Do Socio-Economic Factors Contribute to Maternal Mortality in sub-Saharan Africa? Evidence from MDG Era and PMG Approach to Panel Data Analysis

Presley Kehinde Osemwengie[1]

Abstract: The objective of this study is to provide robust evidence on the contribution of socio-economic determinants to maternal mortality in sub-Saharan Africa (SSA). The paper covers the era of MDG (1990-2015) using panel data from selected 43 sub-Saharan Africa countries. The era was chosen to understand the interaction between the socioeconomic variables and MMR with the aim of providing a policy framework for SDG going forward. A model of *Pooled Mean Group* (PMG) was adopted in the analysis of data. For robustness, a panel cross-section dependence test was conducted for validity purpose. The PMG results showed strong evidence in support of the short and long-run elasticity impact of per capita health expenditure, female labour force participation rate, female employment and GDP per capita on maternal mortality in SSA. The study identified these socio-economic variables as key policy instruments in reducing maternal mortality in SSA. Also, the results have important policy implications both domestically for countries in SSA with a high rate of maternal deaths, and globally, if the SDG-5 of reducing maternal deaths by less than 70 per 100,000 live births before 2030 can be achieved.

Keywords: Maternal health; Maternal deaths; Panel unit root tests; Pooled mean group

JEL Classification: C130; H51; R23

1. Introduction

The importance of improving maternal health particularly reducing maternal deaths in sub-Saharan Africa region has received serious attention recently. Sub-Saharan Africa is one of the less developed regions of the world and it is faced with several challenges of health problems, including cancer, tuberculosis, HIV/AIDs, high infant and under-five mortality rate, low life expectancy and high prevalence of other preventable diseases, apart from severe maternal deaths. The region is also confronted with the incidence of poverty, economic and social deprivation, insecurity, gender divides and income inequality (Oriakhi, Osemwengie & Amaechi, 2014), thus reducing her ability to confront most of the preventable

[1] Lecturer, PhD, Department of Economics, University of Benin, Nigeria, Address: Benin City, Edo State, Nigeria, Tel.: +2348038226071, Corresponding: presley.osemwengie@uniben.edu.

diseases including maternal deaths. While maternal mortality ratio (MMR) has declined significantly in high- income countries, low-income countries in Africa, particularly sub-Saharan Africa (SSA), still has the greatest burden and plague of MMR in the world. According to Burchett and Mayhew (2009), MMR is about 12 times higher in developing countries. Almost all maternal deaths (99 per cent) occur in developing countries. More than half of these deaths occur in SSA and almost one third occur in South Asia (World Health Organization, 2015). In 2012, the Millennium Development Goal (MDG) report indicates that 56 per cent of world maternal deaths occurred in SSA. The maternal mortality ratio in developing countries in 2015 stood at 239 per 100, 000 live births as against 12 per 100 000 live births in developed countries (WHO, 2015).

Sub-Saharan African countries have been the most affected by maternal deaths and the region has the highest cases of mortalities in the globe. WHO (2015) estimates of MMR revealed that more than 830 women die every day in the world due to complications related to pregnancy or childbirth. Of these deaths, about 550 deaths occurred in SSA daily and this represents about 66. 3 per cent of the global deaths that occurred daily in the world compared to 180 that occurred daily in Southern Asia and 5 daily in developed countries (WHO, 2015). According to the most recent estimate by WHO (2019), SSA was the only region in the world with high MMR in 2017, estimated at 542 with the lifetime risk of maternal death being 1 in 37, compared with just 1 in 7800 in Australia and New Zealand. The estimated maternal deaths for the SSA region in 2017 was estimated at 196 000 deaths, representing 66 per cent of the global deaths (254 000). When compared with the 2015 MMR estimates, it showed that SSA only had about 0.3 per cent decline between 2015 and 2017. This implies that the region has the lowest declining rate of MMR and this has a serious concern for the region.

Furthermore, Socio-economic determinants or factors which fall under the purview of the indirect (proximate and distant) factors also account for the causes of maternal deaths (Rosendo, Roncalli & Azevedo, 2017; Meh, Thind & Ryan, 2019). Generally, mothers' health involves a whole range of factors, including her behaviour, emotion, psychology, social, economic, cultural and physical wellbeing (United Nation, 1995). Apart from the medical determinants identified as direct factors (haemorrhage, Hypertensive disorders of pregnancy, eclampsia, sepsis, embolism and complications of unsafe abortion), different interactive factors tend to contribute to maternal morbidity and death, and this includes the behaviour of families and communities, social status, education, income, nutritional status, age, parity, and availability of health services (Rogo, Oucho & Mwalali, 2006) as well as governance. Other factors such as good /clean water and sanitation, roads and communication, and internal security, also influence maternal outcomes in SSA (Sommer, Shandra, Restivo & Coburn, 2015).

Interestingly, medical determinants of maternal deaths have received high-level attention from researchers (Say, Chou, Gemmill, Tuncalp, Moller, Daniels, Gulmezoglu, Temmerman & Alkema, 2014; Fagbamigbe & Idemudia, 2015; Choe, Kim, Kim, Park, Kullaya & Kim, 2016; Adamu, Adamu & Okagbue, 2018), health concerns and stakeholders all over the world, and emphasis has been on reducing maternal deaths especially those resulting from medical shortcomings, while less attention has been given to the non-medical determinants of maternal deaths, and most of the death occurring from maternal cases are tied to social, environmental, economic and cultural factors apart from direct causes. Also, studies on SSA countries are very scanty. The few ones (Bour & Bream, 2004; Laithapersal-Pilly & Udjo, 2014; Dersarkissian, Thompson & Arah, 2013; Akinlo, Idemudia, Ogunjuyigbo & Solanke, 2016; Ariyo, Ozodiegwu & Doctor, 2017) used naive method of analysis such as binomial regression, correlation and chi-squares. The current study deviates by focusing on the non-medical (socio-economic) causes of maternal deaths employing a novel or robust method of analysis such as pooled mean group (PMG) technique to panel data analysis. To the best of my knowledge, it is the first study to use PMG technique in investigating the contribution of socioeconomic factors to maternal mortality in SSA region.

Why the study? First, it will help to identify and understand the short and long-run impact of socio-economic factors on maternal mortality in SSA. Second, the outcome of the study will be useful to government, policy makers, stakeholders and investors or partners in the health sector in making informed policy intervention on maternal mortality in the region. Third, it will be meaningful to understand the contribution of socio-economic factors to maternal health if SDG goal 5 of reducing maternal mortality by less than 70 per 100,000 live births by 2030 can be achieved in SSA region. Therefore, the study represents a contribution to extant literature and methodology.

2. Empirical Literature

Meh, Thind, Ryan and Terry (2019) investigate the levels and determinants of maternal mortality in Nigeria focusing on the northern and southern region. The findings revealed that education and media exposure were associated with maternal mortality in the north while the use of contraceptive, residence type and wealth index were associated with maternal deaths in the south. For the both region, age and community wealth were significantly associated with maternal mortality. In another study, Rosendo, Roncalli and Azevedo (2017) examine the prevalence of maternal morbidity and its association with socioeconomic factors, using a cross-sectional study conducted based on a multi-stage complex sampling. The finding shows that the prevalence of maternal morbidity was estimated at 21.2 per, cent and that socioeconomic status remained significant in maternal mortality and that women in a worse socioeconomic situation had a higher prevalence of maternal morbidity.

Girum and Wasie (2017) investigate the correlates of maternal mortality in developing countries using a sample of 82 countries. It observed that maternal mortality ratio has an inverse and significant correlation with adult literacy rate, gross national income and per capita income. Ayadi, Hill, Larger, Subramamian and McCormick (2015) compare sociodemographic and pregnancy characteristics of pregnancy-related deaths identified by the sisterhood method and the household/verbal autopsy method in Bangladesh. The study submits that there were no significant differences between reporting sister characteristics and deceased women's characteristics in education attainment, working status, husband's educational attainment, and spouse educational parity.

Furthermore, Idowu, Edewor and Amoo (2014) investigated the influence of working conditions on maternal health in the face of poor provision of amenities and infrastructural decay pervading urban centres in sub-Saharan Africa using Nigeria as a case study. The study specifically investigated the plight of women in Lagos State. The findings show that socio-environmental conditions including poverty, inefficient transportation system, gender bias, work stress and poor quality of life expose a large proportion of women to morbidities, poor nutrition and repeated pregnancies that can increase maternal mortality. Novigon, Olakojo and Nonvignon (2012) conducted a study to examine the effects of public and private health care expenditure on health status in SSA countries. The study employed data for 44 SSA countries from the world development indicators and estimated both the fixed and random effects models using the generalised least square estimator (GLS). The study concluded that public and private health expenditure lead to the improvement in health outcomes and a reduction in the crude death rate. In addition, the study found out that HIV prevalence leads to higher crude death and mortality rates and a fall in life expectancy. Also, real GDP per capita leads to improvement in life expectancy at birth and a fall in crude deaths and mortality.

Kamiya (2010) conducted a study to estimate the determinants of under-five mortality. The study used the system generalised method of moments (GMM) to analyse cross-country panel data from 141 developing countries. The study found evidence of a reduction in mortality rate due to the increase in health expenditure, GDP per capita and access to improved sanitation. Skilled birth attendances, the number of physicians per 1,000 people and immunisation did not have a significant impact on mortality rate. Also, Ogunleye (2011) investigated the relationship between health production, health outcomes and economic growth for SSA countries. The study used the Arellano-Bond Dynamic GMM technique to analyse data for 40 SSA countries. The study suggested that alcohol consumption, urbanization and carbon emission have statistical significant impacts on mortality rate in SSA countries. Also, the study found that food availability, alcohol consumption, urbanization and carbon emission were significant determinants of health outcomes in SSA countries.

Recent studies in Africa (for instance, DerSakissian, Thompson & Arah, 2013; Lalthapersad-Pillay & Udjo, 2014; Osemwengie & Shaibu, 2020; Osemwengie, 2020) have shown evidence of mixed findings between maternal mortality and non-medical factors. DerSakissian, et al. (2013) measured the relationship between maternal mortality ratio and socio-economic, demographic and population- health factors. The study used data from published literature and global agencies (such as WHO, UN and World Bank) and applied correlation, negative binomial and mixed poisson regression models. The study found evidence of a significant relationship between socioeconomic, demographic and population-health factors, and these factors play a significant role in reducing maternal mortality ratio. Similar findings or evidences in the support of a significant impact of socio-economic factors on maternal mortality rate in sub-Saharan Africa were recently conducted by Osemwengie and Shaibu (2020), and Osemwengie (2020). Lalthapersad-Pillay and Udjo (2014) on the other hand, showed evidence of no significant relationship between maternal mortality ratio and non-medical factors such as human development index (HDI), gross national income per capita, total fertility rates and gross secondary school enrolment ratios for girls and contraceptive prevalence rate. The study employed a logistic regression model on survey data based on the individual country. The differences in results may be as a result of the chosen variables, method of analysis or model and the data employed. Thus, more empirical work is needed in this area to further strengthen existing evidence.

3. Model Specification, Estimation Techniques and Data

3.1. Model Specification

The health production function (HPF) will be the theoretical underlying framework for this study. The HPF simply relates output to inputs based on economic analysis. In the framework, health outcome is expressed as a function of health inputs where the inputs can be seen from the socio-economic perspective. Wagstaff (1986) is one of the earliest economists that utilized the health production function in his study on demand for health. According to Wagstaff (1986), the health production function model shows how non-medical factors influence an individual's health behaviour and the individual's health status. Since the postulation of the health production function model by Wagstaff, several studies which include, Filmer and Pritchett (1999) and Ogunleye (2011), have applied the model to empirical studies in economics. Following Ogunleye (2011), we specify the model for estimation in line with the objective of the study in linear econometric form as:

$lnMMR_{it} = \beta_{0i} + \beta_{1i}lnPA_{it} + \beta_{2i}lnHPC_{it} + \beta_{3i}lnLFPR_{it} + \beta_{4i}lnFEMP_{it} + \beta_{5i}lnGDPPC_{it} + \beta_{6i}lnLTRM_{it} + \beta_{7i}lnFR_{it}\ \varepsilon_{it}$ (1)

$i = 1, 2, \ldots, N$, $t = 1, 2, \ldots, T$,. We expect $\beta_{1i}, \beta_{7i} > 0$, $\beta_{2i}, \beta_{3i}, \beta_{4i}, \beta_{5i}, \beta_{6i} < 0$.

ln indicates logarithm, β_0 and $\beta_{i=1,7}$ are intercept and coefficients of the explanatory variables respectively. ε_{it} is the stochastic or error term which is assumed to follow a white noise process, randomly distributed with zero mean and constant variance. MMR_{it} is the maternal mortality ratio of country i at time t, the dependent variable. Explanatory variables- PA_{it} is the prevalence of anaemia of country i at time t. HPC_{it} is health care investment of country i at time t. This is measured in terms of per capita health expenditure. $LFPR_{it}$ is female labour force participation rate of country i at time t. Female $employment_{it}$ is used as a proxy for the social status of women in country i at time t. $GDPPC_{it}$ is gross domestic product per capita of country i at time t, which is used as a measure of economic growth or standard of living. $LTRM_{it}$ is the life-time risk of maternal mortality of country i at time t. and FR_{it} is the fertility rate of country i at time t

3.2. Estimation Technique

Equation 1 will be estimated using *pooled mean group (PMG)* estimator developed by Pesaran, Shin and Smith (1999). This method allows for short-run heterogeneous dynamics and a long-run homogenous relationship for SSA countries in our study which involves both pooling and averaging. This estimator (PMG) is superior and more apt in comparison to the traditional pooled estimators, such as the fixed and random effects estimators, where the intercepts are allowed to fluctuate across groups and at the same time, compelling all other error variances and coefficients to be constant. More so and essentially, PMG is a dynamic panel estimator that has the potential of revealing the true nature of the data used in estimation.

Going forward, the autoregressive distributed lag, ARDL equation for the long-run model stated in equation 1 is given by equation 2.

$lnMMR_{it} = \varepsilon_{it} + \theta_{10i}lnPA_{it} + \theta_{11i}lnPA_{it-1} + \theta_{20i}lnHPC_{it} + \theta_{21i}lnHPC_{it-1} + \theta_{30i}lnLFPR_{it} + \theta_{31i}lnLFPR_{it-1}\ \theta_{40i}lnFEMP_{it} + \theta_{41i}lnFEMP_{it-1} + \theta_{50i}lnGDPPC_{it} + \theta_{51i}lnGDPPC_{it-1} + \theta_{60i}lnLTRM_{it} + \theta_{61i}lnLTRM_{it-1} + \theta_{70i}lnFR_{it} + \theta_{71i}lnFR_{it-1} + \lambda_i lnMMR_{it-1} + \mu_{it}$ (2)

The associated error correction equation or equilibrium is states as:

$\Delta lnMMR_{it} = \phi_i(lnMMR_{it-1} - \beta_{0i} - \beta_{1i}lnPA_{it} - \beta_{2i}lnHPC_{it} - \beta_{3i}lnLFPR_{it} - \beta_{4i}lnFEMP_{it} - \beta_{5i}lnGDPPC_{it} - \beta_{6i}lnLTRM_{it} - \beta_{7i}lnFR_{it}) - \theta_{11i}\Delta lnPA_{it} - \theta_{21i}\Delta lnHPC_{it} - \theta_{31i}\Delta lnLFPR_{it} - \theta_{41i}\Delta lnFEMP_{it} - \theta_{51i}\Delta lnGDPPC_{it} - \theta_{61i}\Delta lnLTRM_{it} + \theta_{71i}\Delta lnFR_{it} + \mu_{it},$ (3)

Where $\beta_{0i} = \frac{\varepsilon_{it}}{1-\lambda_i}$, $\beta_{1i} = \frac{\theta_{10i}+\theta_{11i}}{1-\lambda_i}$, $\beta_{2i} = \frac{\theta_{20i}+\theta_{21i}}{1-\lambda_i}$, $\beta_{3i} = \frac{\theta_{30i}+\theta_{31i}}{1-\lambda_i}$, $\beta_{4i} = \frac{\theta_{40i}+\theta_{41i}}{1-\lambda_i}$, $\beta_{5i} = \frac{\theta_{50i}+\theta_{51i}}{1-\lambda_i}$, $\beta_{6i} = \frac{\theta_{60i}+\theta_{61i}}{1-\lambda_i}$, $\beta_{7i} = \frac{\theta_{70i}+\theta_{71i}}{1-\lambda_i} = \phi_i = (1-\lambda_i)$.

The error correction equilibrium in equation 3 allows an ARDL (1,0,0,0,0,0,0,0) as a special consideration.

Further, the study uses both the common (homogenous) and individual (heterogeneous) unit root tests proposed by Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003) respectively to investigate the stationarity properties of the series in MMR model. The procedure was applied by Shaibu and Osemwengie (2017), Osemwengie and Shaibu (2020) and Osemwengie (2020) recently. Besides, the long-run co-integrating equilibrium relationships between the variables combined are carried out using the panel data technique proposed by Pedroni (1997). Other stability tests were conducted for robustness.

3.3. Data Sources

The period for the study covers the era of MDG (1990 to 2015) but the non-availability of some socio-economic variables (for example, per capita health expenditure) between 1990 and 1994, when the MDGs benchmark was launched limited the study to the use of 1995 to 2015.The MDG era was chosen so that the outcome of the study in terms of findings will provide a useful policy direction for the attainment of SDG 5 by 2030.43 SSA countries were included in the study based on data availability. The countries are Angola, Burkina Faso, Cameroon, Comoros, Ghana, Guinea Bissau, Kenya, Lesotho, Liberia, Madagascar, Mali, Mauritania, Namibia, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Zimbabwe, Benin, Eritrea, Zambia, Central Africa Republic, Ethiopia, Mozambique, Uganda, Guinea, Niger, Botswana, Burundi, Chad, Rwanda, Congo Brazzaville, Equatorial Guinea, Congo Democratic Republic, Togo, Côte d'Ivoire, Gabon, Gamble, Malawi, Mauritius, Nigeria and Switzerland. The data were sourced from the World Development Indicator (WDI) of the World Bank.

4. Analysis of Results

4.1. Panel Unit Root Test Results

Table 1 presents the panel unit root test results for all the variables used in the analysis. The unit root results indicate that all the variables are unit root free (stationary) in level using the LLC test under common unit root process at 5 per cent level of significance. However, under the individual unit root process using IPS test, the results show that two variables (LMMR and LLTRM) had unit roots in levels. After the first difference, they became unit root free and difference stationary at 1 per cent level of significance. Therefore, we reject the hypothesis of a unit root in the variables.

Table 1. Panel Unit Root Test of Variables

Variables	**Common Unit Root Process (LLC)**		**Individual Unit Root Process (IPS)**	
@ Level	**Stat. & Significant Level**	**Remark**	**Stat. & Significant Level**	**Remark**
LMMR	4. 29***	Stationary	4. 90	Non-Stationary
LHPC	-1.77**	Stationary	-3.57***	Stationary
LLFPR	-1.88**	Stationary	-2.17***	Stationary
LLTRM	-3.18***	Stationary	-0.04	Non-Stationary
LGDPPC	-1.59**	Stationary	-1.68**	Stationary
LFEMP	-2.66**	Stationary	-3.99***	Stationary
LFR	-30.49***	Stationary	-43.11***	Stationary
LPA	11.35***	Stationary	13.96***	Stationary
@ First Difference				
DLMMR			-2.41***	Stationary
DLLTRM			-3.74***	Stationary

Note**: *, **** and *** indicate statistical significance at 10%, 5% and 1% levels respectively

Source: Author's estimate using Eviews 9

4.2. Pedroni Residual Panel co-integration Test Results

The Pedroni residual panel co-integration test results displayed in Table 2 was conducted using all the seven residual-based tests for the null of no co-integration to check whether the panel data are co-integrated. Four are based on pooling the residuals of the regression for the within-group (common AR coefficients) and the other three are based on pooling the residuals for the between-group (individual AR coefficients). The within-group test results indicate that the null hypothesis of no co-integration can be rejected for both the panel PP and ADF statistics at 1 percent level of significance respectively. Also, the between-group test also showed that the null hypothesis of no co-integration can be rejected for both the group PP and ADF statistics at 1 percent level of significance. Therefore, the LMMR model appears to be co-integrated at 1 percent level of significance according to both within-group and between-group tests. Thus there is a long-run relationship between LMMR and all the variables in the model as revealed in the result in Table 2.

Table 2. Pedroni Residual Cointegration Test

Series: LMMR LLTRM LHPC LGDPPC LPHIV LFEMP LFR LPA Sample: 1995 2015 Included observations: 903				
Alternative hypothesis: common AR coefficients. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	2.68	0.00	-2.90	0.99
Panel rho-Statistic	8.32	1.00	7. 39	1.00
Panel PP-Statistic	1.60	0.94	-8.23	0.00***
Panel ADF-Stat.	-0.82	0.20	-3.27	0.00***
Alternative hypothesis: individual AR coefficients. (between-dimension)				
	Statistic		Prob.	
Group rho-Stat.	9. 62		1.00	
Group PP-Statistic	-17. 52		0.00***	
Group ADF-Stat.	-2.91		0.00***	

*Source: Author's estimation, using E-views 9. Note- *** indicates significance at 1 percent*

4.3. Analysis of PMG Results and Policy Implication

The PMG results are reported in Table 3.Being an ARDL model due to lag sensitivity, we imposed a maximum lag length of one for Hannan-Quinn criterion to obtain optimum lag length selected automatically for the various variables. Besides, the variables were integrated of order 1, this justifies the lag structure used.

Table 3. PMG Results for Sub-Saharan Africa, one lag (1, 1, 1, 1, 1, 1, 1, 1)

Variable	Coefficient	Standard error	T-statistic	Probability
Long Run Equation				
LPA	0.624	0.079	7. 885	0.000***
LHPC	-0.009	0.002	-3.066	0.002***
LLFPR	1.086	0.166	6. 513	0.000***
LLTRM	0.963	0.016	58.507	0.000***
LGDPPC	0.058	0.006	8.768	0.000***
LFEMP	-0.940	0.158	-5.932	0.000***
LFR	-0.706	0.061	-11.493	0.000***
Short Run Equation				
ECT	-0.097	0.046	-2.097	0.036**
D(LPA)	0.101	0.213	0.474	0.635

D(LHPC)	-0.036	0.031	-1.146	0.252
D(LLFPR)	0.406	0.281	1.445	0.149*
D(LLTRM)	0.905	0.068	13.180	0.000***
D(LGDPPC)	-0.006	0.003	-1.834	0.067**
D(LFEMP)	0.152	0.126	1.211	0.226*
D(LFR)	-1.248	0.490	-2.545	0.014***
C	0.287	0.142	2.025	0.043**
Mean dependent var	-0.024	S. D. dependent var	0.035	Mean dependent var
S. E. of regression	0.004	Akaikeinfo criterion	-8.060	S. E. of regression
Sum squared resid	0.006	Schwarz criterion	-5.562	Sum squared resid
Log likelihood	3307.696	Hannan-Quinn critr	-7.095	Log likelihood

Note: *, ** and *** indicate statistical significance at 10%,5% and 1% levels respectively

Source: Author's estimation using Eviews 9

The PMG results in Table 3 reports both the short and long-run impact of the socio-economic variables employed on maternal mortality in SSA. As shown in the results, the error correction term (ECT) is significantly negative at 5 per cent level. This indicates the existence of a stable and converging long-run relationship between maternal mortality ratio and all the exogenous variables used in the analysis. Also, the speed of adjustment reflected by the convergence coefficient is estimated to be slow as indicated by its value of 9.7 per cent. Thus, it will take a longer time for the variables to bring LMMR back to a steady-state path should shock from the exogenous variables disrupt the initial equilibrium.

A look at the results further indicates that LLTRM has the correct sign in both runs (short and long) and affects MMR at 1 per cent level of significance. One percent increase in the risk of maternal mortality will lead to 90.5 percent rise in maternal deaths in the short-run and 96. 3 percent in the long-run. Thus, LLTRM is a significant factor to contend with in the goal of reducing maternal deaths in SSA. In the same manner, LFR proved to be a significant determinant of maternal mortality in both short and long-run at 1 percent level of significance. But the variable has a negative relationship with maternal mortality. This negative sign may be due to the increase in the gross level of education (both male and female) in the region as well as the enlightenment of both sexes on the acceptance and the use of contraceptive. Based on this understanding, a percent rise in controlled-fertility rate would lead to a decrease in maternal deaths by 124 percent in the short-run and 70.6 percent in the long-run. Thus making the variable to be an important determinant of maternal mortality in SSA. Therefore, the control of fertility rate through family planning is key to the reduction of maternal mortality in sub-Saharan Africa.

LGDPPC proved to be significant in both the short and long-run. In the short run, LGDPPC is negatively significant indicating that the higher the level of per capita GDP, the lower the rate of maternal deaths in the region. Maternal mortality will reduce by 0.6 percent in the short-run and rises by 5.8 percent in the long-run. The rise of maternal death in the long-run may be due to infrastructural deficit especially in the health sector and probably other structural bottlenecks such as delay in accessing and identifying viable health institution, inadequate physicians, poverty rate or level of the region. Health expenditure per capita (LHPC) and the prevalence of anaemia among women (LPA) indicate weak determinant of maternal mortality in the short-run. However, in the long-run, both LHPC and LPA showed a significant relationship with maternal mortality in SSA. LHPC had the correct sign in both runs, and the weak impact of LHPC may probably explain the fact that initial investment in maternal health may not translate immediately to the reduction in maternal deaths rather it is expected to have a long-run impact on maternal mortality. Furthermore, the positive relationship between LPA and LMMR is expected. The result shows that anaemia among pregnant women may not lead to death in the short-run but in the long-run, it is highly fatal.

Another interesting variable that proved to be an important determinant of maternal mortality in SSA in both the short and long-run is the log of female labour force participation rate (LLFPR). But the variable indicates a positive relationship with LMMR which may not be expected. The reason for the positive sign may be due to the inclusion of a particular country in SSA region into the sample. The social status of women, proxy by female employment rate (LFEMP), shown to be a significant determinant of maternal mortality in SSA in both short and long-run. In the short run, the variable sign is unexpected. However, in the long-run, the social status of women influence maternal deaths negatively. Maternal deaths may rise at first in the short-run by 15.2 percent and latter expected to fall in the long-run by 94 percent. This result may be true, because, at the early stage of employment, the income earned or received may probably fall-short of what is expected to be invested in maternal health. As the social status rises as income rises, investment in maternal health is expected to increase and this is expected to reduce maternal mortality in the long-run.

4.4. Robustness Check of PMG Model

Despite the significance of all the variables at conventional significance level as displayed in Table 3, it was still plausible to carry robustness check to ascertain the efficiency of the estimator and the validity of the test statistics. To this end, a panel cross-section dependence test was conducted.

4.4.1. Panel Cross-Section Dependence Test of PMG Model

This test is very important, especially, where the study used panel series. Ignoring cross-sectional dependence in estimation can lead to serious consequences. Particularly, where the residual dependence is unaccounted for, this can result in estimator efficiency loss and invalid test statistics. In the literature, there are a variety of tests for cross-section dependence. But for this study, we adopted the commonly used tests proposed by Breusch and Pagan (1980) and Pesaran (2004). The results are presented in Table 4.

Table 4. Residual Cross-Section Dependence Test

Null hypothesis: No cross-section dependence (correlation) in residuals Cross-sections included: 43 Total panel (unbalanced) observations: 723			
Test	Statistic	d. f.	Prob.
Breusch-Pagan LM	7100.335	903	0.0000
Pesaran scaled LM	144.8179		0.0000
Pesaran CD	46.88883		0.0000

Source: Author's estimation using Eviews 9

Table 4 displayed the results of residual cross-section dependence test using Breusch-Pagan LM, Pesaran scaled LM and Pesaran CD. Accordingly, all the tests are asymptotically standard normal, and the test statistic results of 7100.33, 144. 81 and 46. 88 respectively, strongly reject the null of no cross-section dependence at conventional statistical levels using the associated p-values of 0.00 respectively. This results, therefore, revealed the absence of efficiency loss and invalid test statistic by our estimator and it can be used for drawing meaning inferences.

5. Conclusion and Recommendations

The study investigated the short and long-run impacts of socio-economic factors on maternal mortality in SSA using PMG model. In the short –run result, the log of female labour force participation rate, a log of lifetime risk of maternal death, a log of GDP per capita, log of female employment ratio and log of fertility rate all proved to be significant determinants of maternal deaths in SSA. The result suggests that these variables are quite significant in the reduction of maternal mortality in the short-run, and if the contribution of these variables is sustained in the long-run, maternal deaths will drop significantly in SSA. Furthermore, the aforementioned variables combined with the log of prevalence of anaemia among pregnant women and log of per capita health expenditure all indicated to be long-run significant determinants of maternal mortality in SSA.

Byways of recommendation, the policy focus should be on empowering women through active participation in the workforce, education and decision-making in maternal health. This would enhance their status and make them a joint partner in issue bordering on maternal health and their wellbeing. The study has shown evidence that socioeconomic variables matters and would play a key role in the fight against maternal deaths and would be useful for policy interventions in SSA particularly the target to make sustainable progress in the SDG-5 of reducing maternal deaths by less than 70 before 2030.Finally, estimating the long-run relationships between MMR and socio-economic factors is quite important because the effect of these variables on MMR may take a longer time to affect MMR, unlike the direct medical determinants. Therefore, examining the long-run and short-run effect of these socio-economic variables on MMR is in place for policy direction.

References

Adamu, P. I.; Adamu, M. O. & Okagbue, H. I. (2018). Data in Support of High Rate of Pregnancy Related Deaths in Maiduguri, Borno State, Northeast Nigeria. *Data Brief Elsevier*, 18, pp. 409-414.

Akinlo, A.; Idemudia, E. S.; Ogunjuyigbe, P. O. & Solanke, B. L. (2016). Women’s Empowerment Status and Exposure to Maternal Mortality Risks in Nigeria. *Gender and Behaviour*, 14(1), pp. 7085-7099.

Ariyo, O.; Ozodiegwu, I. D. & Doctor, H. V. (2017). The Influence of Social and Cultural Environment on Maternal Mortality in Nigeria: Evidence from the 2013 Demography and Health Survey. *PLOS One.* 12(12).

Ayadi, M. A.; Hill, K.; Larger, A.; Subramanian, V. S. & McCormick, M. (2015). Comparability of Sociodemographic and Pregnancy Characteristics of Pregnancy-Related Deaths Identified Via the Sisterhood Method Versus the Household/Verbal Autopsy Method. *International Journal of Gynecology & Obstetrics*, 129(3).

Bankole, A.; Adewole, I. F.; Hussian, R.; Awolude, O.; Singh, S. & Akinyemi, J. O. (2015). The Incidence of Abortion in Nigeria. *International Perspectives on Sexual Reproductive Health*, 41(4), pp. 170-181.

Bour, D. & Bream, K. (2004). An Analysis of the Determinants of Maternal Mortality in sub-Saharan Africa. *Journal of Women’s Health*, 13(8), pp. 926-938.

Breusch, T. S. & Pagan, A. R. (1980). The Lagrangian Multiple Test and Its Applications to Model Specification in Econometrics. *The Review of Economic Studies*, 47(1), pp. 239-253.

Burchett, H. E. & Mayhew, S. H. (2009). Maternal Mortality in Low Income Countries: What Interventions have been evaluated and how should the Evidence Base be Developed Further? *International Journal of Gynecology and Obstetrics*, 105, (1), pp. 78–81.

Choe, S. A.; Kim, J.; Kim, S.; Park, Y.; Kullaya, S. M. & Kim, C. Y. (2016). Do Antenatal Care Visits Always Contribute to Facility-Based Delivery in Tanzania? A Study of Repeated Cross-Sectional Data. *Health Policy Planning,* 31(3), pp. 277-284.

Dersarkissian, M.; Thompson, C. A. & Arah, O. A. (2013). Time Series Analysis of Maternal Mortality in Africa from 1990 to 2005.*Journal of Epidemiology and Community Health*, 67(12), pp. 992-998.

Fagbamigbe, A. F. & Idemudia, E. S. (2015). Barriers to Antenatal Care Use in Nigeria: Evidences from Non-Users and Implications for Maternal Health Programmimg. *BMC Pregnancy Childbirth*, 15(95), pp. 1-10.

Filmer, D. & Pritchett, L. (1999). The Impact of Public Spending on Health: Does Money Matter? *Social Science and Medicine*, 49(10), pp. 1309-1323.

Girum, T. & Wasie, A. (2017). Correlates of Maternal Mortality in Developing Countries: An Ecological Study in 82 Countries. *Maternal Health, Neonatology and Perinatology,* 3(1), p. 19.

Idowu, A. E.; Edewor, P. A. & Amoo, E. O. (2014). Working Conditions and Maternal Health Challenges in Lagos State, Nigeria. *Research on Humanities and Social Sciences*. 4(9), p. 2224-5766.

Im, K. S.; Pesaran, M. H. & Shin, Y. (2003). Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics*, 115, pp. 53-74.

Kamiya, Y. (2010). Determinants of Health in Developing Countries: Cross-Country Evidence. *Osaka: Osaka School of International Public Policy* (OSIPP).

Lalthapersad-Pillay, P. & Udjo, E. O. (2014). The Association between Maternal Mortality and Non-Medical Factors in African Countries. *Journal of Economics and Behavioural Studies*. 6 (5), pp. 351-362

Levin, A.; Lin, C. F. & Chu, C. S. (2002). Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. *Journal of Econometrics*, 108, pp. 1-24.

Meh, G.; Thind, A.; Ryan, B. & Terry, A. (2019). Levels and Determinants of Maternal Mortality in Northern and Southern Nigeria. *BMC Pregnancy Childbirth,* 19, p. 417.

Novigonon, J.; Olakojo, S. A. & Nonvignon, J. (2012). The Effects of Public and Private Health Care Expenditure on Health Status in sub-Saharan Africa: New Evidence from Panel Data Analysis. *Health Economics Review*, 2(1), pp. 1-8.

Ogunleye, E. K. (2011). Health and Economic Growth in Sub-Saharan African Countries: A Production Function Approach. *Tanzanian Economic Review*, 1(1-2), pp. 1-43.

Oriakhi, E. D.; Osemwengie, K. P. & Amaechi, J. (2014). Foreign Direct Investment and Poverty in Nigeria: Further Evidence. *Journal of Governance & Development*, 10(1), pp. 45-74.

Osemwengie, K. P. (2020). Socio-Economic Determinants of Maternal Mortality in sub-Saharan Africa: Evidence from Generalised Method of Moments (GMM) Approach to Panel Data Analysis. *Amity Journal of Healthcare Management,* 5 (1).

Osemwengie, K. P. & Shaibu, I. (2020). Traditional Pooled Data Estimates of the Socio-economic Determinants of Maternal Mortality in sub-Saharan Africa: Case Study of MDG Era. *KIU Journal of Social Sciences*, 6(3), pp. 55-66.

Pedroni, P. (1997). Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis: New Results, Indiana University *Working Paper* in Economics.

Pesaran, M. H. (2004). General Diagnostic Tests for Cross Section Dependence in Panels. *CESifo Working Paper Series*, CESifo Group Munich.

Rogo, K. O.; Oucho, J. & Mwalali, P. (2006). *Disease and Mortality in sub-Saharan Africa* (2nd ed.). Washington, DC: World Bank.

Rosendo, S. T.; Roncalli, G. A. & Azevedo, O. G. (2017). Prevalence of Maternal Morbidity and Its Association with Socioeconomic Factors: A Population-Based Survey of a City in Northeastern Brasil, *Rev. Bras. Ginecol. Obstet,* 39(11).

Say, L.; Chou, D.; Gemmill, A.; Tuncalp, O.; Moller, A.; Daniels, J.; Gulmezoglu, A. M.; Temmermam, M. & Alkema, L. (2014). Global Causes of Maternal Death: A WHO Systematic Analysis. *Lancet Glob Health*. 2(6), pp. 323 –333.

Shaibu, I. & Osemwengie, K. P. (2017). Modelling Share Prices of Selected Quoted Firms in Nigeria (2005-2014): A Panel Analysis. *Asian-African Journal of Economics and Econometrics*, 17(1), pp. 141-154.

Sommer, J. M.; Shandra, J. M.; Restivo, M. & Coburn, C. (2015). *Water, Sanitation, and Health in sub-Saharan Africa: A Cross-National Analysis of Maternal and Neo-natal Mortality.* Human Ecology Review, *22 (1), pp. 129-152.*

United Nations (1995). *The World Women 1995 Trends and Statistics*. United Nations, New York.

WHO, UNICEF, UNFPA, World Bank, & UNPD (2019). Maternal Mortality: Levels and Trends. *Sexual and Reproductive Health*, pp. 1-104.

WHO, UNICEF, UNFPA, World Bank & UNPD (2015). *Trends in Maternal Mortality: 1990 to 2015.*Geneva: World Health Organization.

Wagstaff, A. (1986). Demand for Health: Theory and Applications. *Journal of Epidemiology and Community Health*, 40, pp. 1-11.