ASSOCIATION BETWEEN INFANT MORTALITY AND FERTILITY CHANGE IN SUB-SAHARAN AFRICA

By

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A Research Project Report submitted in partial fulfillment of the requirements for the award of the Degree of Master of Arts in Population Studies at the Population Studies and Research Institute of the University of Nairobi.

November, 2015

DECLARATION

I hereby declare that this is my original work and has not been presented for a degree in this or any other university.

…… …….

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I thank all my class mates for the teamwork spirit we embraced throughout our study period and to my entire family, I cannot thank you enough for the support and sacrifice you accorded me throughout my study period.

DEDICATION

I dedicate this project to my twin children: Trevor and Antonnete for, because of you, I gained the resilient spirit that kept me going.

ABSTRACT

Sub-Saharan Africa begun to experience fertility decline in the latter part of the 1980s and especially after the initiation of fertility decline in other parts of the developing world during 1960s and 1970s.This decline has been associated with many factors. The objective of this study was to investigate the association between infant mortality and fertility change in 24 Sub-Saharan Africa countries for the period 2003 and 2014. This was primarily to provide us with a better understanding of the role that infant mortality plays in determining fertility change in Sub-Saharan Africa i.e. whether it plays a direct or indirect role. Data was obtained from Measure DHS – STATCOMPILER between 2003 and 2014. Standard multiple linear regression model was the main method of data analysis. The dependant variable was change of Total fertility rate between the last two surveys for the 24 Sub-Saharan countries while explanatory variable was Infant Mortality Rate. Other variables were also included as control variables. They included: use of any modern contraceptive, education status, place of residence and economic status.

The results showed that infant mortality did not have a significant association with fertility change although, fertility change showed significant association with other control variables such as: Use of any modern contraceptive, education status and place of residence had an association at a multivariate level. A significant relationship was also seen between infant mortality and education status at bi-variate level of analysis hence we can say that infant mortality does not have a direct association with fertility change at all level of analysis but associates to it through other control variables like education status. This therefore leaves us with the implication that using macro data, infant mortality does not have a direct association with changes in fertility in Sub-Saharan Africa but has to pass through socio-economic and proximate factors.

This study recommends that Sub-Saharan Africa countries should continue adopting more policies and programmes that encourage contraceptive use, urbanization and programmes that can improve education status for their residents since this will help them to achieve fertility decline and finally attain the replacement level of 2.1.

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CHAPTER ONE
GENERAL INTRODUCTION

1.1 Background of the study

Sub-Saharan Africa (SSA) has high fertility rate and was the last major world region to go through fertility decline that all developed countries had realized. United Nations estimates its Total Fertility Rate at 5.1children per woman compared to 2.2 for both Asia and Latin America and the Caribbean hence the transition in Sub-Saharan Africa has been comparatively slow.

Fertility decline has been evident at the national level only in the latter part of the 1980s and especially after the initiation of fertility decline in other parts of the developing world during 1960s and 1970s. From 1992 to 1998, the average annual decline in TFR was 0.07 for sub-Saharan Africa and 0.08 for both Asia/North Africa and Latin America. As a consequence of the late initiation of fertility transition, the region experienced a prevalence of stalling of fertility decline, a slow pace and an overall level of fertility that is more than twice the level in Asia or Latin America. Averagely, fertility decline in sub-Saharan Africa was 0.05 children per year compared to 0.08 in Asia and 0.12 in Latin America. However, for the period between 1998 and 2004 the average fertility decline were only 0.02 per year in sub-Saharan Africa, compared to 0.10 in Asia/North Africa and 0.07 in Latin America. (Shapiro et al., 2015 and Bongaarts 2008).

Reduction in infant mortality is a major factor contributing to fertility decline in sub-Saharan Africa. This relationship is seen to be unique as a result of the contribution of HIV/AIDS which reduces fertility for infected women and on the other part leaving other women with an increased desire to have more children to replace the dead ones. (Fortso 2009, Bongaarts 2005, Magadi and Agwanda 2010, Dube Jara et al., 2013, Onoja and Osayomore, 2012). The association between infant mortality rate and fertility change in Sub-Saharan Africa has been debated by different researchers, some say that infant mortality as a health factor directly affects the fertility change while others argue that it works through socio-economic and proximate / intermediate factors.(Shapiro et al. 2015 and Westoff, 2013). This study examined the relationship between

infant mortality and fertility change in 24 sub-Saharan Africa countries with the most two recent Demographic and Health Survey (DHS) for the period between 2003 and 2014.

1.2 Problem Statement

Despite extensive research, there are still unanswered questions regarding the persistence of high total fertility rate in Sub-Saharan Africa. Infant mortality has been regarded as one of the factors that determine fertility behavior (Preston, 1978; Montgomery and Cohen, 1998). Previous studies have argued that fertility transition pattern can be understood by examining the relationship between fertility and socioeconomic indicators such as life expectancy at birth, literacy among adults, GDP per capita, place of residence and education status. Place of residence is being associated with availability of contraception, desired smaller family size and increased access to education. At individual data level, infant mortality is seen to be a determinant of number of children desired and born by a woman hence affecting fertility level. (Notestein 1945, Bongaarts & Potter 1983, Bongaarts 2005).

Evidence from literature suggests that infant mortality is connected to modernization or urbanization which in turn affects fertility but there is no direct association between infant mortality and fertility change (Montgomery 2003:201, Alberto1997 and Notestein, 1945). Fertility change in Sub-Saharan Africa is observed to be affected by intermediate factors such as contraceptive use which is in-turn determined by socio-economic & health factors such as infant mortality rates, education status, rural-urban residence, and economic status. The other argument is that relationships which exist between changes in selected health (infant mortality) and socio-economic indicators and the Total Fertility Rate are not fully captured by changes in the intermediate fertility measures hence strong relationships appear with changes in some indicators but not all. (Westoff, 2013).

More questions are raised as other studies still indicate that infant mortality does not lead to fertility decline (Coale 1973, Van de Walle 1986). This argument was countered by Matthiessen and McCann (1978) who observed that a decline in infant mortality led to fertility decline. Assessment of this relationship at aggregate (Macro) level indicated that there was a positive relationship between infant mortality and fertility change (Galloway et al. 1998) but a similar

assessment with the same aggregate data showed a weak fertility response to infant mortality changes.

Women characterized by high infant mortality rate end up having high fertility rate as a measure of insuring their children against those who might not survive (Notestein 1945) but changes in other socio economic factors during demographic transition are seen to be responsible in the decline of infant mortality which consequently leads to fertility transition in developing countries (Fernandez-Villaverde 2001, Doepke 2005, Cong Wang 2013 and Galor 2012). This is attributed to the demographic transitions that developing countries realized after World War II when medical technology improved and consequently reduced infant mortality.

The state of the association between infant mortality rate and fertility change in Sub-Saharan Africa may be unique courtesy of the contribution of HIV/AIDS as it increases the rate of Infant mortality and consequently reduces fertility for infected women and increasing it on other women who might feel like insuring them against high rate of infant mortality (Fortso 2009 and Bongaarts 2005). This body of knowledge leaves us with two school of thoughts: One argues that infant mortality is directly associated with fertility change and the other argues that infant mortality associates with fertility change through other socio economic factors like place of residence and education. These set of arguments and counter arguments created a void of knowledge on whether infant mortality, among other socio economic and proximate factors, has a direct significant association with fertility change in Sub-Saharan Africa. As result of this, the researcher addressed the following question:

i.) Does infant mortality have association with fertility change in sub-Saharan Africa?

To answer the question above, this study sought to first compute the pace of TFR change in the 24 Sub-Saharan Africa countries to give us the status of total fertility rate during this period of analysis (2003 to 2014) hence enable us to measure our dependent variable which was change in total fertility rate and sufficiently give us data to support our literature on the cases of countries which are reported to be having high fertility decline like the case of Rwanda.

1.3 Objectives of the Study

The general objective of this study was to investigate the association between infant mortality and fertility change in 24 Sub-Saharan Africa countries.

The specific objectives were:

i.) To establish the pace of TFR change rate in sub-Saharan Africa for the period 2003 to 2014 at an aggregate (Macro) level: (National, Urban, and Rural).

ii.) To determine association between infant mortality rate and TFR change in sub-Saharan Africa for the period 2003 to 2014, net of other factors.

1.4 Justification of the study

Studies on fertility are important because they address the persistent high rate of reproduction within regions like Sub-Saharan Africa. First, this study is going to fill the knowledge gap on whether infant mortality as a health factor has a direct effect to fertility change in Sub-Saharan Africa.

Second, the study will help policymakers in Sub-Saharan Africa countries at an aggregate level to formulate right policies that can help in driving the region towards attaining the replacement level of fertility (a TFR of 2.1) and for the fertility program implementers to choose the right programs to implement. This is because the study establishes factors that are directly associated with fertility decline in Sub-Saharan Africa.

1.5 Scope and Limitations of the study

This study was based primarily on an aggregate (MACRO) Demographic and Health Surveys (DHS) data from a sample of 24 Sub-Saharan Africa countries that have conducted at least two surveys since 2003 to 2014. The focus was on changes in country characteristics and their relationships with changes in fertility indicators within sub-Saharan Africa. The study was only to establish the association between infant mortality and fertility change in Sub-Saharan Africa in one direction and excludes the reverse effect of fertility on infant mortality (Palloni 1997, Lloyd and Ivanov 1988).

The nature of this data (MACRO) dictates that the study could not capture individual information like in the case of child replacement or insurance effect and this forms part of data

limitation hence may affect findings of this study since aggregate national data usually masks unique individual situations. The source of our data was from a DHS-program (Measure DHS) and the quality of DHS data was found to be of high standard. There was an issue of time lag between the two surveys across all the 24 Sub-Saharan countries, but the limitation was minimized by standardizing each variable to improve on quality and homogeneity taking into consideration that countries were having different survey periods which had different situations unique to those particular periods.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section presents a review of theoretical perspective, empirical studies on the association between infant mortality and fertility change and finally a review on other factors associated with fertility change.

2.2 Theoretical perspective

2.2.1 Demographic transition theory

Frank Notestein (1945)'s demographic transition theory explains a demographic transition process that include mortality decline preceding fertility decline and is characterized by stages i.e the first stage having both birth and death rates high and population grows slowly. This was witnessed in Europe between pre-history and about 1650.

Birthrates remain high in the second stage of socio-economic development, but death rates fall sharply as a result of improved medical technology, nutrition, health care, and sanitation. Population begins to grow rapidly. This began in Europe slowly after 1650, and then became more rapid after the Industrial Revolution spread in the early 19th century. Most developing countries like sub-Saharan Africa still belong to this stage.

The third stage of transition has birthrates beginning to drop rapidly while death rates drop relatively slowly. Economic and social gains, combined with lower infant mortality, reduce the desire for large families (in Europe, birthrates in some nations began to fall in the 19th century and spread across the region by the early 20th century). The slowing of population growth theoretically results from better standards of living, improvements in health care, education (especially for women), sanitation, and other public services, hence decrease in infant mortality rate. This led to the fourth stage where both birth and death rates are in balance, but at a much lower rate; population growth is minimal and this was the case of Europe since 1970s. Nowadays there is a fifth stage which describes a stable populations and this includes countries like USA.

This study anchored its operation around this theory since it explains how mortality and fertility behaves with each other. It states that mortality declines before fertility and this trend occurs amid socio-economic development that takes place over different stages of fertility transition. The theory relates with the study in the sense that both of them explains how mortality relates with changes in fertility amid socio-economic development in developing countries.

2.3 Empirical studies on the association between infant mortality and fertility change

Literature shows that improvements in infant mortality are responsible for fertility decline in Sub-Saharan Africa (Gyimah, 2002). The crucial role played by infant mortality decline in the fertility transition is well documented. The failure by many countries in sub-Saharan Africa to achieve real fertility transition is attributed to essential high levels of infant and child mortality in the region (Gyimah 2002, Hirschman and Young 1998, Mason 1997). Women with prior infant deaths had more subsequent births than those without experience of infant mortality, suggesting both a physiological and behavioral response (Gyimah, 2002).

Another factor is the health issues that have been faced by the different nations over the different periods of times. Improved health facilities have lead to increased life expectancy and consequently led to fertility decline since preference of women shifted towards having fewer children due to desire for quality of children rather than quantity (Angeles 2010, Lorenz 2002 and Soares 2005). If the woman's health is not good the chances are of high infant mortality rates and high fertility rates because of the hope that few of them will survive. If children are diseased and are unhealthy then those children will grow up to form sick adults, prone to disease, dampens economic progress in many ways i.e. it decreases workers' productivity, and reduces the enrolment in the schools, and unavailability of the health facilities like vaccinations, doctors etc, would be a burden because the health related expenditure will increase (World development Report (1993).

Mortality rates no doubt decrease as it is a general view that when a person thinks that her children can live long life (Soares, 2003), definitely a woman will want fewer children and this will reduce the fertility rates. As Lloyd and Ivanov (1988) argue, improvement in child survival creates an environment within which the relationship between the number of children ever born

and those surviving becomes predictable enough for couples to set family size goals. Couples could be expected to regulate reproductive behavior if they are confident that the few children they have will survive into adulthood. This is particularly relevant in the context of sub-Saharan Africa where the intergenerational flow of wealth goes from children to parents as Caldwell (1982) has emphasized. Understanding the childhood mortality-fertility relationship is thus of practical policy relevance and goes to the heart of public intervention programs. As Wolpin (1998:74) argues;

> *"the fertility and mortality processes are the driving forces governing population changes, so an understanding of the way they are linked is crucial for the design of policies that attempt to influence the course of population change."*

While considerable research efforts have been given to understanding the physiological effects of infant deaths on subsequent fertility, less often studied but potentially of equal importance are the other pathways.

Hirschman and Young (1998) observed that when mortality is low the costs of raising many children may lead parents to have fewer children. A related study by Lloyd and Ivanov (1988) observed that child survival, family planning, and fertility could be linked through a number of steps in a mortality transition. The study noted that the stages in this linkage would involve family formation by fate and family formation by design, insurance, and replacement. It is argued that the evolution of family formation strategies and mortality declines over time depend on the prevailing socio-cultural environment.

According to the classical demographic transition theory, once fertility decline is underway, it continues until replacement level of fertility is attained. This pattern has been interrupted in a number of developing countries, where fertility seemed to have stucked at levels above replacement in the late 1990s and early 2000s. Researchers have offered possible explanations why fertility may stall above replacement level. However, it is not yet clear why fertility varies or remains constant over the course of time.

Bongaarts (2006) studied the causes of stalling fertility transitions in developing countries. He noted that evidence in the late 1990s showed that fertility had stalled in mid transition in five countries, including Bangladesh, Dominican Republic, Ghana, Kenya, and Turkey. He observed that the level of stalling varied from 4.7 births per woman in Kenya to 2.5 births per woman in Turkey. The findings attributed stall fertility to low contraceptive prevalence and demand for

contraception and also a stall in women's desired number of children. The findings did not reveal any particular pattern in the socioeconomic determinants of fertility during period of fertility stall. For instance, in Kenya and Ghana, fertility was found to have stalled, while development indicators had not changed. But in Turkey, Peru, and Columbia socioeconomic development was noted to have continued. He concluded that stalling fertility was therefore attributed to the stagnant levels of socioeconomic development in Kenya and Ghana.

Many factors have been proposed to explain fertility transition such as socioeconomic factors and infant/childhood mortality. Can it be true that infant mortality is a major and important contributor in fertility behavior as noted by (Preston, 1978; Montgomery and Cohen, 1998)?

2.4 Other Socio-economic factors

These factors are: Education status, place of residence, economic status and contraceptive use (intermediate factor) i.e.

2.4.1 Education

Literature indicates that those women with no education tend to have significantly higher fertility and those with higher levels of education tend to have significantly lower numbers of children ever born than their counterparts with lower levels of schooling. (Bledsoe et al. 1999, Shapiro et al. 2015, Ndahindwa et al 2014, Onoja and Osayomore, 2012). Boehmer & Williamson (1996) observed that an educated mother is more likely to take good care of her child. Educated mothers try to give their children good nutrition and diet, because they are well aware about the food requirements for proper and hygienic nutrition of children (Gubhaju, 1986). The more funds spent on education, the more awareness about bringing up children hence reducing the risk regarding mortality of their children. Women's education is associated with demand for fewer numbers of better-educated children (what economists refer to as the quality-quantity tradeoff), reduced exposure to the risk of pregnancy via delays in marriage associated with increased schooling (Shapiro,2015 and Shapiro & Gebreselassie, 2014).

Generally it is observed that those educated women are more aware about the contraceptive use than illiterate women (Shah, Makhdoom A. et al, 1998). Education enable them to acquire new knowledge, attitude and values which conflict with their traditional roles of childbearing hence changing their contraceptive behavior (Dixon-Mueller,1993) and also enable them to engage in other roles other than reproduction and child care such as labor market and wage

employment (Caldwell, 1987 and United Nations 1995) Educated women have fewer children as compared to that of the uneducated one. Women with no schooling have infant mortality rate above 2.5 times. In most cases the educated woman delays marriage because they want to complete the education first, then they secure their careers and make their lives stable in this way (Salehi-Isfahani, 2000). Education may be private or public education, so the parents who are likely to educate their children in private schools have higher cost so they prefer few children (Azarnert 2006). The education of the woman has negative correlation with the mortality rate as Ram & Schultz (1997) proposes that one percent increase in the education level decreases mortality by almost 1.9 percent and falling mortality is associated with the increase in the life expectancy which may enable the person to invest in providing the better education of their children.

2.4.2 Place of residence - (Urban population)

Studies have also shown that fertility for women in urban areas is lower compared with women in rural areas (Cohen 1993, Ekisa and Hinde 2005, Westoff 1994, Woldemicael 2005). Women in urban areas not only are more educated than rural women, on average, and have more access to job opportunities and better health care but are also better able to embrace new values and ideas regarding childbearing and rearing (Diamond et al. 1999, Montgomery and Lloyd 1999, Oheneba-Sakyi and Takyi 1997). It has been observed that high costs associated with urban living are not supportive of large family sizes. Mlewa (2001) established that men in urban areas were more likely to desire smaller families compared with their rural counterparts. Shapiro et al. (2015) in their assessment observed that both the first and last surveys, there is an inverse association between the percentage urban in a country and the TFR, with the simple correlation between these two variables being almost -0.5 for the first survey and about -0.4 for the last survey but the relationship between changes in percentage urban and changes in the TFR was distinctly weaker and very slightly positive.

Region of residence has also been observed to exert a strong influence on the number of children desired, reflecting differences in language, ethnic origin, and religion as well as economic development (Westoff 1994). On the other hand women living within rural setting tend to have less developed economy, not educated on how to take care of their children in terms of nutrition, they are not also educated on contraceptive use and they also give birth to many

children due to in anticipation of the death of their infants (Montgomery and Lloyd 1999). This was measured by taking % urban population.

2.4.3 Economic status / Gross National Income per capita (GNI)

Generally, researchers believe that well-being of the economy (improved GDP) can have impact on the mortality reductions like socioeconomic development (Moon, 1991). Whenever an economy grows it makes substantial advancements in acquiring new technologies to improve health and improve the living standard of masses, thus lowering mortality as well as fertility. This all could be done through increasing the trade, urbanization and education. But in some countries this is not the case, because there are such countries that have high income but their infant mortality rate is higher than the countries having low incomes (Pai, 1991). This is mainly because they do not make investments in the fields of health and betterment of the society.

Bhutto et al. (2012) included the log of Gross Domestic Product (GDP) per capita in their regression analysis in their study of effects of infant mortality on fertility change in middle income countries. GDP is considered as one of the best indicators of an economy i.e. a country with higher GDP per capita tend to have better living standards which end up reducing infant mortality hence fertility decline. Fertility transition was also found to be more pronounced in urban areas compared with rural areas. Moreover, the findings identified education, infant and child mortality, modern contraceptive use, the percentage of women in union, and place of residence as significantly related to fertility levels. A study by Garenne (2007) attributed stalling fertility transitions at the national level to changes in age at birth, contraceptive use, and socioeconomic conditions.

Lack of fertility decline have been attributed to slowing socio-economic development, high levels of infant and child mortality, short birth intervals, declines in contraceptive prevalence, and high HIV/AIDS prevalence (Bongaarts 2006, Garenne 2007, Shapiro and Gebreselassie 2008, Westoff and Cross 2006). Using DHS data from 24 countries with multiple surveys, Shapiro and Gebreselassie (2008) examined the status of fertility transition in sub-Saharan Africa and the extent to which it had stalled. They attributed stalling fertility in some of the countries to faltering in the pace of socioeconomic development, as reflected in the laggard infant and child mortality rates and lagged growth in GDP per capita. However, in some of the countries slower declines in fertility were associated with higher growth in GDP per capita, which was contrary to

expectations. As a country develops from a pre-industrial to an industrialized economy there is a transition from higher birth and death rates to lower birth and death rates (Notestein 1945). This study used Gross National Income per capita (GNI) to measure the economic status since we will be using aggregate data at national level.

2.4.4 Use of Modern Contraceptive (Proximate factor)

Provision of information about the contraceptives may be good source to reduce fertility. Use of contraceptives has helped in fertility reduction, and consequently lowering the fertility (Robinson, 1992). Most writers suggest that by the use of condoms the threat to HIV/AIDS is lowered and also lowered the fertility. In this regard, HIV/AIDS reduces fertility for infected women but has no effect for un-infected women (Fortson, 2009). As it has been noted that transitions have started in the Asia and Europe, but they are still in pre-mature phases in African Countries. Caldwell (1992) also propounded that awareness and utilization of contraceptives directly affects birth interval. In developing countries such as Latin America, Asia and many African countries showed a decline in total fertility rate in population of people living in urban area and this transition was associated to availability of contraception in urban area (Westoff et. al. 2013). Married women with unmet need for contraception are more likely to have high fertility rate (Ndahindwa et al., 2014).

2.5 A summary on the Literature review

Literature has suggested different views on how infant mortality associates with fertility change. One argument postulates that infant mortality is directly associated with fertility change while the other suggests that infant mortality associates with fertility through socio-economic and proximate determinants. Scholars have argued that relationships which exist between changes in selected health (infant mortality) and socio-economic indicators and the Total Fertility Rate are not fully captured by changes in the intermediate fertility measures hence strong relationships appear with changes in some indicators but not all.

In summary, literature has outlined two schools of thought: one arguing that infant mortality has a direct influence on fertility change while the other postulates that it works through socio-economic and proximate factors.

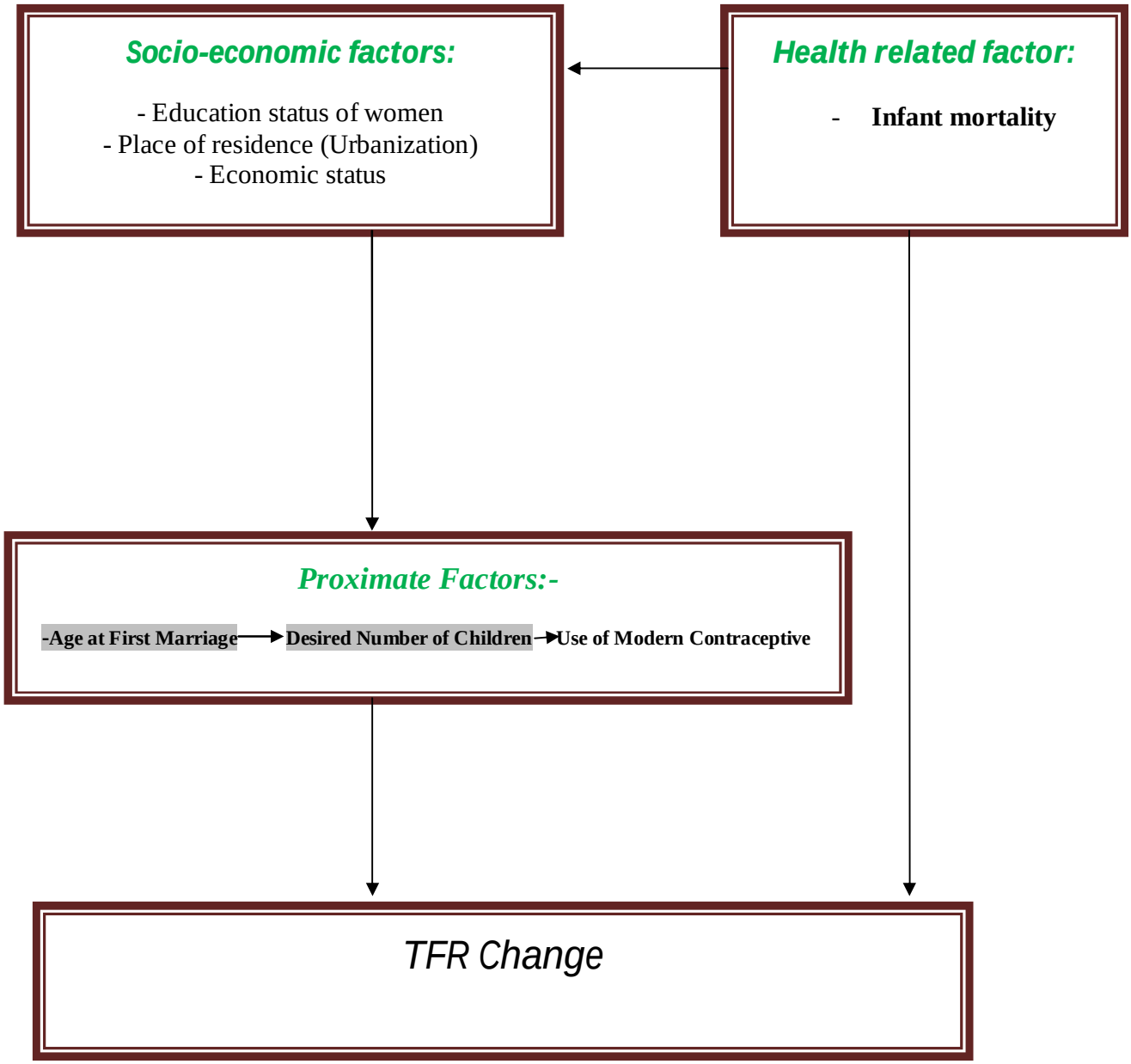
2.6 Conceptual framework that helps in understanding the association – infant mortality and fertility change

This study adapted the conceptual framework used by Westoff et al. (2013) which he also borrowed from Bongaarts (1978). The study deemed it fit and relevant since Westoff et al. (2013) were also studying indicators of fertility trends in Sub-Saharan Africa. The framework is also relevant to this study because it can enable the researcher to either link infant mortality to fertility change directly or to link it through socio-economic and proximate factors. The goal of this study was to examine changes in country characteristics i.e. infant mortality and their relationships with changes in fertility indicators. Change in total fertility rate (TFR) was the ultimate focus, hence this framework helped us to understand the relationship between socio-economic and health factors, proximate or intermediate factors and fertility change in Sub-Saharan Africa.

Although, Westoff (2013) had (% rural residence, % exposed to mass media, mean economic status, mean years of schooling, and infant mortality rate) as socio-economic and health related factors, the study excluded ‘‘% exposed to mass media’’ since this is one of the indices that is a function of economic status and staying in urban. Since economic status and staying in urban area was to be included in terms of “Population urban” and ‘‘Gross National Income per capita’’, the study deemed it not important.

On the other hand, among the intermediate factors, we also dropped ‘‘age at first marriage’’ and ‘‘Desired number of children’’ since Westoff (2013)’s study findings indicated that they were not significant determinants of fertility change. Our conceptual framework is as presented in Figure1 below:

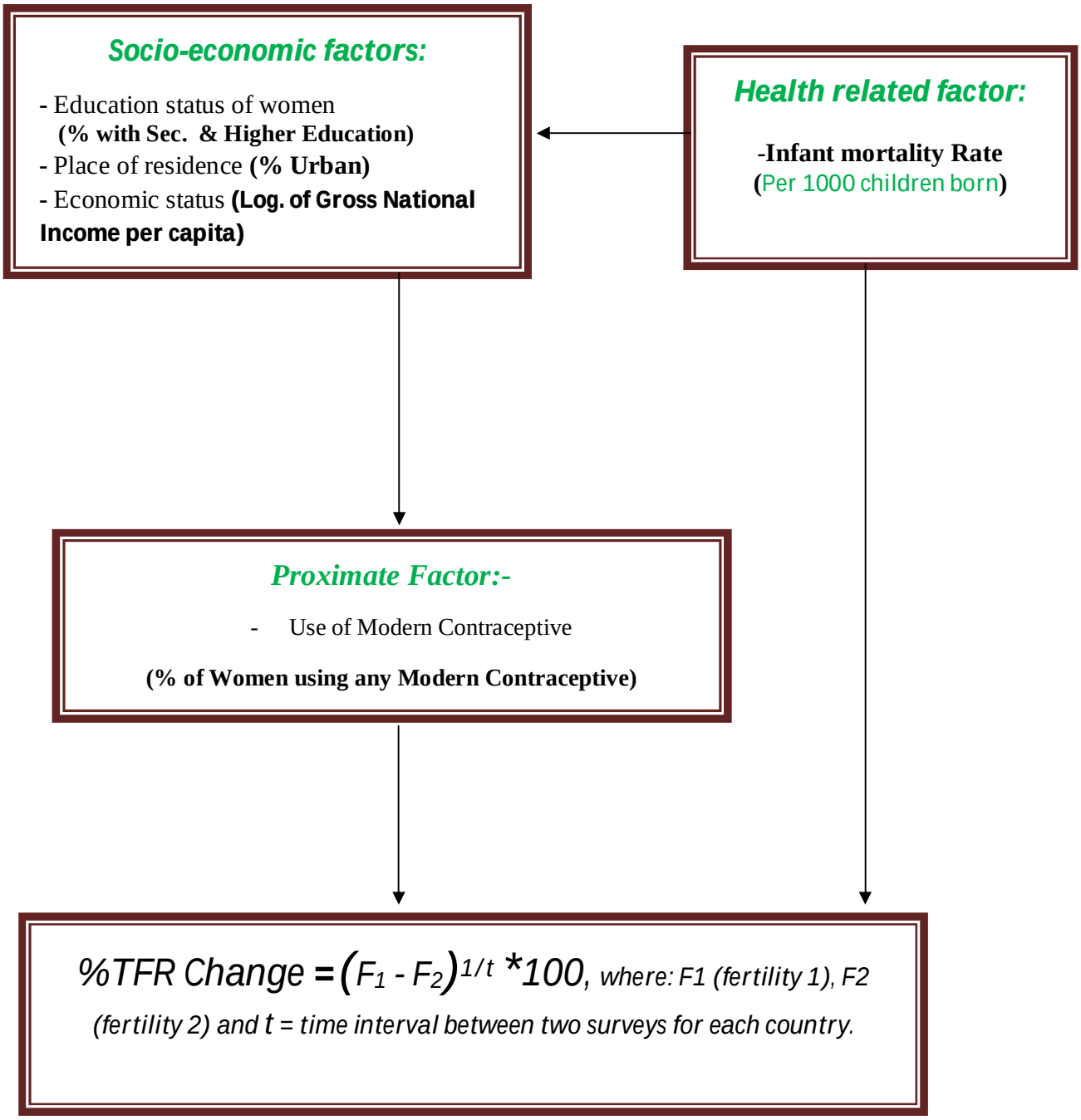
Figure 1: Conceptual Framework to explain association infant mortality and fertility change



Source: Adapted from Westoff (2013)

From the above conceptual framework, we came up with the following operational framework (Figure 2):

Figure 2: Operational framework to explain association infant mortality and fertility change:



Source: Adapted from Westoff (2013)

2.7 Operational Hypothesis

There is association between Infant Mortality Rate and Fertility (TFR) change in Sub-Saharan Africa.

CHAPTER THREE

DATA AND METHODOLOGY

3.1 Introduction

This chapter presents source of data and methods of data analysis. Data was analyzed using three methods i.e descriptive statistics, correlation tests and standard multiple linear regression. The chapter will be presented as follows:

3.2 Source of data

The study used secondary data i.e. Demographic and Health Survey (DHS) data extracted from Measure-DHS (STATCOMPILER- DHS Program) for the sampled 24 Sub-Saharan Africa countries. A sample of 24 countries were selected because they were the countries that had complete information (variables) needed without any missing information. Studies like Shapiro and Gebreselassie (2008) had also used the same sample. This choice of data-set provided the study with an aggregate information on variables such as Total Fertility Rate (TFR), Infant Mortality Rate (IMR), women with secondary and higher education, Place of residence (Urban), Women using any modern contraceptive and Economic status (GNI per capita). Economic status (GNI per capita) and population urban were extracted from World Bank Data. Our unit of analysis was "Country."

Each country was observed for the last two recent DHS survey periods i.e. DHS 2003 data and DHS 2008/09 data for all selected Sub-Saharan Africa countries. The study focused on the association of infant mortality (IMR) on fertility (TFR) change during the demographic transitions. The infant mortality rate was taken as per 1000 infant deaths and fertility was taken as total births per woman. The rest of the variables are the control variables that are used in order to reduce the omitted variable bias.

3.3 Methods of data analysis

The study used descriptive statistics, correlation tests and standard simple multiple linear regression to achieve its objectives. The methods are described as follows:

3.3.1 Descriptive statistics

At uni-variate level, this study computed the pace of TFR change at national, urban and rural level to give us the status of total fertility rate during this period of analysis (2003 to 2014) hence enable us to measure our dependent variable which was change in total fertility rate and sufficiently give us data to support our literature on fertility status for certain countries like Rwanda which is reported to be having high fertility decline.

3.3.2 Correlation tests and simple linear regression

At bi-variate level of analysis, the study did a correlation test first between all variables to assess how they interrelate with each other hence help in identifying whether some control variables influenced the main regressor variable (infant mortality rate). Second, other bi-variate tests were also carried between selected controlling variables to see whether they were, one on one, associating with the main regressor variable (infant mortality rate).

A simple linear regression was also utilized to assess how each predictor variable related with the dependent variable in terms of strength of association and level of significance. The study adopted the following simple linear regression:

$$\mathbf{Y = a + x}\,\boldsymbol{\beta_1}\mathbf{x_1} \mathbf{+ e} \quad ,$$

Where:

Y = Dependant variable (Change in TFR)

a = Y-intercept, a constant

x = Independent variable (each at a time)

β_1 = Slope

e = Error term

3.3.3 Standard multiple linear regression

At this level, standard multiple linear regression model was utilized to help in measuring the association between infant mortality and fertility change, net other factors. It also helped us to know the importance of associations, assess how independent variables related with the dependent variable in terms of strength of association (R^2) and their level of significance, to evaluate how individual independent variable such as infant mortality rate relates with change in total fertility rate; net of other factors in the 24 Sub-Saharan Africa countries (t-test). This enabled us to achieve our specific objective number two. The focus was on changes in country characteristics and their relationships with changes in fertility indicators within sub-Saharan Africa. The unit of analysis was country.

Change in total fertility rate was our dependent variable while Infant mortality rate, Education status, Place of residence (% Urban), Use of any modern contraceptive, Logarithm of Gross National Income, were the explanatory variables. The study treated Infant mortality rate as the main regressor variable and held the rest as controlling variables to avoid biases.

The analysis followed the same econometric model used by Bhutto et al. (2012) in their attempt to analyze effects of infant mortality on fertility change in low middle income countries. This was because the study also wanted to analyze / establish the association between infant mortality and fertility change in Sub-Saharan Africa. The empirical multiple regression model was as follows (as used by Bhutto et al. 2012):

$$\textbf{\% Change in } TFR_{it} = \beta o + \beta_1 IMR_{i1} + \beta_2 EDU_{i2} + \beta_3 UMC_3 + \beta_4 PR_4 + \beta_5 (logY)_{i5} + u_{it}$$

Where: TFR = Total Fertility Rate

% Change in TFR = $(F_1 - F_2)^{1/t} * 100$, ***where:*** *F1 (TFR 1), F2 (TFR 2) and t = time interval between two surveys for each country.*

(All independent variables were also standardized using the same method)

βo = The constant (Intercept for the dependant variable)
IMR = Infant Mortality Rate
EDU = Women with Sec. & Higher education
UMC = Use of any Modern Contraceptive
LogY = Logarithm of Gross National Income per capita (Economic status)
PR = Place of residence (% Urban)
u_{it} = Error term

3.4 Variables and their Measurements

3.4.1 Dependent variable:-

The dependent variable was percentage change in Total Fertility Rate obtained from measure-DHS (STATCOMPILER) for the 24 Sub-Saharan Africa countries in any last two surveys between the year 2003 and 2014. The average change was obtained by computing the geometric rate of change between two surveys. Percent change in Total Fertility Rate was defined and standardized by subtracting TFR in the second survey from TFR in the first survey then taking the result - exponential (one divided by the years between the two surveys) i.e. $(F_1 - F_2)^{1/t} * 100$, ***where:*** F_1 was the Total Fertility Rate in the first survey, F_2 was the Total Fertility Rate in the second survey and t was the time interval between two surveys for each country (Bhutto et al. 2012). The division by the time between the years was done to standardize the rate change because not all surveys were done between the same period intervals.

3.4.2 Independent variables

Independent variables were divided into two i.e. socio-economic and health factors and intermediate/proximate factors. This is presented as follows:

Socio-economic and health related variables:-

Socio-economic and health related variables included in this study were:

i.) Infant Mortality Rate:

This was taken as deaths of children below one year per 1000 live births experienced by the 24 Sub-Saharan Africa countries in any last two surveys between the year 2003 and 2014 and it was the main regressor variable in this study. This variable was standardized by subtracting IMR in the second survey from IMR in the first survey then taking the result - exponential (one divided by the years between the two surveys). i.e. $(IMR_1 - IMR_2)^{1/t} * 100$, ***where:*** IMR_1 was the Infant Mortality Rate in the first survey, IMR_2 was the Infant Mortality Rate in the second survey and t was the time interval between two surveys for each country.

ii.) Education status (% having secondary and higher education)

This was measured in terms of % women having secondary and higher education in the 24 selected Sub-Saharan Africa countries in any last two surveys between the year 2003 and 2014. The variable was standardized by subtracting % having secondary and higher education in the second survey from % having secondary and higher education in the first survey then taking the result - exponential (one divided by the years between the two surveys). i.e. $(EDU_1 - EDU_2)^{1/t} * 100$, ***where:*** EDU_1 was the % having secondary and higher education in the first survey, EDU_2 was the % having secondary and higher education in the second survey and t was the time interval between two surveys for each country.

iii.) Place of residence (% Urban)

This variable referred to where the respondent was living at the time of survey, and was measured as % urban population of the 24 Sub-Saharan Africa countries by the year 2013.

iv.) Economic status (Logarithm of Gross National Income per capita):

The study used Gross National Income per capita (GNI) from world-bank aggregate country data to measure the economic status of the 24 selected Sub-Saharan Africa countries by the year 2014. Gross National Income per capita was measured by taking its logarithm i.e. Log (GNI).

Proximate/ Intermediate Factors

The only intermediate / proximate factor used in this study was use of any modern contraception as stated below:

i.) Use of any modern contraception (% women using any modern contraceptive):

Contraceptive use represents a deliberate effort by a woman to avoid conception. This study used % women using any modern contraceptive as at the time of survey for the 24 Sub-Saharan Africa countries in any last two surveys between the year 2003 and 2014. The variable was measured and standardized by subtracting % women using any modern contraceptive in the second survey from % women using any modern contraceptive in the first survey then taking the result - exponential (one divided by the years between the two surveys). i.e. $(UMC_1 - UMC_2)^{1/t} * 100$, ***where:*** UMC_1 was the % women using any modern contraceptive in the first survey, UMC_2 was the % women using any modern contraceptive in the second survey and t was the time interval between two surveys for each country.

CHAPTER FOUR

ASSOCIATION BETWEEN INFANT MORTALITY AND FERTILITY CHANGE IN SUB-SAHARAN AFRICA

4.1 Introduction

This chapter discusses the results of the study showing the association between infant mortality rate and change in total fertility rate in the 24 Sub-Saharan Africa countries in any last two surveys between the year 2003 and 2014, net of other factors. Change in total fertility rate in Sub-Saharan Africa was described at National, urban and rural level i.e.

4.1.1 Total Fertility Rate change at National level:

The description of national fertility change rate is presented in Tables 4.1 and 4.2 below. The percentage distribution of national Total Fertility Rate (TFR) results show that between the year 2003 and 2014, 17 countries out of 24 (70.9 %) sampled sub-Saharan countries had experienced fertility transition at national level, 6 (25%) countries had experienced an increase in TFR between the two surveys and finally one (4.2%) country had no change rate in TFR.

The country with highest transition rate was Rwanda (30%), the highest nation with fertility increase was Niger (-10%) and finally Namibia had no change rate. The results also indicated that majority of Sub-Saharan Africa countries have different total fertility change rate i.e. 37.5% Sub-Saharan Africa's countries have different fertility change rate.

These results imply that majority (70.9 %) of Sub-Saharan Africa countries experienced fertility transition (TFR decline) at their national level. In the literature review, we observed that Rwanda's national government adopted policies and programmes for family planning and this could be a major contributor towards it being the country with the highest fertility transition rate (30%).

Table 4.1: Percentage distribution National TFR Change rate in Sub-Saharan Africa

% National Change rate		
Type of Change	**Country**	**National TFR Change Rate**
Fertility Increase (25% of the countries selected)	Niger	-10.0
	Zimbabwe	-6.0
	Congo (Brazzaville)	-5.0
	Mozambique	-5.0
	Burkina Faso	-1.4
	Cameroon	-1.4
No Fertility Change (4.2% of the countries selected)	Namibia	.0
Fertility decline (70.9% of the countries selected)	Lesotho	4.0
	Nigeria	4.0
	Sierra Leone	4.0
	Malawi	5.0
	Tanzania	5.0
	Kenya	6.0
	Senegal	6.0
	Ghana	8.0
	Madagascar	8.0
	Liberia	8.3
	Mali	8.3
	Guinea	8.6
	Ethiopia	10.0
	Uganda	10.0
	Zambia	15.0
	Benin	16.0
	Rwanda	30.0

Table 4.2: Summary of percentage distribution National TFR Change rate in Sub-Saharan Africa

	n = 24 Sub-Saharan countries (National)			
	Number of countries	Percent countries	Highest % change rate	Country with the highest:-
TFR decline	17	70.9	30	Rwanda
TFR Increase	6	25.0	10	Niger
No Change	1	4.2	0	Namibia

4.1.2 Total Fertility Rate change at urban level:

The results of the TFR change rate at urban level are presented in Tables 4.3 and 4.4 below. Data from Sub-Saharan Africa – urban indicated that between the year 2003 and 2014, 12 countries out of 24 (50.3 %) sampled Sub-Saharan countries had a fertility transition at urban level, 8 (33.6%) countries experienced fertility increase and 4 (16.7%) countries having no change rate.

The country with highest transition rate was Rwanda (26%), the nation with the highest fertility increase was Congo Brazzaville (11.7%) and finally Cameroon, Ghana, Liberia and Nigeria had no change rate. Results for Sub-Saharan Africa – urban had half of its sampled countries having fertility decline. It was also observed that majority of Sub-Saharan Africa's urban areas have a much more different total fertility change rate than experienced at national level i.e. 83.3% Sub-Saharan Africa's urban have different (unique) fertility change rate.

This can imply that people staying in urban areas are heterogeneous i.e. they are interdependent and end up making independent fertility decision based in the situations in their respective countries.

Table 4.3: Percentage distribution urban TFR Change rate in Sub-Saharan Africa

Type of Change	Country	Urban TFR Change Rate
Fertility Increase (33.6% of the countries selected)	Congo (Brazzaville)	-11.7
	Zimbabwe	-10.0
	Burkina Faso	-7.1
	Lesotho	-4.0
	Ethiopia	-3.3
	Tanzania	-1.7
	Namibia	-1.4
	Mozambique	-1.2
No Fertility Change (16.7% of the countries selected)	Cameroon	.0
	Ghana	.0
	Liberia	.0
	Nigeria	.0
Fertility decline (50.3% of the countries selected)	Malawi	3.3
	Senegal	4.0
	Sierra Leone	6.0
	Mali	6.7
	Kenya	8.0
	Niger	8.3
	Guinea	8.6
	Zambia	10.0
	Benin	12.0
	Uganda	12.0
	Madagascar	16.0
	Rwanda	26.0

Table 4.4: Summary of percentage distribution Urban TFR Change rate in Sub-Saharan Africa

	n = 24 Sub-Saharan countries (Urban)			
	Number of countries	Percent countries	Highest % change rate	Country with highest:-
TFR decline	**12**	**50.3**	**26.0**	**Rwanda**
TFR Increase	**8**	**33.6**	**11.7**	**Congo Brazzaville**
No Change	**4**	**16.7**	**0**	**Cameroon, Ghana, Liberia & Nigeria**

4.1.3 Total Fertility Rate change at rural level

Results of the study population at rural level are presented in Tables 4.5 and 4.6 below. Data from Sub-Saharan Africa – rural indicated that between the year 2003 and 2014, 17 countries out of 24 (71.3 %) sampled sub-Saharan countries had a fertility transition at rural level, 7 (29.4%) nations experienced fertility increase and none with no change rate.

There were two countries with highest rural fertility transition rate i.e. Rwanda and Benin (18%), the nation with the highest fertility increase at rural level was Niger (13.3%). There was no country that experienced no change rate. Majority of Sub-Saharan Africa's rural have a much more different (unique) total fertility change rate than at national and urban level i.e. 87.5% Sub-Saharan Africa's Rural have different fertility change rate.

Sub-Saharan Africa had a mean TFR of 5.4 & 5.1 for any last two surveys respectively leading to a 0.3 % National Total Fertility Rate transition rate. Implications of these results are discussed after Table 4.5 and 4.6 below.

Table 4.5: Percentage distribution rural TFR change rate in Sub-Saharan Africa

% rural TFR Change rate		
Type of Change	**Country**	**Rural TFR Change Rate**
Fertility Increase (29.4% of the countries selected)	Niger	-13.3
	Congo (Brazzaville)	-6.7
	Mozambique	-6.3
	Namibia	-5.7
	Cameroon	-4.3
	Zimbabwe	-4.0
	Burkina Faso	-2.9
Fertility decline (71.3% of the countries selected)	Liberia	1.7
	Lesotho	2.0
	Nigeria	2.0
	Sierra Leone	2.0
	Kenya	4.0
	Malawi	5.0
	Uganda	6.0
	Tanzania	6.7
	Guinea	7.1
	Senegal	8.0
	Ethiopia	8.3
	Madagascar	10.0
	Mali	11.7
	Ghana	14.0
	Zambia	15.0
	Benin	18.0
	Rwanda	18.0

Table 4.6: Summary of percentage distribution rural TFR Change rate in Sub-Saharan Africa

	n = 24 Sub-Saharan countries (Rural)			
	Number of countries	**Percent countries**	**Highest % change rate**	**Country with the highest:-**
TFR decline	**17**	**71.3**	**18.0**	**Rwanda & Benin**
TFR Increase	**7**	**29.4**	**13.3**	**Niger**
No change	**0**	**0**	**0**	**0**

The results above could imply that situations/data in rural areas are homogeneous and people staying in rural areas are associated with socialism and tend to follow the same trend of reproduction. It also indicates that governments in Sub-Saharan Africa countries employed more effort in programmes that help in reducing fertility. This can be confirmed by how Rwanda displayed high fertility decline rate at all level i.e. National, Urban and Rural level.

4.2 Correlation tests and simple linear regression

4.2.1 Simple Bi-variate correlation for all variables

The study wanted to establish how all variables were to relate to each other in the final regression model and to identify whether independent variables had some effect on each other. Correlation tests results for all variables showed that there is a significant inter-association between the following: Secondary & higher education, use of any modern contraceptive, urban population and Economic status (Gross National Income).

The result has shown that among those variables with association, education status relates with the majority of variables that determines fertility than the rest. However, this correlation test did

not find any significant relationship between fertility change and all variables included in the study. These results are summarized in Table 4.7 below:

Table 4.7: Summary of correlation test for all variables

	% National change rate	Stdized Laggard IMR	Stdardized IMR	% SUM Sec. & Higher Educ.	Stdzed Modern Contraceptive	Stdzed % Urban population ,2013	Log. Of GNI, 2014
National TFR Change - (Sig).		.425	.613	.310	.397	.847	.495
Stdized Lagged IMR - (Sig).	.425		.057	.370	.525	.937	.448
Standardized IMR -(Sig).	.613	.097		.091	.389	.430	.890
Sec. & Higher Educ. - (Sig).	.310	.370	.091		.041*	.001***	.001***
Modern Contraceptive (Sig).	.397	.525	.381	.041*		.344	.614
Urban pop., 2013 -- (Sig).	.847	.937	.430	.001***	.344		.008**
Log. Of GNI, 2014	.495		.890	.001***	.614	.008**	

Key: $P \leq 0.001$ (***), $P \leq 0.01$ (**), $P \leq 0$ .05 (*)

4.2.2 Correlation test between change in Total Fertility Rate and change Infant Mortality Rate

Since the study's main focus was on how infant mortality associates with fertility change, the researcher was interested in establishing how infant mortality (both laggard and subsequent) correlates with fertility change at National, Urban and Rural level. The Correlation test at this level indicated that there was no relationship between: National TFR change and Infant Mortality Rate; Urban TFR change and Urban Infant Mortality change Rate; Rural TFR change and Rural Infant Mortality change Rate; National TFR change and National lagged-Infant Mortality change Rate. This implies that using macro data, both laggard infant mortality and standardized infant

mortality change do not have any correlation with Total Fertility Rate change and this could be as a result of the nature of data (macro) and the different DHS periods (time lag). These results are described in Table 4.8 below:

Table 4.8: A summary of correlation test between change in Total Fertility Rate and change Infant Mortality Rate in Sub-Saharan Africa

	% National IMR Change Rate (Sig. 2-tailed)	% Urban IMR Change Rate (Sig. 2-tailed)	% Rural IMR Change Rate (Sig. 2-tailed)	% National Lagged-IMR change (Sig. 2-tailed)
% National TFR Change Rate	.613			
% Urban TFR Change Rate		.904		
% Rural TFR Change Rate			.481	
% National TFR Change				.425

4.2.3 Correlation test between Total Infant Mortality change Rate and the following variables: Education status, Modern contraceptive use and urban population

Infant Mortality being our main regressor variable, the study resorted to test its correlation with some of its co-independent variables as stated in Table 4.9 below. This was done to investigate on what literature says about the effects of socio-economic factors (education and staying in urban area) on infant mortality and the results indicated that education status has a significant relationship with total Infant mortality rate in Sub-Saharan Arica. Being in urban area and use of any modern contraceptive were also slightly above the (parameter) significance level of (0.05). This implies that, within the independent variables, education status had some effect to Infant mortality Rate and might have influenced how infant mortality related to fertility change. This is consistent with other studies which posit that educated mothers are more likely to take good care of their children (Boehmer & Williamson, 1996, Gubhaju 1986, Ram & Schultz 1997).

Table 4.9: A summary of correlation test between Total Infant Mortality Change Rate and the following variables: Education status, Modern contraceptive use and urban population in Sub-Saharan Africa

	Education status (Sig. 2-tailed)	Modern contraceptive use (Sig. 2-tailed)	Urban population (Sig. 2-tailed)
Infant Mortality Rate	**.045**	**.191**	**.215**

4.2.4 Simple linear Regression between dependant variable (TFR Change) and each independent variable

The study performed a simple linear regression between dependent variable (TFR change) and each of the following variables: Infant Mortality Rate, Women using any modern contraceptive, Women with Secondary & Higher education, Urban population, Gross National Income per capita (All independent variables). This was aimed to assess how each predictor variable related with the dependent variable in terms of strength of association and level of significance. The results showed that there were no significant relationships of all the variables i.e. National Change in Infant Mortality Rate, Education status, use of any modern contraceptive, Economic status (GNI), Urban pop with the national TFR change rate.

The coefficient results at this bi-variate level indicated that the strength of each association with Change in Total fertility Rate were as follows: Secondary and higher education registered the strongest association of (-0.216) standardized coefficient followed by use of any modern contraceptive, Logarithm of Gross National Income per capita, National Infant Mortality change Rate (0.181, -0.146 and 0.109) respectively while Urban population comes last with a standardized coefficient of (0.042). Education and Gross National Income (GNI) took a negative direction.

From the R Square (R^2) results at this level of analysis, we can generalize that education could enable majority of Sub-Saharan Africa nations to achieve the Total Fertility change Rate reported at the uni-variate level while staying in urban area helped a very small portion of Sub-

Saharan Africa nations to achieve the same. The summary of these results are described in Table 4.10 below:

Table 4.10: A summary of simple linear Regression between dependant variable (TFR Change) and each independent variable i.e.:

	Standardized Beta (Coefficient)	Significance	R Square
National Infant Mortality Rate	**.109**	**.613**	**R^2 = 0.012**
Standardized Sec. & Higher Educ.	**-.216**	**.310**	**R^2 = 0.047**
Any Modern contraceptive use	**.181**	**.397**	**R^2 = 0.033**
Urban population	**.042**	**.847**	**R^2 = 0.002**
Gross National Income per capita	**-.146**	**.495**	**R^2 = 0.021**

We can therefore say that using macro data, at all level of bi-variate analysis, there is no association between Infant Mortality and fertility change in Sub-Saharan Africa. This can be attributed to the fact that aggregate data usually masks individual cases and if individual data can be used, it can generate different results.

4.3 Standard Multiple Linear Regressions

In this section, we performed two different standard multiple linear regressions. The first one included National Infant Mortality change Rate as one of the independent variables as summarized in Table 5.11 and the second regression included laggard-national Infant mortality Rate and also summarized in Table 5.12. This was done to test whether laggard infant mortality rate could have some different influence on fertility change compared to the subsequent infant

mortality rate as explained by the demographic transition theory. The section is presented as follows:

i.) Standard Multiple Linear Regression with: National Infant Mortality change Rate

The researcher wanted to determine the association between the standardized infant mortality (calculated from IMR_1 and IMR_2) and fertility change, net other factors and to know the importance of associations. The study also wanted to assess how independent variables related with the dependent variable in terms of strength of association (R^2) and their level of significance. The study performed the following multiple linear regression: National TFR Change rate = National IMR Change Rate, Standardized % Sum of Sec & Higher Education, Standardized % Modern Contraceptive use, Standardized % Urban pop. 2013, Logarithm of Gross National Income per capita (Atlas method) - Year 2014. Results were as follows:

Education Status is a significant determinant of fertility change in Sub-Saharan Africa and it had a negative significant effect on fertility change in Sub-Saharan Africa (Bledsoe et al. 1999, Shapiro et al. 2015, Ndahindwa et al 2014, Onoja and Osayomore 2012, Boehmer & Williamson 1996, Gubhaju 1986, Ram & Schultz 1997). This implies that Sub-Saharan Africa countries need to enroll more girl-child in to education system for them to realize the fertility transition that is desired, possibly to attain fertility replacement level (2.1)

Use of any modern contraceptive is a significant determinant of fertility change in Sub-Saharan Africa. Use of any modern contraceptive had a positive effect on fertility change (Ndahindwa et al., 2014, Rutayisire et al. 2014, Caldwell 1992). It increased fertility change in a positive direction, implying that women in Sub-Saharan Africa were consuming modern contraceptive and this enabled them to increase their fertility transition rate.

Staying in Urban area is a significant determinant of fertility change in Sub-Saharan Africa. Staying in Urban area had a positive effect on fertility change in Sub-Saharan Africa. This implies that urban population helped Sub-Saharan Africa countries to increase their fertility transition rate by offering access to services like modern contraceptives (Cohen 1993, Ekisa and Hinde 2005, Westoff 1994 & Westoff et. al. 2013, Woldemicael 2005).

The study however didn't establish any significant relationship between Infant Mortality Rate, Gross National Product (GNI) and fertility change in sub-Saharan Africa using this macro data.

Generally, the study had $R^2 = 0.521$ meaning, of all the tested variables, three explain 52% significant level.

The strength of each association with respect to change in Total fertility Rate in a standard Linear multiple regression having % standardized National Infant Mortality change Rate were as follows: Secondary and higher education registered the strongest association of (-1.409) standardized coefficient followed by Urban population, use of any modern contraceptive and Logarithm of Gross Income per capita (1.125, 0.992 and -0.061) respectively while % national Infant Mortality change Rate coming last with a standardized coefficient of (-0.011). The summary of the results are presented below:

Table 4.11: A summary of Standard Multiple Linear Regression with National Infant Mortality Change Rate in Sub-Saharan Africa

	Un-standardized Coefficients		Standardized Coefficients	t	Sig.
Model	**B**	**Std. Error**	**Beta**		
(Constant)	**-18.285**	**16.645**		**-1.098**	**.286**
Standardized Change in IMR	**.000**	**.007**	**-.011**	**-.062**	**.951**
Standardized %Sum of Sec & Higher Educ.	**- 4.957**	**1.321**	**-1.409**	**-3.751**	**.001*** **
Standardized % Modern Contraceptive use	**2.767**	**.702**	**.992**	**3.941**	**.001*** **
Standardized % Urban pop. , 2013	**3.984**	**1.055**	**1.125**	**3.778**	**.001*** **
Logarithm of Gross National Income per capita	**1.615**	**6.045**	**.061**	**.267**	**.792**
$R^2 = 0.521$					

Key: P ≤ 0.001 (***), P ≤ 0.01 (**), P ≤ 0 .05 (*)

ii.) Standard Multiple Linear Regression with: Laggard- National Infant Mortality Rate

The researcher wanted to determine the association between the laggard infant mortality (the first infant mortality – IMR_1) and fertility change, net other factors and to know the importance of associations. The study also wanted to assess how independent variables related with the dependent variable in terms of strength of association (R^2) and their level of significance. The study performed the following multiple linear regression: National TFR Change rate = National Lagged-IMR Change Rate, Standardized % Sum of Secondary & Higher Education, Standardized % Modern Contraceptive use, Standardized % Urban population by 2013, Logarithm of Gross National Income per capita (Atlas method) - Year 2014. This regression equation yielded the following results:

Education Status is a significant determinant of fertility change in Sub-Saharan Africa (Shapiro et al. 2015, Bledsoe et al. 1999, Ndahindwa et al 2014, Onoja and Osayomore 2012, Gubhaju 1986, Ram & Schultz 1997, Boehmer & Williamson 1996).It had a significant negative effect on fertility change in Sub-Saharan Africa. This implies that Sub-Saharan Africa countries need to enroll more girl-child in to education system for them to realize the fertility transition that is desired, possibly to attain fertility replacement level (2.1)

Use of any modern contraceptive is a significant determinant of fertility change in Sub-Saharan Africa. It had a positive effect on fertility change. (Ndahindwa et al., 2014, Rutayisire et al. 2014, Caldwell 1992). It increased fertility change in a positive direction, implying that women in Sub-Saharan Africa were consuming modern contraceptive and this enabled them to increase their fertility transition rate.

Staying in Urban area is a significant determinant of fertility change in Sub-Saharan Africa (Cohen 1993, Ekisa and Hinde 2005, Westoff 1994 & Westoff et. al. 2013, Woldemicael 2005). It had a positive effect on fertility change in Sub-Saharan Arica. This implies that urban population helped Sub-Saharan Africa countries to increase their fertility transition rate by offering access to services like modern contraceptives.

The study however didn't establish any significant association between Laggard-Infant Mortality Rate, Gross National Product (GNI) with respect to fertility change in sub-Saharan Africa.

Generally, the study had R^2 = 0.521 meaning, of all the tested variables, three variables (Education, Staying in urban area and contraceptive use) explained the model fitness at 52% significant level.

The strength of each association with respect to change in Total Fertility Rate in a standard Linear multiple regression having % National-Laggard Infant Mortality were as follows: Secondary and higher education registered the strongest association of (-1.388) standardized coefficient followed by Urban population, use of any modern contraceptive and National Gross Income per capita (1.112, 0.987 and 0.060) respectively while standardized laggard-IMR coming last with a standardized coefficient of (-0.031). There are bits of variations from the previous regression. Significance level for urban population increased from .001 to .002 in the regression with laggard-IMR. The summary of the results are presented below:

Table 4.12: A summary of Simple Standard Linear Multiple Regression with Laggard-Infant Mortality Rate in Sub-Saharan Africa

	Un-standardized Coefficients		Standardized Coefficients	t	Sig.
Model	**B**	**Std. Error**	**Beta**		
(Constant)	**-19.373**	**17.827**		**-1.087**	**.292**
Standardized Lagged-IMR	**.074**	**.412**	**.031**	**.180**	**.859**
Standardized %Sum of Sec & Higher Educ.	**- 4.884**	**1.271**	**-1.388**	**-3.844**	**.001*** **
Standardized % Use of any Modern Contraceptive	**2.754**	**.703**	**.987**	**3.919**	**.001*** **
Standardized % Urban pop. , 2013	**3.940**	**1.075**	**1.112**	**3.667**	**.002** **
Logarithm of Gross National Income per capita	**1.593**	**5.827**	**.060**	**.273**	**.788**
R^2 = 0.522					

Key: P ≤ 0.001 (***), P ≤ 0.01 (**), P ≤ 0 .05 (*)

In conclusion, the study findings at all level indicated that infant mortality did not have a significant association with fertility change in Sub-Saharan Africa, although at multivariate level of analysis, fertility change showed significant association with other control variables such as: Use of any modern contraceptive, education status and place of residence had an association at a multivariate level. A significant relationship was also seen between infant mortality and education status at bi-variate level of analysis hence we can say that infant mortality does not

have a direct association with fertility change at all level of analysis but associates to it through other control variables (socio-economic factors) like education status. This therefore leaves us with the implication that using macro data, infant mortality does not have a direct association with changes in fertility in Sub-Saharan Africa but has to pass through socio-economic and proximate factors. The findings agree with the following studies: (Shapiro et al. 2015, Fernandez-Villaverde 2001, Doepke 2005, Cong Wang 2013, Galor 2012, Coale 1973 and Van de Walle 1986). They observed that there was no relationship between the pace of infant mortality decline over a period of ten years and the rate of fertility decline.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary, conclusion and recommendations based on the study findings and how the results are consistent with the past studies. It was presented as follows:

5.2 Summary

This study sought to establish association between infant mortality and fertility change in Sub-Saharan Africa. It was based in 24 Sub-Saharan Africa countries which had the most two recent DHS surveys. The dependent variable was change in TFR and Infant mortality rate was its main independent variable. Other controlling variables were: education status, modern contraceptive use, urban population and Gross National Income per capita (GNI) to prevent the model from being bias.

The methods used to analyze data were: Descriptive statistics (Frequency distribution), correlation tests / simple linear regression and standard multiple linear regression respectively. Results at all level of analysis indicated that there is no association between Infant Mortality Rate and fertility change in Sub-Saharan Africa. Nevertheless, other controlling variable showed some significant association with the dependent variable (Change in TFR)

5.3 Conclusion

This study was set to establish the pace of TFR change rate in Sub-Saharan Africa' National, Urban, and Rural levels for the period 2003 to 2014 and to determine association between infant mortality rate and TFR change in sub-Saharan Africa for the period 2003 to 2014, net of other factors. The study established the pace of TFR change rate indicating Rwanda to be leading in fertility transition in Sub-Saharan Africa among other results presented at uni-variate level in Section 4.2.

At all level of data analysis, the results have indicated that using this macro data, there is no association between Infant Mortality Rate and fertility change in Sub-Saharan Africa. This can be as a result of the following factors: First, at uni-variate level of analysis, some countries

experienced an increase in TFR while others had a decline in TFR and this could affect the results since the study did not separate them as per type of change but focused on Sub-Saharan Africa as a whole i.e. was analyzing countries with TFR decline, increase and those with no change altogether. Maybe a different study with the countries with TFR decline alone could generate different results. Secondly, is about the nature of data because we were using aggregate (Macro) data which always masks individual cases. For example in the case of insurance effect and child replacement, we must depend on individual data. Such individual cases might not have been captured with the type of data this study was using.

The findings of this study agree with the findings of studies like (Shapiro et al. 2015, Fernandez-Villaverde 2001, Doepke 2005, Cong Wang 2013, Galor 2012, Coale 1973 and Van de Walle 1986). They observed that there was no relationship between the pace of infant mortality decline over a period of time and the rate of fertility decline. Finally, demographic transition theory, which this study anchored its operation on, states that it is the socio-economic developments which results in the availability and access to modern contraceptives, better education, better living standards and health facilities which consequently helped in reducing infant/childhood mortality hence fertility transition. This leaves the study to accept the alternative hypothesis which states that: Infant Mortality does not have a direct association with fertility change in Sub-Saharan Africa. (Notestein, 1945 and Kirk, 1996).

5.4 Recommendations

5.4.1 Recommendations for further research

Future research should be conducted on association between infant mortality and fertility change in Sub-Saharan Africa in countries that experienced fertility decline differently and those which experienced fertility increase differently using macro data and another same study using individual data. This will help in closing the gap of whether the results can still be the same with the ones found in this study.

5.4.2 Recommendations for policy and programmes

Sub-Saharan Africa countries should adopt policies and programmes that help in improving education status among their residents since this will consequently aide women with skills in rearing their children hence reducing infant mortality rate and consequently reducing fertility rate.

Sub-Saharan Africa countries should also continue having policies and programmes that encourages their people to continue living in urban areas (urbanization) since this reduces incidences of infant mortality due to access to better health care and consequently reducing fertility rate.

Finally, Sub-Saharan Africa countries should also continue having policies and programmes that encourages their people to utilize any modern contraceptive which help in deliberate prevention of conception hence reducing fertility rate.

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