

Human Development and Maternal Mortality: Evidence from Sub-Saharan Africa

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Abstract

Maternal mortality is a serious development challenged faced by developing countries especial Sub-Saharan Africa(SSA) countries and has been marked as key development goal by both the Millennium Development Goal(MDGS) and the Sustainable Development Goals (SDGs). The Human Development Index(HDI) a measure of population wellbeing has been estimated to account for 80% to 82% of the variations in maternal mortality among developing countries. The Human Development report for 2011 has categorized 35 countries in the sub-region as low income countries. The objective of this study is to investigate the effect of maternal mortality on human development in SSA. The result of the J-statistics confirms that the instruments used in our model are valid and there is no evidence of serial correlation. The result of the Fixed Effect(FE) and the System GMM estimation showed a significant negative of maternal mortality on human development measured by the HDI in Sub-Saharan Africa. Thus, a unit increase in maternal mortality will reduce human development by 0.015 to 0.023points in the sub-region.

Keywords: *Human development- Maternal mortality – System GMM - Sub-Saharan Africa*

1 Introduction and background

For many centuries, the sub-Saharan African region has been confronted with numerous social and economic problems; and the lack of interventions to address these challenges have contributed to high levels of poverty, maternal mortality, infant mortality, unemployment and inequality. The persistent increase in these social and economic challenges have reflected in development report on the sub-region. The UN-economic commission for Africa reports for 2015 showed that the number of people in the sub-region living below \$1.25 a day has increased consecutively by a population of 100million since 1990 to 2019. The number of the population living under \$1.25 in 1990 was 290 million and finally increased to 414million in 2015 (UN-Economic commission for Africa Report 2015, 122). The United Nation Millennium development goal report for 2015 also indicated that the sub-region has the highest maternal mortality ratio of 546 per 100,000 live which is more than half of the global maternal mortality ratio of 216 per 100,000 live births (WHO 2016, 1) Again the sustainable development report for 2017 published by WHO recorded high maternal mortality estimate of 542maternal deaths per 100,000 live birth (WHO 2017,1) However, irrespective of the recent improvement and commitment by international organizations to reduce maternal mortality, it is still high in developing countries, especially sub-Saharan African. What is most worrying, is that about 94% of the death related to pregnancy and child birth that occur in low income countries such as Sub-Saharan Africa are preventable.

The United Nations Development programme report on human development index (HDI) categorized 35 countries in the sub-region as low human development countries (UNDP 2011, 127-130). Again in 2018, the United Nations Development report for 2017 on Human Development indicators ranked the sub-region as the lowest among developing regions such as Arab states, East Asian and the Pacific, South Asia, Latin America and Caribbean, Central Europe and Central Asia (UNDP online database 2018). Human development became more important in the economic literature in the 20th century when Kuznet 1934,1-

12 who proposed GDP as a measure of economic growth warned against using it as a measure of economic wellbeing (Kuznet 1934,1-12). However, in order to assess how rich a country is, in terms of the total well-being of its inhabitants, indicators such as health, economic and social status should be of interest. One measure which captures the overall well-being of the inhabitants of a country is the Human Development Index(HDI). The human development index, is a statistical measure used to assess the level of well-being and the quality of the inhabitants of a country. The index consists of three components; namely health, education and income. The health aspect of the index is measured by life expectancy at birth, which aggregates the long and healthy life of the population. The education component also captures how knowledgeable the inhabitants are, is measured by adult literacy and their level of education. The income component which also captures the standard of living of the population is measured by per capita gross domestic product (GDP).

The Human Development Index, have been found both in the economic and population development literature to explain maternal mortality and it has been estimated to account for about 80 to 82% of differences in maternal mortality among countries, especially the developing ones (Lee et al.1997, 430-433). Maternal mortality which is a misfortune event for many developing communities and a key health indicator for a country's development is also predicted by factors such as economic status, education and health care. These population development measures have received attention in the economic and public health literature; and have been addressed in the Millennium Development Goals and the Sustainable Development Goals, but there is still lack of academic research on the effect of human development measured by the human development index on maternal mortality in Sub-Saharan African region, even though several studies have investigated the effect of education, income and life expectancy on maternal mortality (Bhalotra and Clarke 2014; Amiri and Gerdtham 2013; Buor and Bream 2004, 926-934) . The main question is, to what extent has maternal mortality influence human development measured by human development index in the sub-region? It is against this background that the study is conducted to investigate the effect of maternal mortality on human development in the Sub-Saharan African region.

This paper consists of five sections. The first section specifies the research gap and the purpose of the study. The second section focuses on the theoretical and empirical literature of the study. The third section is on the methodological framework of the study. The fourth section discusses the results and major findings of the paper, and the fifth section is on the conclusion and policy implication of the study.

2 Literature Review

Human development and maternal mortality have been an important issue for this discussion, both theoretically and empirically. This section of the paper provides a theoretical and empirical review on the relationship between human development and maternal mortality.

2.1 Human Development and Maternal mortality; Gender stratification theory perspective

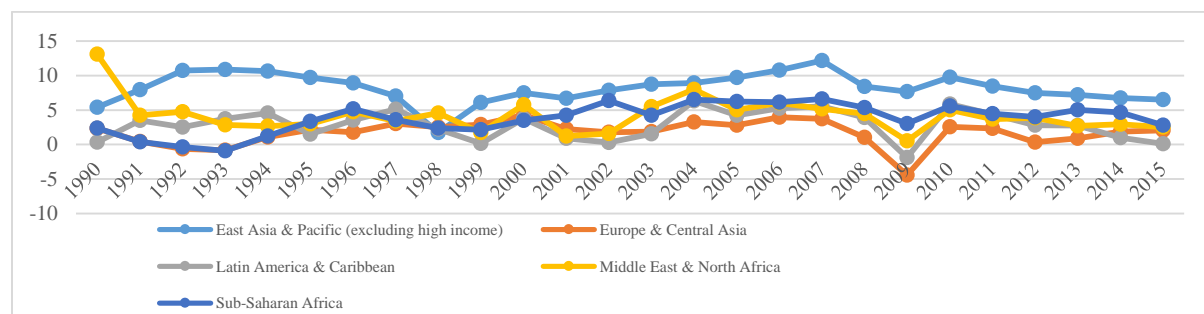
The connections between the differences and privileges in society can best be explained by the gender stratification theory. It's one theory that is different, but likewise have relations with other aspect of inequalities that place emphasis on social class and ethnicity. The gender stratification theorists are of the view that society where women are self- sufficient and autonomous are probable of having lower maternal mortality than a society dominated by low status and more dependent women. The reason being that women with high status in society, have high income and the right to decide on the number of children to have. Societies with women who are self- sufficient, autonomous and with high level of income will definitely have lower maternal mortality rate because these women are probable of having improved nutrition and access to improved maternal health care services during pregnancy. According to Shen and Williamson 1999,197-214 women who are more dependent and have low status in society are probable of having to many children. These women start childbearing at tender ages and end at the later stages of their reproductive life, hence exposing them to high maternal mortality risk. These notions of gender

stratification theorists and; Shen and Williamson 1999,197-214 were not considered as important in the modernization theory. From the modernization theorist perspective, the status of a woman will be enhanced through the provision a more labour participation opportunity, which in the long run increase her access to improved income and maternal health care services, and her control over these resources should lead to a decline in maternal mortality and mortality in general. According to theorist, these can be achieved through industrialization and modernization. The assumptions of the modernization theory have been challenged by finding from studies conducted by Abraham 1988; Boserup 1970). Thus, the United Nations report, 1995 supports the argument of the gender stratification theorists that a decrease in fertility through access to education, employment and contraceptive usage reduce the risk of a woman dying from pregnancy and childbirth related complications (UN 1995,1-44)

2.2 Maternal mortality and human development: modernization theory perspective

The neoclassical economic theory and the modernization theory which are both development theories are closely linked from the theoretical and empirical point of view. These two important theories see economic development as a link to the gap between developed and under developed countries through a derived process. The demographic transition theory which is developed from the modernisation theory observe fertility and maternal mortality to be associated with each other. According to this theory, a community such as Sub-Saharan African community where fertility is high will have higher maternal mortality rate. This is because high level of education will lead to low maternal mortality ratio. Again economic development will contribute to high living standard and modern medical technology that is associated with lower fertility and maternal mortality (Shen and Williamson 1999,197-214). Theoretically, as health status of the population, in the form maternal mortality decreases, economic development achieved through human development increases. According to Kelly and Cutright 1980, 315-329; Van de Walle and Knodel 1980,3-44 the process of maternal mortality influencing economic development needs greater level of industrialization, urbanization and education. The effort to improved usage of family planning is linked to modernization from the perspective of the modernization theory. The theory also hypothesises that higher level of modernization in a country increases the drive of a woman to control birth which is also achieved through human development in the form of education. The high level of modernisation also decreases the probability of exposing women to pregnancy and child birth related deaths (Kelly and Cutright 1980, 315-329). The theory further argues that economic development obtained as a result of human development is associated with improved welfare and highly trained medical professionals will lead to lower maternal mortality and fertility rate. From the modernization theory perspective, countries that have experience modernization, will have lower fertility rate which will results in lower maternal mortality rate. Thus, a decline in maternal mortality which is a key health status indicator of the population should improve the level of economic development.

FIGURE 1 Trend of economic growth in Sub-Saharan African compared to other regions in the world (1990-2015)



Source: Authors own construction from world Bank online database 2019

Aside the progressive improvement in economic growth in the sub-region during global financial crisis in 2007 and 2008 (Figure 1), the region still lags behind in two important social and economic indicators for both the millennium development Goals and Sustainable Development Goals. A critical observation of the United Nation Development programme report for 2018, showed that the sub region's performance was not impressive in all the three statistical measures of the Human development index (Table 1). For instance, the health component of the index, captures the health of the individual and population as a whole. This component is very important, in the sense that it indicated the physical conditions of the inhabitant of a nation. According to Kumar 2011, 668-679 a population with wealthier people can pay for private medical care and have longer life. Comparing the life expectancy at birth for Sub-Saharan Africa(60.7rs) with other sub region such as South Asia(69.3yrs), Arab States(71.5yrs), East Asia and Pacific(74.7yrs), Europe and Central Asia(73.4yrs) and Latin America and the Caribbean(75.7yrs) shows that Sub-Saharan Africa has the lowest which is very worrying. The results confirm the argument that the long and healthy life style of the poor mainly depends on factors such as public health, nutrition, environment and sanitation services. The sub-region has been battling with all these conditions hence the low life expectancy at birth. Again the education component which is measured by literacy rate, capturing productive skill and knowledge of the inhabitant is also very low comparing it with South Asia and other sun-regions. Sub-Saharan Africa recorded 10.1 years for expect years of schooling and 5.6years for means years of schooling. In this measure of the index, sub-Saharan Africa is ranked the lowest among all the other sub-regions. This shows that performance in terms of education is very low in sub-Saharan Africa. The income index, constructed from the GNI per capita measures the standard of living of the population. The income component of the index for Sub-Saharan Africa (\$3,399) is very low compared to South Asia(\$6,473), Arab States(\$15,837), East Asia and Pacific(\$13,688), Europe and Central Asia(\$15,331) and Latin America and the Caribbean(\$13,671).the figures in table 1 shows that the income measure of the Human development index for Sub-Saharan Africa(\$3,399) is almost two times lower than that of South Asia(\$6,473) and almost five times lower than that Arab States(\$15,837), East Asia and Pacific(\$13,688), Europe and Central Asia(\$15,331). The low human development for the sub-region is contributed by the low rank in all the three measures of the human development index as presented in table 1.

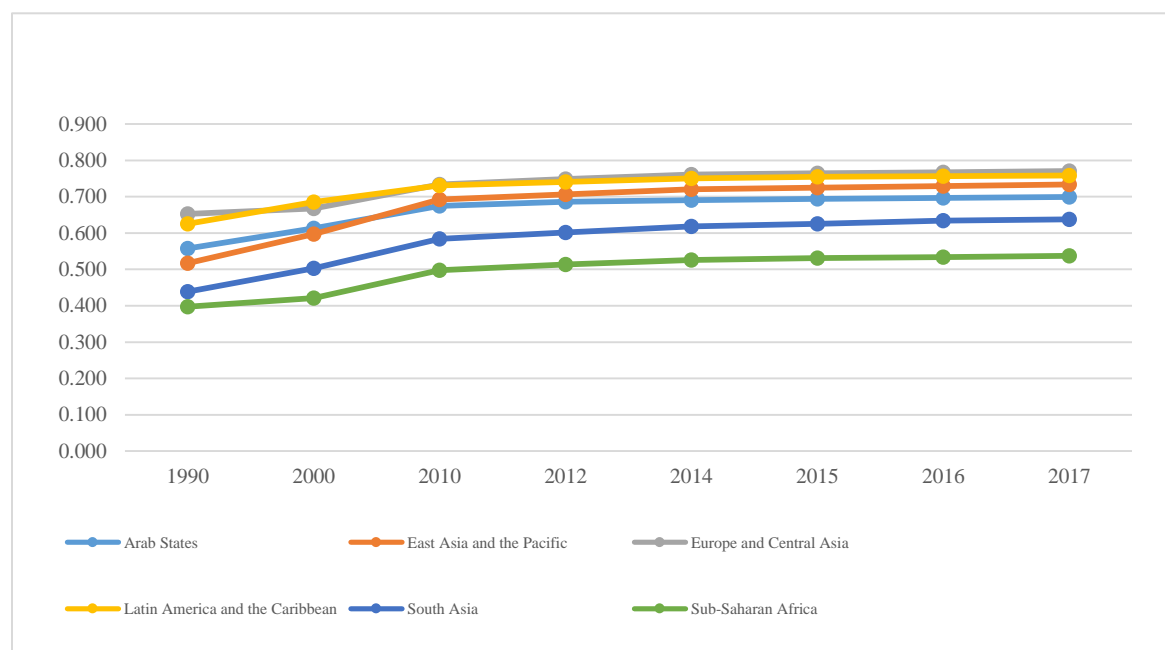
TABLE 1 Components of Human Development Index in Sub-Saharan African compared to other regions in the world

Regions/indicators	Human Development Index (HDI)	Life expectancy at birth(years)	Expected years of schooling(years)	Mean years of schooling(years)	Gross national income (GNI) per capita(2011 PPP \$)
Arab States	0.699	71.5	11.9	7.0	15,837
East Asia and the Pacific	0.733	74.7	13.3	7.9	13,688
Europe and Central Asia	0.771	73.4	14.1	10.3	15,331
Latin America and the Caribbean	0.758	75.7	14.4	8.5	13,671
South Asia	0.638	69.3	11.9	6.4	6,473
Sub-Saharan Africa	0.537	60.7	10.1	5.6	3,399

Source: UNDP online database 2019

The trend of Human Development Index for the region, from 1990 to 2017 shows a low performance in terms of the index as compared to other regions in the world (Figure 3). The region has the lowest Human Development Index which measures overall wellbeing. From figure 1, the economic performance for the region was impressive during the economic crisis in 2007, 2008 and afterward, but this was not the case, in terms of wellbeing measured by the Human Development Index.

FIGUR 2 Trend of Human Development Index in Sub-Saharan African compared to other regions in the world (1990-2015)

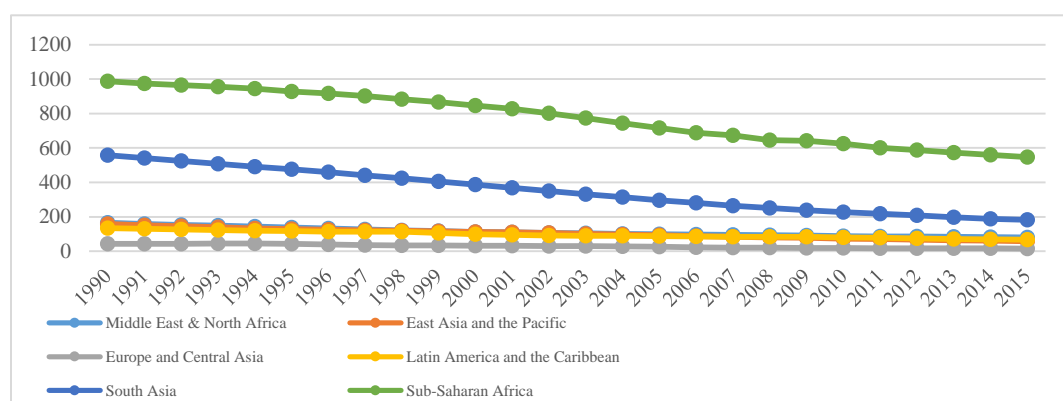


Source: Authors own construction from UNDP online database 2019

The performance of Sub-Saharan Africa in reduction of maternal mortality a key population development as a target in both the Millennium Development Goals and the Sustainable Development Goal has not been impressive. The sustainable development report of the WHO for 2017 estimated a maternal mortality of 542 maternal deaths per 100,000 live for the region, compared to the global rate of 211 maternal deaths per 100,000 live birth for the same year (WHO 2017, 32). As observed in figure 3, all the maternal mortality ratio estimated for SSA from 1990 to 2015 has been consistently very high as compared to other sub-regions in the world. The figure depicts a decreasing trend in maternal mortality for the regions of the world, including Sub-Saharan Africa, but the worrying situation is that maternal mortality ratio for the sub-region is still very high. As shown in figure 2, in 2015 the Sub-Saharan African region recorded a maternal mortality ratio of 547 maternal deaths per 100,000 live births compare to Middle East and North Africa (81 maternal deaths per 100,000 live birth), in East Asia and Pacific (59 maternal deaths per 100,000 live birth), Europe and Central Asia (16 maternal deaths per 100,000 live birth), Latin America and the Caribbean (67 maternal deaths per 100,000 live birth) and South Asia (182 maternal deaths per 100,000 live birth). A critical observation of WHO report 2015 on the Millennium Development Goals 5 reveals that maternal mortality estimates for SSA region is thirty four times higher than that of the estimate of Europe and Central Asia (16 maternal deaths per 100,000 live birth), nine times higher than East Asia and Pacific (59 maternal deaths per 100,000 live birth), eight times higher than Latin America and the Caribbean (67 maternal deaths per 100,000 live birth) and seven times higher than the estimate for Middle East and North Africa (81 maternal deaths per 100,000 live birth). Though, South Asia (182 maternal deaths per 100,000 live birth) is the second highest in the world, the estimates for SSA is three times higher than that of South Asia.

The Human Development index values and the maternal mortality ratio estimates indicates that economic policies and reforms the engineer economic growth in the region have minimal or no impact on the health status of the inhabitants.

FIGURE 3 Trend of maternal mortality ratio in Sub-Saharan compared to other regions in the world (1990-2015)



Source: Authors own construction from WHO online database 2018

TABLE 2 Empirical studies on maternal mortality and human development measured by HDI

Author(s)	Nature of examination	Country	Timeframe	Estimation Technique	Major Finding(s)
Alimohamadi, Y., et al. (2019)	HDI , under five mortality and maternal mortality	West Asian countries	1980-2010	Correlation Analysis	The results showed a negative relationship between HDI, maternal mortality. HDI increased in the period of study. This result in decrease in a MMR and U5MR
Nuhu, K. M., et al. (2018)	HDI, maternal mortality, neonatal mortality and healthcare spending	188 countries	2010-2014	Latent Growth Curve Model(LGCM)	The result of the latent growth model showed a negative relationship between HDI, MMR and NM. The results further showed that increasing health spending will improve HDI and also reduce MMR and NM
Larroca, S. G. T., el al (2017)	Human Development index and	Spain	2010-2016	Multiple Logistic Regression	Women from countries with low human development

	perinatal outcomes				index has significant neonatal outcomes.
Premakumara, G. S., & Kavitha, S. V. (2017).	Maternal mortality and HDI	15 medium Human development countries	2015	Regression, Correlation and Factor Analysis	The results showed a significant association between HDI and maternal mortality. HDI accounts for the variations in MMR in medium development countries
Ruiz, Juan Ignacio, et al.(2015)	Human development Index, MMR and IMR	188 countries in the world	2013-2014	Ordinary Least Squares(OLS)	HDI and IHDI are strongly correlated with IMR and MMR. The regression results showed that inequality play an important role in the health status of a population.
Lalthapersad-Pillay, P. (2014)	Maternal mortality and non- medical factors such as HDI	African countries	2010-2013	Logistics regression	Countries with low HDI are 3times more probable of having high maternal mortality rate than countries with high human development Index.
Tajik, Parvin, et al. 2012	Maternal mortality and inequality	Iran	2004-2006	Regression and correlation analysis	The results of the regression analysis showed significant association between HDI and maternal mortality.
McAlister, Chryssa, and Thomas F. Baskett (2006)	Female education and maternal mortality	148 countries	2003	Polynomial regression analysis	The findings of the study showed that HDI is the most powerful predictor of the variations in maternal mortality.
Lee, Kwang-sun, et al (1997)	Human development index, maternal	Countries in the world	1987-1990	Regression and correlation analysis	Components of the Human development index is strongly

	mortality and infant mortality				correlated with IMR and MMR
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Source: Author(s) own construction

3 Methodology

3.1 Model Specification Data

The general conclusion drawn from the empirical and the theoretical literature presupposes a negative implication of human development measured by the Human development index on maternal mortality. The channel of this linkage can be observed through the modernisation theory and the gender stratification theory. Based on these propositions, the study seeks to test the hypothesis that maternal mortality has a negative effect on human development measured by human development index in Sub-Saharan Africa. Therefore, to investigate this relationship a dynamic panel data estimation method will be adopted. According to Baltagi 2008,153-173 economic phenomena, which are dynamic in nature can be best explained using panel data estimation techniques. These dynamic relationships are normally derived by adding lagged terms of the dependent variable as a predictor variable, which is expressed as follows:

$$y_{it} = \psi y_{i,t-1} + x_{it}\beta + \varepsilon_{it} \quad i = 1, \dots, N \quad t = 1, \dots, T \quad (1)$$

Where y_{it} represent the dependent variable, $y_{i,t-1}$ represent the lagged term of the dependent variable, ψ is a scalar, x_{it} is 1x P explanatory variables, β is P x 1 and ε_{it} is the error term. Making the assuming that ε_{it} is a one-way error component model, then Eq. (2) can be expressed as follows

$$\varepsilon_{it} = \mu_i + z_{it} \quad (2)$$

where $\mu_i \sim iid(0, \sigma_\mu^2)$ and $z_{it} \sim iid(0, \sigma_z^2)$ are independent of one another and among each other as well. Eq. (1) which is a dynamic panel model considered as autocorrelation due to the existence of the individual effects considered by the heterogeneity among variables and the presence of the lagged term of the dependent and explanatory variables. According to Baltagi 2008, 153-173 these problems makes the Ordinary Least Squares(OLS) estimators inconsistent and biased, hence, rendering the fixed effect estimates biased as well. To address this problems of biasedness and inconsistency of the OLS estimators, Keane and Runkle 1992, 1-9; Arellano and Bond 1991, 277-297 proposed a dynamic panel model estimation procedure which is more efficient.

This study will examine the effect of maternal mortality on human development measured by the human development index in SSA countries employing a dynamic panel model estimator proposed by Arellano and Bond 1995, 28-51 and finally developed by Blundell and Bond 1998,115-143. Based on this, the will adopt a dynamic panel framework by David and Ampah 2018, 165-175 to examined the effect of maternal mortality on human development measured by the human development index expressed in Eq. (3) below:

$$Human\ Dev_{it} = \alpha_0 + \phi Human\ Dev_{it-1} + \beta_0 LMMR_{it} + \beta_1 LIMR_{it} + \partial Z_{it} + \phi_i + \varepsilon_{it} \quad (3)$$

Where Human development is denoted by a human development indicator, LMMR is the natural log of maternal mortality, LIMR is the natural log of infant mortality. Z denote a vector of other control variables considered in the study, ϕ represent the unobserved country- specific time - invariant effect, ε denote the usual constant error term. The parameters ϕ, β, ∂ are coefficients of the prior value of the human development indicator, maternal mortality, infant mortality and other control variables to be assessed. The subscript i in the model represent a particular country and t representing the time period. The Z variables, which represents the control variables are chosen based on the theoretical and empirical literature.

$$Z = f(TFR, LLEXP, GDPPP) \quad (4)$$

Where TFA represent total fertility rate, LLEXP represent natural log of life expectancy at birth and GDPPP is the GDP per capita.

This study seeks to examine the effect of maternal mortality on human development measured by the human development index by using System GMM proposed by Arellano and Bond 1995, 28-53 and finally developed by Blundell and Bond 1998, 115-143. The reason for using the System Generalized Moment Method panel data framework are that the ordinary least squares estimators are biased and inconsistent because of the error associated with the unobserved time invariant country effect (Baltagi 2008, 153-173). The System GMM addresses the inefficiencies of Ordinary Least Square estimators. Again, the parameter estimates from System GMM regression are efficient and consistent since regressors are not always exogenous, since the current and past errors are correlated in way that will call for the existence of heteroscedasticity and autocorrelation within individual (Roodman 2009a,86-136). Another advantage of System GMM according to Nickell 1981, 1417-1426 is that it eliminates the bias in dynamic panel data and also addresses the problem of fixed effect and endogeneity of the regressors. This is done through the introduction of instrumental variables that are uncorrelated with the fixed effect. Lastly, comparing the estimates of the System GMM estimators to the Difference GMM estimators developed by Arellano and Bond 1991, 277-297, estimates of the System GMM estimators are consistent and efficient since it permits for the introduction of more instrumental variables and additional assumption which allows for the first differences of the instrumented variables to be uncorrelated with the fixed effect (Roodman 2009a, 86-136).

The overall System GMM model data generating process is given as follows.

The panel model for the first order autoregressive is express in Eq. (5) below

$$\begin{aligned} y_{it} &= \phi y_{i,t-1} + \lambda X_{it} + \omega_{it} \\ \omega_{it} &= \pi_{it} + \Omega_{it} \end{aligned} \quad (5)$$

Where X_{it} represent the vector of the dependent variables, ω_{it} represent the constant error term., the subscripts i in the model represent a particular country and t representing the time period. The parameters π_{it} and Ω_{it} stands for the fixed effect and the individual shocks respectively. They are assumed to have one way component error with the following assumptions as specified in Eq. (6) to (12)

$$E(\pi_{it}) = 0, E(i\Omega_{it}) = 0, E(\pi_{it}, \Omega_{it}) = 0 \quad i = 1, \dots, n; t = 2, \dots, T \quad (6)$$

$$E(y_{i1}, \Omega_{iv}) = 0 \quad i = 1, \dots, n \text{ and } t \neq v \quad (7)$$

The initial condition provides for the following assumptions to hold, as expressed in Eq. (8) and (9)

$$E(\pi_{it}, \Omega_{iv}) = 0 \quad \text{for all } t \geq 2 \quad (8)$$

$$E(\pi_{it}, \Delta y_{i2}) = 0 \quad (9)$$

The linear moment conditions expressed by Eq. (10) and (11) hold under assumptions (6), (7), (8) and (9)

$$E(y_{i,t-v} \Delta \omega_{it}) = 0 \quad \text{for } t \geq 3 \quad \text{and } v \geq 2 \quad (10)$$

$$E(\omega_{it} y_{i,t-1}) = 0 \quad \text{for } t \geq 3 \quad (11)$$

Based on the assumptions and condition specified in equations (5) to (11) and the two key conditions for consistency of System GMM estimations by Roodman 2009a,86-136 and Hansen 1982,1029-1054, the study will estimate the following dynamic panel equation using System GMM as expressed below

$$HDI_{it} = \beta_0 HDI_{it-1} + \beta_1 LMMR_{it} + \beta_2 LIMR_{it} + \beta_3 TFR_{it} + \beta_4 LLEXP_{it} + \beta_5 GDPPP_{it} + \phi_i + \pi_t + u_{it} \quad (12)$$

Where HDI denotes the Human Development Index, LMMR is the natural log of maternal mortality ratio, LIMR is the natural log of infant mortality rate, TFR represent total fertility rate, LLEXP represent natural log of life expectancy at birth and GDPPP is the GDP per capita. The parameters ϕ_i and π_t denote the individual country fixed and time effect respectively. u_{it} represent the constant noise term.

3.2 Data and Sources

The dataset for the study will be primarily secondary data drawn from the World Bank (World Development Indicators), WHO and UNDP online databases. The data will be panel data set for thirty- five (35) Sub-Saharan African countries spanning between 1990 and 2015. The dataset consists of cross-sectional data from 2008 to 2015 for 35 Sub-Saharan African countries. Sub-Saharan African countries selected for the empirical analysis are, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, and Zimbabwe, Benin,

Botswana, Burkina Faso, Burundi, Cameroon, Central Africa Republic, Chad, Comoros, Congo, Cote d'Ivoire, Democratic Republic of Congo, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria.

TABLE 3 Description of variables

Variable	Description	Sources
Human Development Index(HDI)	Measure of overall wellbeing of the population	UNDPI
Maternal Mortality Ratio (LMMR)	Natural logarithm of maternal mortality	World Bank and WHO
Infant mortality rate (LMMR)	Natural logarithm of infant mortality rate	WDI
Total Fertility Rate (TFR)		WDI
Life Expectancy at birth (LLEXP)	Natural logarithm of life expectancy.	WDI
GDP per capita (GDPPP)	GDP per capita measures the annual percentage growth rate of gross domestic product divided by mid-year population which is based on constant 2010 U.S Dollars	WDI

Source: Authors own construction

4 Results and Discussions

Table 3 report the summary statistics of the variables in the study. The descriptive statistics reported are the mean, maximum and minimum values, standard deviation, skewness, kurtosis and normal distribution. The overall mean of the annual Human Development Index for the region is 0.432 which indicate that the region is able to achieve only 43.2% in Human Development. This is very low compared to other regions in the world. The mean value for maternal mortality is mortality is 686 maternal deaths per100,000 live birth which also higher compared to the global maternal mortality. The overall mean of annual Infant mortality, life expectancy, total fertility and GDP per capita for SSA region are 74 infant deaths per 1000 live birth in a year, 54.529years per 1,000 adults, 5.4 births per 1,000 females and 1.168% of annual growth respectively. The standard deviation values showed that all the variables deviate narrowly from their mean. The number of maternal deaths ranges between a minimum of 23 and a maximum of 2900 death per 100,1000 live birth which is very high. The Human Development index for the region ranges between a minimum of 0.196 and a maximum of 0.782. The normal distribution, reported by Jarque-Bera statistic shows that all the variables are not normally distributed. A critical observation of the descriptive characteristics of the variables showed that most of the variables leptokurtic having kurtosis values less than three (3). The total number of observations for the empirical analysis is 910 as indicated in the summary statistics results.

TABLE 4 Summary Statistics

	HDI	MMR	IMR	TFR	LEXP	GDPPP
Mean	0.432	689.557	74.089	5.4307	54.528	1.168
Median	0.423	648.000	70.600	5.570	54.700	1.568
Maximum	0.782	2900.000	160.600	7.772	74.353	37.535
Minimum	0.196	23.000	12.500	1.360	27.610	-47.503
Std. Dev.	0.114	406.1319	28.586	1.227	6.823	5.196
Skewness	0.489	2.103655	0.434	-0.81200	-0.12800	-1.299
Kurtosis	2.958	11.35527	2.886	3.866	3.925	20.202
Jarque-Bera	36.431	3318.162	29.008	128.4672	35.012	11477.020
Probability	0.000	0.000	0.000	0.000	0.000	0.000
Observations	910.00	910.000	910.000	910.000	910	910.000

Source: Eviews 10

4.1 Correlation Analysis

To determine the level of relationship among the variables, a correlation analysis is performed. Table 4 report the results of the correction analysis. The results showed that none of the variables is highly correlated. Variables with the highest correlation are IMR and LEXP with correlation coefficient of (-0.829) and the lowest correlation is between HDI and GDPP with coefficient of (0.112).

TABLE 5 Correlation Matrix

	HDI	IMR	LEXP	MMR	GDPPP	TFR
HDI	1					

IMR	-0.820	1				
LEXP	0.734	-0.829	1			
MMR	-0.658	0.742	-0.703	1		
GDPPP	0.112	-0.113	0.124	-0.105	1	
TFR	-0.870	0.708	-0.608	0.570	-0.116	1

Source: Eviews 10

4.2 Results for Fixed effect and System GMM

The study employed both the fixed effect(FE) and system GMM estimation techniques to show estimation efficiency and also indicate how results differ when econometric problems such as dynamic panel biases and endogeneity are considered. System GMM is seen as one of the best panel dynamic estimation techniques that address the problem of endogeneity. The empirical results for both the fixed effect(FE) and GMM are presented in Table 6 and 7.

TABLE 6 Results of the fixed effect(FE) model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.020	0.045	-0.450	0.653
HDI(-1)	0.930	0.022	42.915	0.000***
LMMR	-0.015	0.011	-1.355	0.176
LIMR	-0.001	0.012	-0.105	0.917
TFR	-0.004	0.002	-2.410	0.016**
LEXP	0.001	0.000	3.071	0.002**
GDPPP	0.000	0.000	7.343	0.000***
R-squared	0.995			
F-statistic			4611.160	0.000***
Durbin-Watson stat			1.186	

Note: *, **, *** represents Significant level at 10%,5% and 1% respectively.

Source: Authors construction from Eviews 10

The result in Table 6 shows a negative relationship between Human development measure by the HDI, maternal mortality ratio(MMR) and infant mortality rate(IMR) which is consistent with priori assumption

but not statistically significant. This meaning that maternal mortality and infant mortality have negative effect on maternal mortality but in the case of the 35 sampled countries in Sub-Saharan Africa, increase in maternal mortality and infant mortality will not have any effect on Human based on the fixed panel OLS estimation. The results on the relationship between human development measured by HDI, total fertility rate, Life expectancy and GDP per capita a proxy for economic growth are statistically significant at 1% and 5%; and consistent with the prior assumptions. These results support the findings of previous studies (Islam 1995,166-167; Furuoka 2009, 3067-3074).

TABLE 7 System GMM results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HDI(-1)	0.867	0.014	63.343	0.000***
LMMR	-0.023	0.007	-3.251	0.001***
LIMR	-0.019	0.009	-2.212	0.027**
TFR	-0.008	0.001	-6.027	0.000***
LEXP	0.001	0.000	5.795	0.000***
GDPPP	0.0004	0.000	17.182	0.000***
J-statistic	318.475			
Prob(J-statistic)	0.156			

*Note: *, **, *** represents Significant level at 10%,5% and 1% respectively.*

Source: Authors construction from Eviews 10

To address the biasedness and inconsistencies in the results of the fixed panel OLS estimation, a dynamic panel system GMM estimation method was employed. The coefficient of the lagged dependent is statistically significant at 1% and positive. This indicates that model is dynamic. We also used the Hansen over-identifying test to examine the consistency of our estimators, confirm the validity of our instrument and check for the lack of serial correlation (Arellano and Bond 1991, 277-297). Our result found no evidence of rejecting the null hypothesis that our model is appropriate and the instruments used are valid ($p > 0.05$, i.e $p = 0.156$). The Dynamic Panel System GMM estimation showed that both maternal mortality and Infant mortality are statistically significant and have negative effect on Human development. These result are also consistent with the prior assumptions. The results also showed a percent increase in infant mortality will reduce human development by 0.023 points. In other words, increasing human development measured by HDI, by a unit will reduce maternal ratio by 2.3% in the 35 sample countries in Sub-Saharan Africa. This result is consistent with the findings of Lee 1997,430-433. His studies revealed that HDI, which is a measure of overall wellbeing of a population contributes to about 80 to 82 percent of the variations in maternal mortality among countries. He also found a negative relationship between HDI and maternal mortality. This results confirms the arguments by the gender stratification theorists, modernization theorists and the findings of Shen and Williamson 1999,197-241. According to them, increasing the status of women through human development will reduce fertility and which will also reduce maternal mortality. The coefficient of total fertility rate is also negative and statistically significant at 1% level. The negative sign exhibited by the total fertility rate coefficients shows an inverse relationship between maternal mortality and human development measures by HDI in SSA. This means that a percent increase in total fertility rate in SSA would result to 8% decrease in Human Development measured by the HDI in SSA. This result is consistent to the finding of Furuoka 2009, 3067-3074 and also contradicts the findings of Myrskylä et al.2009,1-24 and Harttgen 2014,173-184. They found that countries with HDI greater than 0.9 have higher fertility rate. Shen and Williamson 1999, 197-214 have also found that countries with higher fertility rate tend out having higher mortality rate due to low status would result to low human development. The higher

fertility rate for the sub-region also contributed to the low human development and the higher maternal mortality for the region as compared to other regions in the world. The coefficient of GDP per capita, a measure for economic growth has a positive sign and statistically significant at 1% level. Thus a percent increase in GDP per capita also increases Human development measured by HDI by 0.4%. This result authenticates the findings of Islam 1995,166-167. His studies showed that HDI is sensitive to GDP per capita in low income countries. The also supports the argument the modernisation theorist. They are of the view that urbanisation, industrialization and education influences maternal mortality. They also argue that countries that are modernised have low maternal mortality and improved economic development. This argument contradicts the situation in Sub-Saharan Africa. The analysis in figure 1 showed that the sub-region had high economic performance during the global financial crisis in 2007 and 2008; and even beyond, compared to other regions in the world. The analysis in figure 2 shows that the region has the highest maternal mortality compared to other regions of the world. This result authenticates the argument of Kuznet 1934,1-12 that GDP cannot measure economic wellbeing. This could be associated to the reason why the sub-region grew at 3 percent even during the global financial crisis and still have high maternal mortality rate compare to other regions in the world. This results indicates that increasing economic growth, without a corresponding increase in HDI, will result in high maternal mortality, hence the high maternal mortality in the region. This shows that the low human development in the region is a contributing factor to high maternal mortality.

5 Conclusion and Policy implication

This study investigated the impact of human development measured by the human development index (HDI) on maternal mortality in Sub-Saharan Africa. The empirical analysis was conducted on 35 Sub-Saharan African countries using panel dataset spanning between 1990 and 2015. The study used dynamic fixed effect(FE) and System GMM to find evidence for the inverse relationship between human development measured by HDI and maternal mortality in Sub-Saharan Africa. We found that the result of the System GMM estimators are more robust than that of the dynamic fixed effect(FE) estimators. The empirical results of the Dynamic system GMM showed a negative and significant relationship between maternal mortality and Human development in Sub-Saharan Africa. In addition, infant mortality and total fertility rate also had negative relationship with Human development index, a measure for human development in SSA. These result indicates that increasing infant mortality and total fertility rate will reduce human development in the sub-region. The correlation analysis conducted on the variable for the empirical analysis shows that none of the variable is highly correlated with each other. This also show the absence of multicollinearity. The Hansen J-statistic test also showed that the instruments used in the model are valid, there is no serial correlation and the model is well specified. The study finally concludes that maternal mortality has significant effect on human development index a measure for human development in Sub-Saharan African. The implication of this results is that the Sub-Saharan African countries can increase their human development index proxy for human development if maternal mortality is reduced through the implementation of programmes that will increase the income status of women, education enrolment for women and also increase funds allocated to the health sector, especially maternal health care to reduce pregnancy and child birth complications. This is because high income and education will result in low fertility rate and maternal mortality.

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