Frank Okwan

EXAMINATION OF MATERNAL MORTALITY IN SUB-SAHARAN AFRICA: RELATIONSHIPS AND EFFECTS MODEL ASSESSMENT

Theses of the PhD Dissertation

Szeged,2021

University of Szeged

Faculty of Economics and
Business Administration

Doctoral School in
Economics

EXAMINATION OF MATERNAL MORTALITY IN SUB-SAHARAN AFRICA: RELATIONSHIPS AND EFFECTS MODEL ASSESSMENT

Theses of the PhD Dissertation

Supervisor:

Dr. Habil. Kovacs Peter
Chair, Associate Professor
University of Szeged
Faculty of Economic and
Business Administration
Department of Statistics
and Demography

Szeged, 2021

TABLE OF CONTENTS

1. Background of the study

The death of a woman during pregnancy and childbirth is still one of the major health, social and economic challenges in low and middle-income countries in this 21st century. To have a clear understanding of maternal mortality, as a public health and population development challenge. It is of utmost importance to look back into history. In the 19th Century, the main cause of maternal mortality was puerperal sepsis. Semmelweis (1 July 1818 – 13 August 1865), a Hungarian physician and scientist, now known as an early pioneer of antiseptic procedures described as the "savior of mothers", Semmelweis discovered that the incidence of puerperal fever (also known as "childbed fever") could be drastically cut by the use of hand disinfection in obstetrical clinics. Puerperal fever was common in mid-19th-century hospitals and often fatal. Semmelweis proposed the practice of washing hands with chlorinated lime solutions in 1847 while working in Vienna General Hospital's First Obstetrical Clinic, where doctors' wards had three times the mortality of midwives' wards. In 1959, he started writing his book, The Aetiology, Concept, and Prophylaxis of Childbed Fever, which was published in 1860 (Kadar, 2018; Hanninen et al.,1983).

Semmelweis was a Hungarian obstetrician who first showed that, in all but a few cases, puerperal fever—also known as childbed fever—was caused by an infection introduced into the birth canal from outside, which could be prevented by chlorinous disinfection of the hands of the obstetricians and midwives before they examined mothers in labor. Now, It could be said that *he was the father of preventive medicine and also the founder of Medical Statistics* and asepsis in obstetrics as well as surgery. Because the significance of bacteria was unknown at the time, Semmelweis called the causative agent of childbed fever "decomposing animal organic matter." (Obenchain,2016).

While Semmelweis was working in Vienna, the maternal mortality rate was 18% in the First Department of Obstetrics in Vienna and when he was working in St. Rokus Hospital in Budapest, between 1851-1950, he reduced maternal mortality drastically to as low as 0.1 and 0.3%. This low incidence was attained only during the early years of the 1950s in European and North-American Hospitals. This is why Semmelweis is remembered internationally as "The Savior of Mothers" and his statue is placed alongside Hippocrates in the International Museum of Surgical in Chicago (*Note: This information is retrieved from the Semmelweis University, Hungary website and is cited in the reference list as Ref D*).

In the 20th Century, the leading cause of Maternal Mortality was shifting from puerperal sepsis to Postpartum Hemorrhage (Herczeg,2006) “At the beginning of this century during childbirth parturient mothers were fearful for saving their own lives. In the second half of the 20th-century obstetricians witnessed an unprecedented and rapid development of the management technology of human pregnancy and childbirth especially in the field of electronic surveillance and in the high dependency care of critically ill obstetric patients. In the last 25 years, fetal health was the primary focus in prenatal care and during delivery. Obstetrics in the 21st century will pose new challenges. Some women are prepared to undertake high medical risk to their own life by having a child close to or "beyond" at the extremes of their reproductive life.

The periportal period is one of the most dangerous times of life. Family expectations are very high and the responsibilities of the obstetrician are diverging. It is very difficult to draw a line between good and substandard care, and practitioners of obstetrics are well aware of the fact, that modern reproductive research did not eliminate all the risks and hazards associated with childbirth.

Direct causes of maternal mortality in modern obstetrics include:

1. Post-partum hemorrhage
2. Infections during labor and delivery
3. Puerperal sepsis
4. Complications arising from the second stage of labor
5. Pregnancy-induced hypertension
6. Obstructed labor
7. Abortion related

Even nowadays one of the most frequent, but - with appropriate modern prevention and treatment - avoidable causes of maternal mortality is postpartum hemorrhage, frequently arising from postpartum uterine hypotonia/atonia. Maternal death rates arising from infection and sepsis showed a steady decrease, while hemorrhage related maternal deaths declined more slowly, pointing to the fact, that they are more difficult to prevent

Postpartum hemorrhage is still a leading cause of maternal mortality in some areas of the world. The incidence of postpartum hemorrhage is 3-5% of all deliveries, its incidence is doubled after induced labor. It is the greatest single cause of maternal deaths in the majority of statistics and is directly responsible for 12-60% of maternal mortality in developing countries. Postpartum hemorrhage can be also indirectly responsible - as an associative factor - for a further percentage of maternal deaths, arising from other causes, such as infection and obstructed labor. About one-third of all maternal mortality can be attributed to obstetric hemorrhage. In sharp contrast to antepartum hemorrhages, which usually claim life after 10 hours if left untreated, postpartum hemorrhage kills swiftly in less than two hours if not properly treated.

The overwhelming majority of the cases of hemorrhage is occurring unexpectedly, exploding into a drama in the labor room, where blood is seen everywhere. The mother's face and lips are pale and her skin is covered with a cold sweat. Her calm suggests, that she thinks she is going to die. In such a severe clinical emergency scenario, successful management requires immediate access to specialist expertise and facilities, and the outcome is depending on the instant availability of blood replacement facilities, cool and swift expert decision on the steps necessary to bring the bleeding under control."(Herczeg,2006)

The need to investigate the causes of maternal mortality as observed by Semmelweis (1 July 1818 – 13 August 1865) has brought to light the main global causes of maternal mortality, which are hemorrhage (25%), sepsis (15%), pre-eclampsia/eclampsia (12%), abortion (13%) and obstructed labor (8%). These maternal causes of death contribute to about a quarter to half of all deaths among women in low-income countries. For over two decades, the maternal mortality ratio(MMR) has dropped by 44% from a global estimate of 385 maternal deaths per 100,000live birth in 1990 to 216 maternal deaths per 100,000 live birth in 2015 and subsequently declined to 38% in 2017 with a maternal mortality ratio(MMR) estimate of 211 per 100,00 live birth(WHO,2019). The global number of maternal deaths has also fallen by 43% from an estimate of 532,000 in 1990 to approximately 303,000 in 2015. (WHO,2015) and also further reduced to 35% in 2017 with a maternal death of 295,000 (WHO,2019). The global lifetime risk of maternal death has also decreased from 1 in 73 to 1 in 180 for the past two and half decades. Even though maternal mortality has received increased attention in its reduction by governments and international agencies through the implementation of policies, programs, and strategies to improve maternal health, it remains the leading cause of death in developing countries especially SSA countries. Again, despite the commitments on the part of government

and international organizations to reduce maternal mortality, it is still the 3rd cause of death among women in Africa and also one of the top five causes of death among the general population in Africa. It accounts for 14% of the general population deaths.

The World Health Organisation (WHO) report for 2019 on global maternal mortality estimates reported that in 2017, 295,000 women died during pregnancy and childbirth with a maternal mortality ratio (MMR) ranging between 10 per 100,000 live birth for Europe and 542 per 100,000 live birth for Sub-Saharan Africa. Again comparing the lifetime risk of maternal death of 1 in 7800 for Australia and New Zealand regions for the same year to that of the SSA region which is 1 in 37, showed that there are huge variations in terms of mortality ratio and lifetime risk. The differences in maternal mortality between the developed and developing region is very high (i.e 40 times higher). There are also differences in the number of nursing and midwifery personnel per 10,000 populations for Europe and the SSA region. The number of nursing and midwifery personnel per 10,000 populations for Europe in 2018 is 83.23 whiles that of the SSA region for the same year is 9.94 per 10,000 populations according to the WHO report on Global Work Force statistic (WHO,2020). It has been estimated that about 88-98% of these maternal deaths in developing countries could be avoided if healthcare resources and services are more available (Graham, 2008). According to Shen and Williamson (1999), maternal mortality is a public health indicator that measures the variations between rich and poor countries than any other commonly used public health indicator. It is most often taken as the health indicator which primarily measures the comparative advantages between countries. The statistics from the World Health Organization report that developing regions such as SSA and South Asia account for 86%(254,00) of maternal deaths worldwide with Sub-Saharan accounting for more than half of the global estimate 66% (196,000) in 2017(WHO,2019 The situation of maternal mortality is still worrying. Sixteen out of the forty-eight countries in the region have very high maternal mortality ranging between 500 to 999 maternal deaths per 100,000 live births in 2017 (WHO et al.2019).

The current estimates on maternal mortality show that the maternal mortality ratio, an indicator that measures the number of women dying from pregnancy and childbirth-related complications has decreased by 35%, that is from 451,000 maternal deaths in the year 2000 to 290,000 maternal deaths in 2017(WHO,2019). Though the global maternal deaths have decreased, the maternal mortality ratio for SSA is still high. According to the WHO report for 2019, SSA recorded maternal mortality of 540 maternal deaths per 100,000 live birth in 2017. Notwithstanding, the current outbreak of coronavirus pandemic will rather worsen the maternal

mortality situation in low and middle countries of which Sub-Saharan African countries are not exceptional. According to Robertson, the covid-19 pandemic will increase maternal death by an additional 60% which is 567,000 (Robertson et al.2020).

The issue of the death of a mother during pregnancy and childbirth is seen as a misfortune, and over the years, it has become a burden for governments and other international organizations and a lot of interventions have been made towards addressing it since the late 1980s. It started with the Safe Motherhood Conference in Nairobi,1987 with different meetings that drew the attention of the world on the need to address the problem of maternal mortality by reducing it by half in one decade in developing countries. Thereafter, in 1994 and 1995, the International Conference on Population and Development (ICPD) in Cairo, Egypt, and the Fourth World Conference on Women, Beijing, re-echoed the need to address the issues of maternal mortality through reproductive health, right of a woman, women empowerment and gender equity which are the main foundations to the reduction maternal mortality which is a population development challenge (World Conference on Women and United Nations, 1996).

In 2000, the reducing of maternal mortality ratio was specifically made as a target for the United Nations Millennium Development Goals (MDGs) in 2000 (to reduce maternal mortality ratio(MMR) by 75% by the year 2015) and Sustainable Development Goals (SDGs) in 2015(to reduce maternal mortality ratio to less than 70 maternal deaths per 100,000 live birth for each year by 2030). Data show that despite the notable interventions, yet still, many women die from pregnancy, pregnancy-related complications, and childbirth in the Sub-Saharan African region, and the reason for this is the lack of limited access to quality healthcare services, limited utilization of skilled care during pregnancy, childbirth and postpartum condition that are associated with the low socio-economic status of women and bad cultural beliefs and practices

2. Objectives of the study

The main objective of this study is to examine the maternal mortality situation in Sub-Saharan Africa and the possible ways by which the region can effectively address it.

Specifically, the study seeks to:

I. To investigate the determinants of maternal mortality in Sub-Saharan Africa.
II. Investigate the effect of social development on maternal mortality in Sub-Saharan Africa.
III. To examine the relationship between human development and maternal mortality in Sub-Saharan Africa

IV. Determine some policy implications based on the outcome of the study to address the problem of maternal mortality in Sub-Saharan Africa.

3. Research questions

To achieve the stated objectives, this study formulates the following questions;

I. What are the determinants of maternal mortality in Sub-Saharan Africa?

II. What are the effects of these determinants on maternal mortality in Sub-Saharan?

III. To what extent can social development influence maternal mortality in Sub-Saharan Africa.

IV. Is there any significant relationship between human development and maternal mortality?

4. Hypotheses of the study

The study formulated the following hypotheses based on the theoretical framework by McCarthy and Maine (1992) for analyzing maternal mortality determinants, the neighborhood theory by Ellen et al. (2001),(H_1, H_2, H_3) and the development theory by Amartya Sen's (1999) (H_4, H_5). In addition, the hypothesis on the relationship between maternal mortality and human development is drawn from the modernization and gender stratification theory(H_6).

4.1 The effect and relationship between maternal mortality and its determinants

The empirical chapters of the dissertation present empirical studies on the effect and the relationship between maternal mortality and its determinant in both developed and developing countries. This shows the need to examine these determinants and their effect on maternal mortality in SSA where maternal mortality is a major challenge. To achieve this the following hypotheses were formulated.

1. $\boldsymbol{H_1}$: Improvement in socio-economic determinants will reduce the level of maternal Mortality in SSA.
2. $\boldsymbol{H_2}$: Improvement in health or medical determinants will reduce the level of maternal mortality through the medical or health determinants in SSA.

3. $\boldsymbol{H_3}$: Improvement in socio-cultural determinants will reduce the level of maternal Mortality in SSA.

4.2 The effect of social development on maternal mortality

The death of a mother during pregnancy and after childbirth is a key population development challenge facing developing countries since women are seen as the backbone of the family. According to Mukami et al.2016 factors such as women's status in society, education, quality health care, and access if considered in maternal health intervention will contribute to low maternal mortality. Again Shen and Williamson (1999) have also argued that communities where a woman has high social status such as education, tend to have low fertility and maternal mortality rate. Okwan and Kovacs (2019), also found that social determinants (economic and cultural) have a direct and indirect effect on maternal mortality, but there is no single study on maternal mortality in the sub-region that has attempted to investigate the effect and causal relationship between maternal mortality and social development by apply the Amartya Sen's development theory to reproductive health, to understanding the link between maternal mortality and social development and also recommend policies based on its findings to address the high maternal mortality in the Sub-region, which is contributed by poor social conditions. To examine the effect of social development on maternal mortality the study formulated H_4 and H_5

4. $\boldsymbol{H_4}$: Increasing the rate of social development, will improve the rate of reproductive capability/freedom and reduce the level of maternal mortality in SSA.

5. $\boldsymbol{H_5}$: Increasing the rate of reproductive capability/freedom, will decrease the rate of Maternal mortality in SSA.

4.3 The relationship between maternal mortality and human development

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. Theoretically, as the health status of the population, in the form of maternal mortality decreases, economic development is achieved through increases human development. From the modernization theory perspective, countries that have experience modernization will have lower fertility rates which will result in a 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 which is also achieved through increasing human development. The study investigated this impact by formulation H_6

6. $\boldsymbol{H_6}$: There is no significant relationship between human development and maternal mortality in SSA.

These hypotheses are tested using partial least square structural equation modeling, a multi-dimensional estimation technique, and panel regression estimation methods. This will be done using SmartPLS software version 3, Stata 15, and Eviews version 10

in the SSA region.

5. Significance of the study

The significance of this study is based on its relevance to contemporary economic and health considerations.

I. The study will provide vital information that would be of help in formulating effective and efficient policies towards addressing the issues of maternal mortality in Sub-Saharan African countries.
II. The study will provide a basis for improving the scholar's general perspective on the behavior of maternal mortality determinant variables and provide alternative measures for maternal mortality challenges. The study will serve as a tool in revamping government policies towards maternal mortality reduction in the region.
III. The study will serve as an important guide to policymakers as to what form of policies to implement to assist in the planning of strategic interventions that will effectively reduce maternal mortality.
IV. Finally, this empirical study would point to several areas requiring additional research efforts aimed at the further development of maternal mortality interventional models.

6. Outline of the thesis

The thesis is divided into eleven main sections that are connected to the objectives of the study. The first section covers a brief introduction to the topic and justifies the research problem. The second section discusses the significance of the study. The specific objectives of the study, the research questions, and the hypotheses are covered in sections 3, 4, and 5. The remaining six sections cover the outline of the disserting, specifying how the thesis is structured, the summary of the findings based on the empirical analysis. This section also discusses the data type and

sources, and the estimation methods used for the analysis. Section 8 covers the conclusions of the study, section 9 discusses the policy implications based on the outcome of the study and the contribution of the study to existing knowledge, whiles section 10 and 11 also covers areas for further studies and limitations of the study.

7. Summary of findings

The effects of maternal mortality on population development have been a major challenge for policymakers in developed and developing countries. Several researchers, both academic and professional have tried to formulate models and embark on empirical studies to understand the effects and relationships of maternal mortality with its determinants, social and human development. The inclusion of maternal mortality as a specific target in both the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) call for the need for professionals in the health, demographic development, economics, and academic fields in Sub-Saharan Africa, where the situation is worse to put in more effort for a better understanding of the effects and relationships of maternal mortality with its determinants, social and human development.

The study set three main objectives. The first objective is to investigate the effect of determinants (i.e. socio-economic, socio-cultural, and health or medical) on maternal mortality in Sub-Saharan Africa. To achieve this objective, the study draws insight from the Neighborhood theory by Ellen et al. (2001) and the conceptual model for analyzing the determinants of maternal mortality and morbidity by McCarthy and Maine (1992). The effects and relationships of the socio-economic, socio-cultural, Health or Medical, and maternal mortality were estimated using Partial Least Square(PLS) Structural Equation Modelling (SEM) approach. The second is to examine the effect of social development on maternal mortality in Sub-Saharan Africa and finally examine the relationship between human development and maternal mortality in Sub-Saharan Africa.

The first object of the study is to examine the determinants of maternal mortality in Sub-Sub, specifically their relationship and effect on maternal mortality. The results from the empirical analysis showed that socioeconomic, medical or health, and socio-cultural determinants have a significant effect on maternal mortality. The socio-economic and social-cultural determinants have both direct and indirect effects. The health or medical determinant has a direct effect on maternal mortality. The size of the effect of socio-cultural determinants on maternal mortality is medium and the size of the effect of socio-economic and health or

medical on maternal mortality is large. These results also showed a negative and statistically significant relationship between socio-economic determinants and maternal mortality. There is also a negative and statistically significant relationship between the health or medical determinants and maternal mortality. The results further established a negative relationship between socio-cultural determinants and maternal mortality through the health or medical determinants.

The results of the empirical analysis imply that improving the health or medical, socio-cultural, and socio-economic determinants will reduce maternal mortality. Thus increasing the number of skilled birth attendants, antenatal coverage, contraceptive prevalence rate having improved water source, reducing total fertility rate, increasing gross national products(GNP) per capita income, reducing female unemployment, increasing urban residency, increasing education enrolment and attainment, increasing female skilled workers, increasing female literacy and reducing gender inequality will reduce maternal mortality in Sub-Saharan Africa. The medium and large effect of the determinant indicates that none of these determinants should be left out when addressing the problem of maternal mortality.

The second objective examines the effect of social development on maternal mortality in Sub-Saharan Africa. The study examined the effect of social development on maternal mortality by drawing some ideas from the neighborhood theory by Ellen et al. 2001 and also Sen's (1999) theory on social development as the theoretical framework to achieve this objective. The effects and relationship of social development and maternal mortality were estimated using the PLS-SEM method. The result of the empirical analysis showed a negative and statistically significant relationship between social development and maternal mortality through reproductive freedom/capability. The results also showed that social development has an indirect effect on maternal mortality, while reproductive capability/freedom has a direct effect on maternal mortality.

The findings of the study also indicated that the size of the effect of social development and reproductive capability/freedom is large. The results of the analysis imply that improving social factors such as adult literacy rate, water sources, human development, mobile phone subscribers, internet users, and increasing public health expenditure by building health infrastructure, training of more health personnel, and procuring modern medical equipment will reduce maternal mortality through reproductive capability and freedom. The result also indicates that improving reproductive capability/freedom through increasing the number of

birth attended by skilled personnel, antenatal coverage, contraceptive prevalence rate, immunization and also reducing early marriages will reduce maternal mortality in Sub-Sub-Saharan Africa. The large size of the effect of social development and reproductive capability/freedom suggests that reduction in maternal mortality is driven by social development and reproductive capability/freedom, and these indicators cannot be ignored when considering interventions for maternal mortality in Sub-Saharan Africa.

The third objective of the study investigates the relationship between human development and maternal mortality in Sub-Saharan Africa. This objective was achieved by drawing some insight from the modernization and gender stratification theory. The relationship between maternal mortality and human development measured by the HDI index was examined using the two-step System Generalized Method of Moment (GMM). The result of the empirical analysis on 35 sampled Sub-Saharan African countries indicates a negative and statistically significant relationship between maternal mortality and human development in Sub-Saharan Africa. Thus high maternal mortality levels reduce human development, measured by the HDI index. This also implies that high maternal mortality will contribute to the poor standard of living, reduce education attainment and enrolment and affect life expectancy at birth which are indicators for both economic and social development in Sub-Saharan Africa.

Apart from the major findings, the following findings are also worth noting when addressing the problem of maternal mortality in Sub-Saharan Africa**.**

Socio-economic and health or medical determinants have a direct effect on maternal mortality in SSA. The effect of health or medical determinant on maternal mortality is greater than the effect of socio-economic on maternal mortality, in terms of magnitude. This greater effect is associated with inadequate health care facilities, the inadequate number of health care professionals with sufficient training to provide required health care services, and poor health behavior on the part of pregnant mothers.

Socio-cultural determinants have both direct and indirect effects on maternal mortality. The indirect effect is significant and greater than the direct effect in terms of magnitude. The high indirect effect of the socio-cultural determinant on maternal mortality through the health or medical determinants is a result of bad cultural practices and religious beliefs associated with the use of modern medical care, female literacy, and gender inequality in accessing medical care in SSA.

Economic development has both direct and indirect effects on the model. The direct effect is on social development and the indirect effect is on maternal mortality. The direct effect is greater than the indirect effect. The greater and direct effect of economic development on social development indicates that high economic development reflects in social indicators such as basic social amenities, communication networks, health infrastructure, and education. This supports the argument of Sen's 1999, that economic growth is key through social development.

The results of the empirical analysis on the 35 sample SSA countries also revealed that political development has both direct and indirect effects. The direct effect is on social development and the indirect effect is on maternal mortality. The direct effect is greater than the indirect effect. The high effect of political development on social development indicates that a democratically elected government in SSA has a higher probability of engaging in social development to reduce maternal mortality in the region.

8. Conclusion

The study has examined the relationships and effects of maternal mortality determinants, social and human development in Sub-Saharan Africa(SSA). Three specific objectives were formulated in this study, first to examine the determinants of maternal mortality, specifically the effect of socio-economic, health, or medical and socio-cultural determinants on maternal mortality; to investigate the effect of social development on maternal mortality and finally to examine the relationship between maternal mortality and human development in SSA. The study sampled 35 SSA countries, a cross-sectional dataset spanning between 2008 to 2015 and a panel dataset for the period 1990 to 2015 were used in the study.

The study examined the effect of socio-economic, health or medical, and socio-cultural determinants on maternal mortality using the neighborhood theory by Ellen et al. (2001) and the conceptual model for analyzing the determinants of maternal mortality and morbidity by McCarthy and Maine (1992) as the conceptual and theoretical justification. The PLS-SEM estimation method was used to examine the effects and relationships of the socio-economic, health, or medical determinants and maternal mortality.

To achieve this objective, the study formulated six hypotheses and responded to these hypotheses as follows.

1. H_1: Improvement in socio-economic determinants reduces the level of maternal Mortality in SSA.

The empirical results presented in chapter four indicates that there is a negative relationship between socio-economic determinants measured by GNP per capita determinants such as gross national products(GNP) per capita income, female unemployment, urban residency, increasing education enrolment and attainment, female occupation, and maternal mortality in SSA, implying that improving socio-economic determinants by increasing gross national products(GNP) per capita, reducing female unemployment, increasing urban residency, increasing education enrolment and attainment and female occupation will reduce maternal mortality in SSA. Therefore, based on the empirical evidence, this study fails to reject the null hypothesis that improvement in socio-economic determinants reduces the level of maternal mortality. This also means that there is a direct relationship between the socio-economic determinants and maternal mortality in SSA. These results also support the findings of Germ–Wasie (2017) and Azuh et al. (2017).

Based on the specific objectives, research questions, the above hypothesis, and empirical results, we obtained the first thesis as

Thesis 1: There is a negative and statistically significant relationship between socio-economic determinants and maternal mortality in SSA. We fail to reject hypothesis 1.

2.H_2: Improvement in health or medical determinants reduces the level of maternal in SSA.

The evidence from the empirical analysis also shows that there is a negative relationship between the health or medical determinants measured by skilled birth attendants, antenatal coverage, contraceptive prevalence rate, improved water source, total fertility rate, and maternal mortality in SSA. This result indicates that improving the health or medical determinants by increasing the number of skilled birth attendants, antenatal coverage, contraceptive prevalence rate, having improved water source, reducing total fertility rate will reduce maternal mortality in SSA. These results support the findings obtained from studies by Ahnquist–Wamala–Lindstrom (2012); Pickett–Pearl (2001); Buor and Bream (2004). Therefore, based on the empirical result, this study fails to reject the null hypothesis that improving heath or medical determinants, reduces the level of maternal mortality in SSA. This implies that there is a direct relationship between socioeconomic determinants and maternal mortality in SSA

Based on the specific objectives, research questions, the above hypothesis

and empirical results, we obtained the second thesis as

Thesis 2: There is a negative and statistically significant relationship between the health or medical determinants and maternal mortality in SSA. We fail to reject hypothesis 2.

3.H_3 : Improvement in socio-cultural determinants reduces the level of maternal Mortality in SSA.

The empirical evidence from chapter four suggests that there is a negative relationship between socio-cultural determinants and maternal mortality. This relationship is through the health or medical determinant. This means that increasing female literacy reducing inequality in access to health care and increasing the status of women by giving them more opportunities to occupy decision-making positions will improve medical or health determinants such as skilled birth attendants, antenatal coverage, contraceptive prevalence rate, improved water source and total fertility rate. This means that there is an indirect relationship between socio-cultural determinants and maternal mortality in SSA. Thus, this study fails to reject the null hypothesis that improving socio-cultural determinants reduces the level of maternal mortality in SSA. Based on the specific objectives, research questions, the above hypothesis and empirical results, we obtained the third thesis as

Thesis 3: There is a negative and statistically significant relationship between socio-cultural determinants and maternal mortality in SSA. We fail to reject hypothesis 3

4. H_4: Increasing the rate of social development, will improve the rate of reproductive Capability/freedom and reduce maternal mortality in SSA

The empirical evidence presented in chapter five shows that there is a positive relationship between social development and reproductive capability/freedom in Sub-Saharan Africa. This means that improving social development indicator as adult literacy rate, water sources, human development, mobile phone subscribers, internet users and increasing public health expenditure by building health infrastructure, training of more health personnel and procuring modern medical equipment will reduce maternal mortality in SSA. The results from the empirical analysis support the argument by Sen,2007, social development is important in improving a woman's reproductive capability/freedom such as having access to quality health delivery services. Therefore, based on the empirical evidence, this

study fails to reject the null hypothesis that increasing the rate of social development, will improve the rate of reproductive capability/freedom and reduce maternal mortality. The empirical result also indicates that there is a direct relationship between social development and reproductive capability/freedom and an indirect relationship with maternal mortality through reproductive capability and freedom in SSA.

Based on the specific objectives, research questions, the above hypothesis and empirical results, we obtained the fourth and fifth as

Thesis 4: There is a positive and statistically significant relationship between social development and reproductive capability/freedom in SSA. We fail to reject our hypothesis 4.

Thesis 5: There is a negative and statistically significant relationship between social development and maternal mortality through reproductive capability/ freedom in SSA. We fail to reject hypothesis 4

5. H_5: Increasing the rate of reproductive capability, will decrease the rate of maternal Mortality in SSA

The empirical result in chapter five, suggest that there is a negative relationship between reproductive capability/freedom and maternal mortality in SSA. This means that improving reproductive capability/freedom measures such as increasing the of number birth attend by skilled personnel, antenatal coverage, contraceptive prevalence rate, immunization and also reducing early marriages will reduce the rate of maternal mortality in SSA. This result also supports the findings of Alvarez et al. (2009). Based on the evidence gathered from the empirical analysis in chapter five, this study fails to reject the null hypothesis that increasing the rate of reproductive capability, will decrease the rate of maternal and conclude that increasing reproductive capability/freedom indicators such as increasing number birth skilled birth attendants, antenatal coverage, contraceptive prevalence rate, immunization and also reducing early marriages is key in maternal mortality reduction in Sub-Saharan Africa (SSA). The result also implies that there is a direct relationship between maternal mortality and reproductive capability/freedom in SSA.

Based on the specific objectives, research questions, the above hypothesis and empirical results, we obtained the fifth thesis as

Thesis 6: There is a negative and statistically significant relationship between

reproductive capability/ freedom and maternal mortality in SSA. We fail to reject hypothesis 5

6. H_6: There is no significant relationship between human development and maternal mortality in Sub-Saharan Africa.

   The final empirical result from chapter six shows that maternal mortality has a negative and statistically significant relationship with human development measured by the human development index(HDI) in Sub-Saharan Africa. The results from the empirical analysis based on 35 sampled countries in SSA and a panel dataset spanning between 1990 and 2015 shows that increasing the level of maternal mortality will reduce human development measured by the human development index (HDI). This also means that increasing maternal mortality by a percentage unit will reduce human development measured the HDI by 0.023 percentage points. The results showed that maternal mortality has a negative and statistically significant relationship with human development, implying that human development in SSA is constraint by high levels of maternal mortality, and reducing the level of maternal mortality will increase the standard of living, increase especially female education enrolment and attainment and improve life expectancy at birth for families in SSA that are affected by maternal death. Therefore, based on the empirical evidence drawn from the analysis in chapter six, the study rejects the null hypothesis that there is no significant relationship between human development and maternal mortality in Sub-Saharan Africa and conclude that low standard of living, low female enrolment, and low life expectancy in the region, to some extent, is contributed by the high level of maternal mortality in the region

   Based on the specific objectives, research questions, the above hypothesis

   , and empirical results, we obtained the sixth thesis as

Thesis 7: The is a negative and statistically significant relationship between human development and maternal in SSA. We reject hypothesis 6

9. Policy implications

Governments in the region should improve easy access and use of the health systems and train more health professionals in quality health care delivery. To achieve this, Governments in the sub-region should increase investment in health care infrastructure and also increase the incentive for health staff, especially those in rural communities where maternal mortality is high.

Sub-Saharan Africa, could not achieve the Safe motherhood initiative and the millennium development goals target. The region is still struggling to achieve the Sustainable development goals target. This has become difficult because the region lacks a holistic interventional program that integrates, the socio-economic, health, or medical, and socio-cultural to address the high level of maternal mortality in the region. Governments in the region and the African Union the highest body in the region should design a holistic health policy and also enforce its implementation in the addition to the sustainable development goals to reduce the level of maternal mortality in the SSA region

Political leaders in the region should initiate economic programs that will improve the socio-economic conditions of pregnant mothers and their families. Moreover, governments, opinion leaders, and policymakers should enforce policies aimed at abolishing harmful cultural practices against women in the region. In addition, governments in the region should involve social activist groups, policymakers, stakeholders, and the community in the campaign to reduce the level of maternal mortality by organizing seminars involving women social groups and churches for them to understand their human rights and social justice when it comes to the issue of maternal health

Due to the low economic status of women in the region, socio-economic determinants have become key in maternal mortality reduction, since pregnant women are not able to pay for antenatal and post-natal services, hence increasing their risk of dying from pregnancy and childbirth complications. Governments in the sub-region should implement a free and mandatory health insurance scheme for women when pregnant to help reduce their medical costs to avoid the high risk of complications and reduce the probability of pregnancy-related deaths. These results imply 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 programs 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 childbirth complications. This is because high income and education will result in low fertility rates and maternal mortality.

Education enrolment and attainment are found to increase the status of women, reduce fertility and also reduce the level of maternal mortality in the region. Governments in the region should introduce free and compulsory basic, junior, and senior high school education,

especially for female girls, and also include maternal health education in the education curriculum at the basic, junior and senior high school level to create awareness of the effects of poor maternal healthcare especially during pregnancy.

Governments in Sub-Saharan Africa should be engaged in social development projects in the area of health, education and also enhance the provision of basic social amenities for poor communities, where maternal mortality is high. Social development alone is not enough, they should also strengthen the democratic process in the region to promote economic growth which is made key through social development. In addition, the study also suggests that aside from governments in the region embarking on social development, good governance should also be a priority since it's key in maternal mortality reduction

Contribution to existing knowledge

This thesis adds to the existing literature on the relationships and effects of maternal mortality, its determinants, social development, and human development in the SSA region as follows:

1. On the determinants and maternal mortality
    a) The study adds to the existing knowledge on the effects of maternal mortality determinants on maternal mortality in SSA. Concerning empirical analysis on the effects of maternal mortality determinants on maternal mortality. The study is the first and foremost to examine the effects using the partial least squares structural equation modeling approach. The results of our findings showed that socio-economic determinants have a direct effect on maternal mortality. The socio-economic determinants have a birth direct and indirect effect. The indirect effect is through the health or medical determinant and finally, the health or medical determinants have a direct effect on maternal mortality in SSA.

    b) Secondly, the study is the first to add new literature on the relationship between maternal mortality determinants and maternal mortality using the PLS-SEM algorithm. All other studies used ordinary least square regression. The results of our finding indicated that socio-economic determinant has a negative relationship with maternal mortality, health or medical determinants has a negative relationship with maternal mortality, while the socio-cultural determinants have a direct and indirect negative relationship with maternal mortality. The indirect negative

relationship is through the health or medical determinants. This is a new contribution to the empirical literature.

c) Lastly, on the determinants, no study has examined the size of the effect of the determinants of maternal mortality in SSA. The findings of our empirical analysis show that the size of the effect of the socio-economic and the health or medical is large and that of the socio-economic determinant is medium. These empirical results indicated that the socio-cultural, socio-economic, and health or medical determinants are important when considering intervention to reduce maternal mortality in SSA. This is a new contribution to the empirical literature on maternal mortality in SSA.

2. On social development and maternal mortality.

a) The study adds to the limited studies on social development on maternal mortality, specifically in SSA. This is the first and foremost study that examines the effect of social development on maternal mortality in SSA, which uses the PLS-SEM estimation method, neighborhood theory, and Sen's development theory as the theoretical and conceptual framework to understand the connection between maternal mortality and social development. The empirical evidence drawn from studies shows that social development is important in the reduction of maternal mortality in SSA. This result is new in the empirical literature on maternal mortality.

b) The study has found empirical evidence of the effect of political development and economic development on social development, and the effect of social development on maternal mortality, through reproductive capability/freedom. The study is the first to examine the size of the effects of social development and reproductive capability/freedom in maternal mortality reduction in SSA. The study found that social development and reproductive capability have a large effect. This indicates that social development and reproductive capability/freedom are important in maternal mortality reduction, there is no single study that applies Sen's development theory on reproductive health, in this case, maternal mortality in SSA.

c) This study is a detailed study on the effect and relationship between social development and maternal mortality in SSA, all other studies on maternal mortality estimated the effect and relationship between social development and maternal mortality used ordinary least square regression. This is the only study that examined the effect and

relationship between social development using PLS-SEM estimation to understand the direct and indirect interactions between social development and maternal mortality.

3. On human development and maternal mortality

a) This is the most current and up-to-date study on the relationship between human development and maternal mortality in SSA. This is the only study that used the current data set, spanning from 1990 to 2015, and two-step system GMM to investigate the relationship between human development, measured by the human development index, and maternal mortality. This study is the first and foremost study that examines the relationship between maternal mortality and human development, using the gender stratification and modernization theory, as theoretical justification. The empirical results indicate that there is a negative relationship between maternal mortality and human development measure by the human development index, implying that maternal mortality reduction plays an important role in the improvement of human development in SSA.

b) The study adds to the limited empirical study on the relationship between maternal mortality and human development, particularly in SSA. To the best of my knowledge, the only studies in SSA that examine the relationship between maternal mortality and human development by using System GMM which eliminates the bias in dynamic panel data and also addresses the problem of fixed effect and endogeneity of the regressors. In addition, it is also the first study to test for the cross-sectional dependency of the panel dataset used in examining this relationship. The empirical results from this study are new in the empirical literature on the relationship between human development and maternal mortality studies in SSA.

10. Further studies

Since the interactions between maternal mortality and its determinants are very important in the implementation of intervention for maternal mortality reduction, further studies could examine this interaction by using hierarchical structural equation modeling estimation technique to understand the relationships and effects at both micro and the macro level. This study examined the effects and relationships between maternal mortality and its determinants in SSA. Future studies can also build models for the different regions in SSA and compare the results if the effects and relationships differ from each other in terms of the regions. These studies could be used to confirm the results from these studies.

Again this study used Amartya Sen's development theory as the theoretical justification to examine the effects and relationship between social development and maternal mortality in SSA. The first to apply Sen's theory to reproductive health in SSA. Future studies could also investigate these relationships and effects by applying other development theories to understand the interaction between social development and reproductive health in SSA.

Finally, the study used a two-step System GMM to examined the relationship between human development and maternal mortality in SSA because of the short period. Further studies could also examine this relationship by extending the period and estimate with other dynamic panel models such as the Autoregressive Distributive Lag (ARDL) which also addresses the problem of endogeneity, heterogeneity, and cross-sectional dependency in panel data.

11. Limitations of the study

It is believed that maternal death is under-reported in low-income countries because most of these maternal death occurs in rural settings where there is lack of health facilities with trained health professionals and also incomplete vita registration systems. Data on maternal deaths are also obtained from surveys that are conducted between 2-3 years. Therefore, some of the data obtained on maternal death and other variables from health surveys must be under-reported. However, since these data are obtained from the country's statistical offices and international organizations with appropriate qualified and trained professionals we assumed that these data are reliable and can be used for the empirical analysis. Again, our main is to include more variables and also cover all the 48 countries in Sub-Saharan Africa but because of lack of data on some of these variables were considered only 35 Sub-Saharan African countries in our analysis.

12. Reference

Adeusi, S. O. – Adekeye, O. A. – Ebere, L. O. (2014): Predictors of maternal health as perceived by pregnant women in Eti-Osa, Lagos State, Nigeria. *Journal of Education and Practice*, 5(18), 125–131.

Agan, T. U. – Archibong, E. I. – Ekabua, J. E. – Ekanem, E. I. – Abeshi, S. E. – Edentekhe, T. A. – Bassey, E. E. (2010): Trends in maternal mortality at the University of Calabar Teaching Hospital, Nigeria, 1999–2009. *International Journal of Women's Health*. (No. 2), 249–254.

Ahnquist, J. – Wamala, S. P. – Lindstrom, M. (2012): Social determinants of health – question of social or economic capital? Interaction effects of socioeconomic factors on health outcomes. *Social Science & Medicine*,74 (6), 930–939.

Alvarez, J. L. – Gil, R. – Hernández, V. – Gil, A. (2009): Factors associated with maternal mortality in Sub-Saharan Africa: an ecological study. *BMC Public Health*, Vol. 9. (1), 1–8.

Azuh, D. E. – Azuh, A. E. – Iweala, E. J. – Adeloye, D. – Akanbi, M. – Mordi, R. C. (2017): Factors Influencing maternal mortality among rural communities in Southwestern Nigeria. *International Journal of Women's Health*, 9, 179–188.

Buor, D. – Bream, K. (2004): An analysis of the determinants of maternal mortality in Sub-Saharan Africa. Journal of Women's Health, 13(8), 926–938.

Chukwu, A. U.– Oladeji, R. T. Modelling the Determinants of Maternal Mortality: A Comparative Study of Logistic Regression and Artificial Neural Network Model. *IOSR Journal of mathematics (IOSR-JM), 11*, 47-52.

Demographic Health Survey (DHS),(2018): Online database. https://www.dhsprogram.com/data/available-datasets.cfm

Ellen, I. G. – Mijanovich, T.– Dillman, K. N. (2001). Neighborhood effects on health: exploring the links and assessing the evidence. *Journal of urban affairs*, *23*(3-4), 391-408.

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), 1-6.

Graham, W. J. – Foster, L. B. – Davidson, L – Hauke, E.– Campbell, O. M. (2008). Measuring progress in reducing maternal mortality. *Best practice & research Clinical obstetrics & gynaecology*, *22*(3), 425-445.

Gumanga, S. K. – Kolbila, D. Z. – Gandua, B. B. N. – Munkaila, A. – Malechi, H. – Kyei-Aboagye, K. (2011): Trends in maternal mortality in Tamale Teaching Hospital, Ghana. *Ghana Medical Journal*, 45(3), 105–110.

Lule, E. – Ramana, G. N. V. – Ooman, N. – Epp, J. – Huntington, D. – Rosen, J. E. (2005): Achieving the millennium development goal of improving maternal health: determinants, interventions and challenges.

McCarthy, J. – Maine, D. (1992): A framework for analyzing the determinants of maternal mortality. Studies in Family Planning, 23(1), 23–33.

Mukami, V. – Millham, R. – Puckree, T. (2016): Comparison of frameworks and models for analyzing determinants of maternal mortality and morbidity, IEEE, 1-8.

Okwan, F. – Kovács, P. (2019): Determinants of maternal mortality in Sub-Saharan Africa: a cause-effect model assessment. *Hungarian Statistical Review*, *2*(2), 15-31.

Olaku, D. A. (2016). High-Risk Pregnancies and Perceptions of Maternal Mortality among Women in Plateau State, Nigeria. *FULafia Journal of Social Sciences*, *1*(1), 295-310.

Pickett, K. E. – Pearl, M. (2001): Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *Journal of Epidemiology & Community Health*, *55*(2), 111-122.

Roberton, T. – Carter, E. D. – Chou, V. B. – Stegmuller, A. R. – Jackson, B. D. –Tam, Y. – Walker, N. (2020): Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. *The Lancet Global Health*, 8(7), 901-908

Sarpong, S. A. (2013): Modelling and forecasting maternal mortality; an application of ARIMA models. *International Journal of Applied*, *3*(1), 19-28.

Senah, A. (2003): Maternal mortality in Ghana: the other side. *Research Review NS* 19 (1), 47-55.

Sen, A. (1999): *Beyond the crisis: Development strategies in Asia* (No. 2). Institute of Southeast Asian.

Shen, C. – Williamson, J. B. (1999). Maternal mortality, women's status, and economic dependency in less developed countries: a cross-national analysis. *Social science & medicine*, *49*(2), 197-214.

Thaddeus, S. – Maine, D. (1994). Too far to walk: maternal mortality in context. *Social science & medicine*, *38*(8), 1091-1110.

UNICEF (2008): "The State of the World's Children 2009," United Nations Children's Fund, New York.

United Nation (UN), (1996): Report of The Fourth World Conference On Women: Beijing, 4–15 September 1995. New York. Https://Undocs.Org/Pdf?Symbol=En/A/Conf.177/20/Rev.1

United Nations Development Programme (UNDP) (2018): Annual Report 2018. United Nations Publications. New York. Https://Annualreport.UNDP.Org/Assets/Undp-Annual-Report-2018-En.Pdf

World Bank (2018): World Bank online database. https://dataorg.worldbank.

World Health Organisation (WHO) – UNICEF (United Nations Children's Fund) – UNFPA (United Nations Population Fund) –World Bank. (2015): Trends in Maternal Mortality:1990 to 2015. Geneva. https://apps.who.int/iris/bitstream/handle/10665/194254/9789241565141_eng.pdf

World Health Organisation (WHO) – UNICEF (United Nations Children's Fund) – UNFPA (United Nations Population Fund) –World Bank. (2019): Trends in Maternal Mortality:2000 to 2017. Geneva. https://apps.who.int/iris/handle/10665/327595

World Health Organisation (WHO), (2015): Health in 2015: From MDGs (Millennium Development Goals) To SDGs (Sustain-Able Development Goals). Geneva. Https://Www.Who.Int/Gho/Publications/MDGs-SDGs/MDG-SDGs 2015_Toc.Pdf?Ua=1

Yego, F. – Williams, J. S. – Byles, J. – Nyongesa, P. – Aruasa, W. – D'este, C. (2013): A Retrospective analysis of maternal and neonatal mortality at a teaching and referral hospital in Kenya. *Reproductive Health*, 10(1), 1–8.

Zolala, F. – Heidari, F. – Afshar, N. – Haghdoost, A. A. (2012): Exploring maternal mortality in relation to socioeconomic factors in Iran. *Singapore Medical Journal*, 53(10), 684–689

Hanninen, O. – Farago, M. – Monos, E. *(1983),* "Ignaz Philipp Semmelweis, the prophet of bac. – teriology", *Infection Control, **4** (5): 367–370, doi:10.1017/S0195941700059762, PMID 6354955,*

Kadar, N. . – Romero, R. . – Papp, Z. (2018). Ignaz Semmelweis: the "Savior of Mothers": On the 200th anniversary of his birth. *American Journal of Obstetrics & Gynecology*, *219*(6), 519-522.

Obenchain, T. G. (2016). *Genius belabored: Childbed fever and the tragic life of Ignaz Semmelweis*. University of Alabama Press.

Herczeg, J. (2006). Postpartum hemorrhage. In *Textbook of Perinatal Medicine* (pp. 1995-2004). CRC Press.

Ref D - Semmelweis „Savior of Mothers" his statue is placed alongside with Hippocrates in the International Museum of Surgical Sciences in Chicago https://semmelweis.hu/english/2019/07/closing-ceremony-of-the-semmelweis-memorial-year-in-chicago/

13. List of publications

As at the time this thesis was submitted, two of the empirical studies and other studies related to this thesis have been published in a highly ranked journal, other peer-reviewed journals, and conference proceedings. One of the empirical papers of this thesis have been accepted. This section presents the list of published articles.

Highly ranked journal publications

I. Okwan, F – Peter, Kovacs. (2021). Examining the Causal Effect of Social Development on Maternal Mortality in Sub-Saharan Africa using Partial Least Squares(PLS) Structural Equation Modeling (SEM). *Universal Journal of Public Health, Accepted.*

II. Frank, O. – Mcineka, T. T. (2021). Health Financing and Health Outcomes in Sub-Saharan Africa: A PLS-SEM Application. *Elementary Education Online* 20 (4), 1251-1264.

III. Amenah A. – Frank O. (2021). Estimating the effect of Health and Economic determinants on Infant Mortality in Iraq using Partial Least Square(PLS) Structural Equation Modeling(SEM), Turkish *Journal of Computer and Mathematics Education. Accepted*

IV. Okwan, F – Peter, Kovacs. (2020). Human Development and Maternal Mortality: Evidence from Sub-Saharan Africa. *International Journal of Advanced Science* and Technology, 29(6s), 2517-2532.

V. Okwan, F – Peter, Kovacs. (2019). Determinants of Maternal Mortality in Sub-Saharan Africa: A Cause-Effect Model Assessment. *Hungarian Statistical Review: Journal of the Hungarian Central Statistical Office*, 2(2), 15-31.

Other peer-reviewed journal publications

I. Okwan, F. (2019). Maternal Health Outcome and Economic Growth in Sub-Saharan Africa: A Dynamic Panel Analysis. *International Journal of Economics and Management Engineering* 14(9), 696-704.

II. Okwan, F – Peter, Kovacs. (2019). Testing the Existence of the Ricardian Equivalence in Ghana in this 21st Century. *International Journal of Applied Research in Management and Economics,* 2(2),16-27.

Conference presentations

I. Okwan, F – Peter, Kovacs (2019). Path Analysis of Determinants of Maternal Mortality in Sub-Saharan Africa. *Academics World International Conference on Science, Social Science and Economics,* London, UK.

II. Okwan, F – Peter, Kovacs (2019). Testing the Existence of the Ricardian Equivalence in Ghana in this 21st Century. 2nd International Conference on Research in Management and Economics. Rome, Italy

III. Okwan, F. (2020). Analysis of Global Competitive Pillars among Central and Eastern Europe Countries with Focus On Bulgaria and Romania. *FEB Zagreb 11th International Odyssey Conference on Economics and Business, University of Zagreb***,** Faculty of Economics & Business, Croatia.

IV. Okwan, F. (2020). Maternal Health Outcome and Economic Growth in Sub-Saharan Africa: A Dynamic Panel Analysis. *ICEBR 2020: XIV. International Conference on Economics and Business Research*, Prague