Mortality Rate (MMR) and Carbon dioxide (CO_2) emission in Nigeria during the period of study. This is shown by the chi-square value of 0.796002 and probability value of 0.6717. However, since the probability value of 0.6717 is greater than 0.05% percent. This implies that Maternal Mortality does not contribute to Carbon dioxide (CO_2) emission in Nigeria during the period of study.

(x) Particulate Matter ($PM_{2.5}$) and Government Expenditure on Health (GXH) in Nigeria. From the result of the Toda-Yamamoto test, the study reveals that causality exit between Particulate Matter ($PM_{2.5}$) and Government Expenditure on Health (GXH) in Nigeria within the period of study or there exist a unidirectional causality which runs strictly from $PM_{2.5}$ to GXH with chi-square value of 25.86871 and probability value of 0.0000. This implies that increase in Particulate Matter ($PM_{2.5}$) emission result to Government Expenditure on Health (GXH). Bezverkhyi and Poddubna, (2023) postulated that in the 21st century humanity faced challenges related to its sustainability and survival. The resultant negation effect might be link to pandemic, wars, global climate change and pollution in the enterprise environment

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The study examined the health outcomes of environmental pollution in Nigeria spanning from 1981-2019. In order to achieve the objectives annual time series data of Maternal Mortality Rate (MMR) which was modeled as the response variable and Carbon dioxide emission (CO_2), Nitrous Oxide (N_2O), Particulate Matter of less than 2.5 diameter $PM_{2.5}$ and Government Expenditure on Health (GXH) which acted as the explanatory variables was carried out using Toda-Yamamoto modeling technique to establish the result.

The findings of the study on the basis of which appropriate policy recommendation were

proffered can be summarized as follows:

i. Carbon dioxide emission (CO_2) does not have a causal effect on Maternal Mortality (MMR) in Nigeria in the period of study. Implying that Nitrous Oxide (NO_2) emission does not result to maternal mortality in Nigeria within the period of study.
ii. Nitrous Oxide (N_2O) emission does not have a causal effect on Maternal Mortality Rate (MMR) in Nigerian within the period of study. Implying that Nitrous oxide (N_2O) emission does not result to maternal mortality in Nigeria within the period of study.
iii. Particulate Matter ($PM_{2.5}$) does not have a causal effect on Maternal Mortality Rate (MMR) in Nigeria in the period of study. Implying that Particulate Matter ($PM_{2.5}$) emission does not result to maternal mortality in Nigeria in the period of study.
iv. Government Expenditure on Health (GHX) does not have a causal effect on Maternal Mortality Rate (MMR) in Nigeria in the period of study. Implying that Government Expenditure on Health (GXH) does not result to a reduction in maternal mortality rate in the period of study.
v. Also, Maternal Mortality Rate (MMR) Carbon dioxide (CO_2), Nitrous oxide (N_2O) and Government expenditure on Health (GXH) reveals no causal effect of Particulate Matter ($PM_{2.5}$) in Nigeria within the period of study. Implying that MMR, CO_2, N_2O and GXH does not contribute or result to $PM_{2.5}$ emission in Nigeria within the period of study with the probability value of 0.85582 which is greater that 0.05 percent depicting that the impact is insignificant.
vi. Maternal Mortality Rate (MMR), Carbon dioxide (CO_2), Nitrous oxide (N_2O) and Particulate Matter ($PM_{2.5}$) jointly reveals a causal effect on Government Expenditure on Health (GXH) in Nigeria within the period of study. Implying that MMR, CO_2, N_2O and $PM_{2.5}$ contribute or result to Government Expenditure on Health (GXH) in Nigeria within the period of study with the probability value of 0.0000 which is less than the 0.05 percent depicting that the impact is significant.
vii. Particulate Matter ($PM_{2.5}$) has a causal effect on Government Expenditure on Health (GXH) in Nigeria during the period of study. Implying that increase in Particulate Matter ($PM_{2.5}$) emission result the government to make expenditure on health.

Having examined the target variables, the findings according to Toda-Yamamoto estimation technique reveals that; increase in maternal and infant mortality in Nigeria during the period of study in Nigeria. However, the maternal mortality in Nigeria could basically be as a result of inadequate medical care as postulated by Okereke (2019) and confirmed by Oyediran (1981) who emphasize that the problem of maternal mortality in Nigeria is as a result of inadequate provision of trained medical and paramedical personnel and the inefficient utilization by the community of the services provided.

5.2 Conclusions

Environmental pollution did not result to maternal mortality in Nigeria during the period of study, rather increase in life expectancy contributes to environmental pollution in Nigeria. However, maternal mortality rate decline with steady rate from 2019 (1,122.00) to 1,047.00 in 2020 and 2023 concurrently.

5.3 Recommendations

The following recommendations are made based on the findings of the study.

i. Products that utilize solar energy, wind energy, Hydro energy and other renewable product should be made tax free, in order to encourage mass production.

ii. Females entrepreneurs should be educated highly on prevalence, prevention of maternal mortality

iii. The presence of Atmospheric Particulate matter ($PM_{2.5}$) is not healthy for any country which might degenerate into maternal mortality of female entrepreneurs. On this premise, the government should through the Ministry of health sensitize the public on the dangers of the pollutants.

iv. The government should implement the gas flaring prohibition act promulgated in 2005 and strongest penalty be melted on any company that flout the law.

v. Also, special environmental policy and restrictions need to be done for the females' entrepreneurs (people), planet and profit.

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