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Research Article

Socio-economic and Demographic Covariates of Infant Mortality in Sub-Saharan Africa: Application of Analysis of Variance (ANOVA) and Multiple Regression Models

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Abstract:

The main thrust of the study is investigate the main socio-economic and demographic antecedents and proximate factors influencing Infant Mortality Levels and Patterns in Sub-Saharan African

The source of data of the study is largely from the 2001-2005 UNDP Human Development Reports, National Census Results, DHS data and Demographic survey results of Sub-Saharan African Countries.

The analytical techniques include analysis of univariate and bivaraite frequency distributions, ANOVA, correlation matrix and Multivariate regression models. Each country is taken as the unit of observation and a total of 42 countries are covered. The dependent variable is the level of Infant Mortality whereas 14 independent variables as the predictors influencing the Infant Mortality conditions are considered.

The model outputs suggested that all the fourteen independent covariates appeared to influence the levels of infant mortality positively or negatively, but in varying values of statistical significance, due to multicollinearity among the independent variables as manifested in the correlation matrix which appear to hinder clear understanding of the impact of each independent variable on infant mortality. However, the stepwise regression output identified the critical covariates of the infant mortality levels.

In conclusion, the study indicated that persistent high infant mortality level in the African -Continent has yet to continue for some decades before coming down to acceptable levels. The main reasons which largely appeared to maintain high Infant Mortality Levels among the Sub-Saharan Countries were noted to be the widespread poverty conditions and low level of health services and education in rural Sub-Saharan Africa. Consequently, the high infant mortality in rural Africa has been observed to be influenced by high fertility level, family planning programmes, education and employment, among other background and proximate variables.

Keywords: infant mortality, fertility, covariates, opportunistic illnesses, dependent and independent variables, correlation and multiple regression.

1. INTRODUCTION:

1.0 Background

The field of Demography as a discipline owes its origin from the need for the study of mortality levels, trends , patterns and differentials. The construction of Life Tables of human population was necessitated by the need for setting policies and programmes of social security insurance by private companies and Governmental civil services.

In the 18^{th} -19^{th} centuries, many European countries needed reliable estimates of life expectancy or probability of the incremental quantity in life expectancy of various age/sex groups of the populations and plan formulation and implementation of public health services.

These concerns gave way to the collection and analysis of mortality data and also identify the causes of death. However, investigation on the socio-economic, demographic and biological correlates of mortality has been a recent phenomenon, much more later then the concern for the study on fertility correlates.

As we could recall, most of the Sub-Saharan African (SSA) countries obtained their independence from Colonial rule during the early 1960's where the Sub-Continent developed into a *mixture of heterogeneous and homogenous characteristics*, comprising of 47 politically balkanized small states, with a small population size each with the exception of Ethiopia and Egypt with a population of currently more than 85 million each and Nigeria with more than 100 million in the late 2000.

Demographically, the Continent has been encountered with unprecedented high fertility with moderately declining mortality levels and its population size has increased from about 181 million in 1950 to 621.9 million in 1990 and jumped to about 831.5 million at a revised growth rate of 2.9 percent per annum in 2000 and estimated to reach about 1.5 billion by the year 2020, with a doubling period of every 23 years.

It has been expected by the African States that the Macro-Level Economic Structural Adjustment Programmes of the

World Bank/IMF, environmental management and the political democratization processes would influence the demographic structure, particularly infant mortality and general mortality conditions of the African populations. However , almost all SSA countries are now trapped by huge quagmire of international indebtedness which aggravated the social and economic hardships, abject poverty, manifesting the " vicious circle of poverty".

Consequently, the outputs of Sub-Saharan demographic structure indicate that the reciprocal relationship between high infant mortality and high fertility levels has been well established where fertility tends to be superior to the level of infant mortality. From the two strong relationship, it follows manifesting relatively high survivors which results again having a youthful population, leading to high dependency ratio on the productive and reproductive segments of the population, which again leads to producing high growth potentials for subsequent years with significant detrimental effects on developmental endeavours.

1.1 Problem Statement:

Globally, the population controversy can be seen in two perspectives as *Shrinking population and Progressive population.* The first type is the characteristics of an ageing European populations whose birth and death rates are low, depicting the demographic transition as well as *"demographic dividend"*, including some rapidly industrializing countries of Asia, Latin America and China, whereas the second signifies to the SSA where both fertility and mortality levels and trends have remained persistently high, though fertility has been relatively superior, ensuring that the number of women and men in their productive and reproductive years would continue to grow for several decades and the total births remained consistently high resulting to fast population growth momentum which has been in-built in the age patterns of the populations.

From the current demographic patterns of SSA, we can predict that the "Demographic Transition", *that is a shift from high levels of both fertility and mortality to low levels*, has a long way to go before approaching the demographic transition of the industrialized and the rapidly advancing countries of Asia , Latin America and China.

1.2 Rationale/Justification of the Study:

The study has been motivated by the fact that every year ,about 10 million children under five years of age die from preventable and treatable diseases in developing countries , mostly in Sub-Saharan Africa. (Rumishael etal.,, 2007). The main factors are **(1)** Infant mortality in SSA has the largest share in life expectancy at birth and this index is an important indicator of development as a component of the UNDP Human Development Index (HDI); **(2)** Reduction of infant mortality creates healthy future generation for sustainable development**;(3)** Reduction of infant mortality induces fertility to decline because the two factors are positively related; **(4)** Reduction of infant mortality minimizes pregnancy wastage and maintain the health of mothers; most importantly **(5)**Reduction of infant and childhood mortality to acceptable levels is one of the crucial components of the UN 2000 Millennium Development Goals (MDG 4 and 5).

1.3 Objectives of the Study:

The underlying goal of the study is to expand health delivery services for the eventual reduction of infant mortality to acceptable level of quality of life. Such expression of aspiration is the summation of attainable specific objectives which can be enumerated as follows:

- *Assess the levels and trends of infant and general mortality conditions;*
- *Investigate the main socio-economic and demographic antecedent variables influencing infant mortality in the era of HIV/AIDS ; and*
- *Examine the likely implications on health development,i.e., health service provisions and HIV/AIDS competitiveness or complementarities in their interaction in Sub-Saharan Africa*.

1.4 Data Sources of the Study:

The source of data of the study is largely the 2001 UNDP Human Development Report, being supplemented by DHS data, the results of censuses, intermediate and post-censal demographic and various socio-economic sample surveys and projections, whereas for the HIV/AIDS, the main sources will include estimates provided by the *WHO and UNAIDS reports, World Bank and African Development Bank and references to other Literatures*.

The annual compilations of information and transmission of the socio-economic and demographic data, including data for mortality indicators, which were used to be transmitted to the *UN Headquarters by the African Government Institutions* can possibly have some errors and inconsistencies.

Furthermore, in view of the high illiteracy levels in African countries, the basic data of census results and DHS survey data, particularly in reporting the *Neonatal Mortality*, and the assumptions on the HIV/AIDS estimates and projections and implication on population growth, mortality levels and trends and derivation of life expectancy, impacts on the productive and reproductive segments of the population etc. couldn't be free from some errors.

II. LITERATURE REVIEW:

2.1 At Global and Continental Perspectives

The population growth of SSA has been continuously increasing. Fertility and mortality have remained almost steadily constant since the Second World War, with fertility remained superior to mortality for quite a long period. This phenomenon gave rise to two important demographic patterns, which included high population growth rate, increasing from about 2.2 percent in the early 1950's to about 3 percent in the recent years, and young age-dominated structure, which remained around 45 percent on an average of the total population, inducing sustained high proportions in the productive and reproductive segments of the population.

However, Sub-Saharan populations have usually been encountered, with intermittent and widespread perturbations of catastrophic events such as war, drought, famine epidemics or large scale migration(Samuel,1982); implementation of birth control or spacing through family planning services has been deplorably very low due to the backwardness in all walks of life of the African Societies ; HIV /AIDS pandemic and its intimacy with other "opportunistic illnesses " and STD's to have appeared to spread quickly since1980's, with no sign of slowing down, with a narrowing trend in the gap between urban and rural prevalence rates, which evidently encountered by persistently high mortality condition, particularly with respect to infant mortality levels.

Consequently, recent estimates of infant, childhood and maternal mortality levels remained to be high with high variations among the countries. For example, infant deaths range from 51 per 1000 live-births for South Africa to as high as 182 per 1000 live-births for Sierra Lione; childhood mortality (inclusive of infant deaths before celebrating their first year of life) reported to range from 52 per 1000 under-five children for Botswana to 275 per 1000 for Mozambique, against maternal mortality, ranging from about 230 per 100,000 live births for South Africa to 1500 per 100,000 for Mozambique (UNDP, 1996). Although the general mortality level of the African populations had been slowed down, estimates and projection results indicate that the recent share of the under-five mortality of SSA still constituted about 57 percent higher as compared with the Global level(UNICEF, 1960-2015).

Since the early1970's, the general developmental efforts of many SSA countries have been halted where the social, economic and political environments of Sub-Saharan Africa have been deteriorating. Consequently, the African Nations were obliged to seek bilateral and multilateral assistance and also entered borrowing agreements with the World Bank/ IMF. Governments were forced to cut investments for the key economic programmes such as education , health and supporting to informal sector . Retrenchments continued to add new employment problems to the already stock of the poor. Poverty increasingly became worse and widespread unemployment and debt –burden increased. For example, the outstanding debt increased from 121.9 billion US dollars in 1992 to 349 billion in 1997. This accounted for an annual debt service of 33 billion ,absorbing about 21.3 percent of the export earnings with increasing debt/GDP ratio from 14.5 in 1971 to 67.9 percent in 1997 (Rugumanu Severine M. 2001).

These proportions indicate clear evidence of Africa's incapacity to repay its external debts. In fact 25 of the 32 countries which have been categorized by the World Bank as seriously indebted low income countries are in Sub-Saharan Africa and 24 qualified for debt-relief under the "*Heavily Indebted Poor Countries Scheme ".* It has been anticipated that the Economic Structural Adjustment Programmes of the World Bank/IMF, environmental management and political democratization would influence the demographic structure, particularly infant mortality and general mortality conditions of the African populations.

Although the programmes and policies of the World Bank and IMF had initially applauded for showing some positive impact on the macro-economic performance(specifically the export sector) of a number of Sub–Saharan African countries, recovery had still remained fragile and in due course proved to be neither a capacity building programme , nor a corrective initiative where the balance of payments have not improved (Kapunda ,2001 ; Chikulu , 2001). Instead, almost all SSA countries are now trapped by the huge quagmire of international indebtedness which aggravated the social and economic hardships and abject poverty, resulting in a " vicious circle of poverty" which , resulted in persistent high infant and childhood mortality levels and serious imbalance between population growth and development (ADB,1993; Fenyes,2001).

2.2 The Inception of the HIV/AIDS Pandemic:

While the SSA states have been struggling to come out from the quagmire of all sorts of poverty , including the huge external in-debtedness , they faced with the HIV/AIDS pandemic. Among other social and economic and psychological problems, the pandemic has been noted to strike at the productive and reproductive segment of the population. For example, recent estimates for Ethiopia show that there were about 3 million HIV carriers and 400 thousand AIDS patients in the country and at least 50 percent of this figures were economically active and demographically reproductive population (Ethiopia, 1998). Results of a study of HIV prevalence among pregnant women in Botswana also showed similar patterns where 42 percent of about 1000 sampled pregnant women in the age group 20-24 and 41 percent in the age group 25-29 were reported to have been affected by the pandemic(Innocent Mbo Modisaotsile, 1997).

Since the late 1980's, HIV/AIDS pandemic and its intimacy with other "opportunistic illnesses " and STD's appear to spread quickly, with no sign of slowing down , with a narrowing trend in the gap between urban and rural prevalence rates in the Sub-continent. According to recent estimates, every SSA country is now experiencing the effects of the pandemic in varying degrees where the East African Sub-Region accounted for 11 percent for rural and 18 percent for urban areas.. During these periods, the level for Middle Africa was about 7 percent ; 15 percent for Southern and about 5 percent for the three West African countries. (US/AID/ US Census Bureau ,1999; Karen, 1997).

With respect to health service provisions, Sub-Saharan African states have been required to spend a large amount of resources for combating the pandemic and treating the associated "opportunistic illnesses ". During the incubation periods, the commonly occurring symptomatic diseases include tuberculosis, diarrhoea, pneumonia, influenza etc. which often are instigated by the presence of HIV-virus.

The presence of STD 's in the HIV patient also acts as favourable ground for the spread and development of HIV-

virus. One can, therefore, imagine the enormity of cost implications of the HIV/AIDS pandemic and associated diseases . For example , Abdulhamid (1998) prepared cost estimates for Ethiopia for different health services such as bed-use days, consultation hours, drugs, laboratory service tests and other preventive services and found out that the estimates for 1997-2006 ranged from 49 million US $ in the low cost scenario to 368 million in the high scenario , with a high cost scenario ranging from a per capita of US $ 41.3 for outpatients to US $197 for inpatients ,giving as high as US $628 per capita per annum which is more than five times higher than the National Per Capita income of US $120 .

Similar problems were reported for Kenya, Tanzania , South Africa, Zimbabwe, Zaire and Rwanda where the financial implications of HIV/AIDS treatment alone and treating the associated opportunistic illnesses out of the total public health budget of some African countries have been huge (Kenya ,1996 ; Makhema, 1997; Hope ,1995 ; Ainsworth,1992) .

The effect of the pandemic on mortality can be summarized by the life expectancy index. Accordingly, the decline in life expectancy of the African populations has been anticipated to decrease by a large number of years. By 2010, it is estimated that all SSA countries would lose some years from the expected progress of their life spans. The decrease would account for about 29 percent from the expected of about 62 years to 45 years for SSA as whole , ranging from about 18 percent for Middle African countries to about 39 percent for southern African countries. Consequently, countries which had performed remarkable achievements in increasing their life expectancy in the last two decades or so have now projected to face with considerable decline, tending to reverse the attainments of the 1970's and 1980's .

As could be recalled, the Alma-Ata (1988) conference was concluded by setting a target of *" health for all by the year 2000". I*t was specifically stated that implementation of some selected intervention programmes on social policies (health, education, employment etc), environmental sanitation, improvement of women's status, cultural values, etc were believed to raise the level of immunization, birth weight, nutritional status, literacy, and income thereby attaining at least 50 percent reduction in infant mortality, 100 percent maternal mortality and to reach at least 60 years life expectancy at birth. However, with the inception of the pandemic, the aspiration of attaining the Alma Ata recommendation appeared to face some reversal effects, particularly for Southern and Eastern Sub-Regions of Sub-Saharan Africa (ECA ,1992).

However, the high fertility followed by high infant mortality appears to be the reality, at least until the foreseeable future in Sub-Saharan Africa. For example, by the end of this century , the HIV/AIDS cases for Sub-Saharan Africa is projected to reach between 28-35 million adult victims and between 120-160 million children who would be orphans, homeless and under the custody of elderly people, followed by disintegration of many families (ADB , 1993). Every year, about 5 million HIV/AIDS cases are reported and 95 percent of them are heterosexually transmitted cases in the developing countries (UNAIDS, 1998 , 2002). Sub-Saharan Africa takes very high proportions of all the pandemic cases of the world's total, ie., *65 percent of the HIV/AIDS cases; 80 percent of the AIDS deaths; 70 percent of the HIV infections ; 90 and 94 percent of child HIV/AIDS and total deaths ,respectively ; 68 and 90 percent of HIV infections in the age group 15-24 and children less than 15 years of age, respectively ; and 95 percent of the orphanage rate*.

With respect to health service provisions, Sub-Saharan African states have been required to spend a large amount of resources for combating the pandemic and treating the associated "opportunistic illnesses ". During the incubation periods, the commonly occurring symptomatic diseases include tuberculosis, diarrhoea, pneumonia, influenza etc. which often are instigated by the presence of HIV-virus. The presence of STD 's in the HIV patient also acts as favourable ground for the spread and development of HIV-virus. One can, therefore, imagine the enormity of cost implications of the HIV/AIDS pandemic and associated diseases .

2.3 Levels of Infant Mortality and General Mortality Conditions of SSA.

Infant Mortality Rate is the probability of dying of new born babies before celebrating their first birth day among 1000 live births occurred during a given reference period. Depending on the intensity of age specific infant mortality, the age of infancy is commonly divided into the ***Neonatal Period***, dying within the first 28 days of life; ***Post Neonatal Period***, within 28 days and less than one year; and **Infancy** is the summation of ***Neonatal and Post Neonatal Periods.***.

Accordingly, studies indicate that about 67 percent of infant deaths occur during the neonatal period in which about 50 percent of neonatal death occurs within the first 24 hours of delivery and about 75 percent during one week to three months after delivery (UNICEF,1960-2015). Infant deaths take the highest share of all deaths of the various age segments of the population in the developing world.

Advancement in medical technology, such as vaccination programmes, oral rehydration therapy, availability of antibiotics and general improvement in socio-economic conditions world wide has improved infant and childhood mortality levels significantly, which generally dropped rapidly over the last 25 years. For example, childhood mortality dropped from about 25 million in the 1980's to about 11 million in the 1990's. In the same vein, infant mortality levels have manifested incipient decline since 1950 in many countries of the world, including in a number of Sub-Saharan African countries (WHO,1992).

Average estimates of infant, childhood and maternal mortality levels in the early 2000 for the world as a whole and Sub-Saharan Africa are summarized in **Table 1**. This Table clearly shows that the levels of the three health sensitive indicators for Sub-Saharan African countries have been

deplorably high and unacceptable conditions, even when compared with the Asian and Latin America countries.

Table-1: Levels of Infant mortality rate (IMR0, Childhood Mortality (CMR) and Maternal Mortality Rate (MMR) by Major regional Classification

Region	IMR	CMR	MMR
World	56	80	-
Developed	6	6	12
Developing*	61	89	150
East Asia	34	44	-
South Asia	69	97	-
Latin America**	32	39	-
SSA	107	172	500-900

Source: Compiled and arranged from UNDP Report: 2000-2005, New York

However, there exited some variations in the level among the SSA countries. For example , in the countries of the Southern African Sub-region, infant mortality has dropped from around 130 per 1000 live births in 1950 to about 60-65 in 1995 with an average of about 90 per 1000 live births for Sub-Saharan Africa and about 10 for Europe in the early 2000's (UNECA, !995).

According to the UNDP Human Development Report (2001), the recent infant mortality level in SSA ranges from 56 for South Africa to 125 for Mozambique in Southern Africa Sub-Region; from 76 for Kenya to 116 for Ethiopia inr East Africa; 56 for Gabon to 129 for old Zaire in Middle Africa and from 76 for Senegal to 156 for Niger in West Africa Sub-region.

In the light of available evidence , **Table 2** further examines the mortality levels of some selected SSA countries during the early 2000. This Table shows that SADC member States generally manifest relatively better mortality levels than the others with Botswana and South Africa performing relatively well in reducing their infant, childhood and maternal mortality levels, extreme cases appear in Mozambique, Zambia and Malawi in SADC states, while Ethiopia (IGAD) and Nigeria (ECOWA's) have exhibited unacceptable mortality conditions in all the three measures of mortality levels..

Although some evidence show progress in the campaign and implementation of immunization programmes to reduce infant and childhood mortality levels in many Sub-Saharan African countries, coverage still remain low for a number of them.(Arowolo, 2007). For example, the following eight countries reported big gap coverage of immunization rates: 29 % for central African Republic; 35 % for Congo; 36 % for Chad; 37 % for Sierra Leone; 37 % for Mauritania ; 40 % for Rwanda; 46% for DRC.; and 40 % for Burkina Faso.

In the Asian and Latin American industrializing countries, more infants are surviving the neonatal and post neonatal mortality risks, whereas Sub-Saharan Africa has remained far behind. However, countries which having been progressing (though slowly) and expected to meet the MDG Target of two-third reduction in under-five mortality by the year 2015 include Egypt, Tunisia, Morocco, Botswana, Cape Verde, Guinea, Mauritius and Madagascar. On the other hand, Benin, Burundi, the Central African Republic, Ethiopia, Mozambique Namibia, Nigeria , Senegal, Swaziland, Uganda, and Zambia appear to make some progress, though relatively in slow paces (Arowolo, 2007).

Table 2: Mortality differentials among selected representative of Sub-Regional countries (1998) :

Sub-Region	*IMR*	*CMR*	*MMR*	*Sub-Region*	*IMR*	*CMR*	*MMR*
(1) SADC Countries	***85***	***135***	***645***	***(2) I GAD Countries:***	***85***	***149***	***1083***
Botswana	55	52	250	Ethiopia	111	175	1400
South Africa	51	67	230	Kenya	57	87	650
Zimbabwe	70	74	570	Uganda	86	185	1200
Namibia	60	78	370	***(3)ECCAC's***	***75***	***122***	***525***
Swaziland	72	107	-	Cameroon	64	99	550
Lesotho	72	-	610	Gabon	85	145	500
Zambia	110	203	940	***(4) ECOWAC's***	***90***	***147***	***870***
Mozambique	116	275	1500	Ghana-	68	107	740
Malawi	147	219	560	Nigeria	112	187	1000
Tanzania	92	143	770				

Note: IMR = Infant Mortality Rate; CMR=Childhood Mortality Rate; MMR=Maternal Mortality Rate; SADC=Southern Africa Development Countries; IGAD= Inter-governmental Authority of Development; ECCASs = Economic Community of Central Africa States; ECOWAS = Economic Community of West Africa States**.**
Source: **Compiled and computed from UNDP: Human Development Report, 1996,1997,1998 and 1999 New York**

Further information on the level of infant and other mortality measures are also compiled for selected countries and presented in **Table3** by class size of the measures..

This Table shows that 21 countries reported an IMR in the range of 100-199 per 1000 live births in 1998 and 18 countries reported more than 900 maternal deaths per 100,000 live births. These rates are extremely high as compared with other societies, with. an IMR of 64 for all developing countries, 6 for industrialized and 58 for the world as a whole during the same period (UNDP, 1999).

Reduction in under-five mortality encounters by complex socio-cultural and general development matrix. For example, in many African societies, a large number of children is perceived as social security and prestige, economic assets and as perpetuation of lineages, which motivate fertility to remain persistently high.. Literatures in family planning programmes have indicated that the performance of high fertility has been detrimental to mother and child health. Besides, fertility and infant mortality have reciprocal relationships as positive or negative relationship. These hypotheses and other antecedents of infant mortality levels will be tested in our forthcoming topic of regression analysis.

Table 3: Mortality indicators for some SSA countries by size- class interval of the rates :

Parameter/ Indicator	***Death –Intervals***	***# of Countries in the interval***	***% of total countries* in each interval**
IMR	50-99	27	56.2
	100-199	21	43.8
	200+	0	0.0
	Total	48	100.0
CMR	50-99	6	37.4
	100-199	7	43.8
	200+	3	18.8
	Total	16	100.0
MMR	<500	9	19.1
	500-899	20	42.6
	900-1299	12	25.5
	1300+	6	12.8
	Total	47	100.0

Note: IMR= Infant Mortality Rate, CMR=Childhood Mortality Rate; MMR= Maternal Mortality Rate
Source: Compiled and Prepared by Author from UNDP 1997, 1998 and 1999; UNFPA, 1998

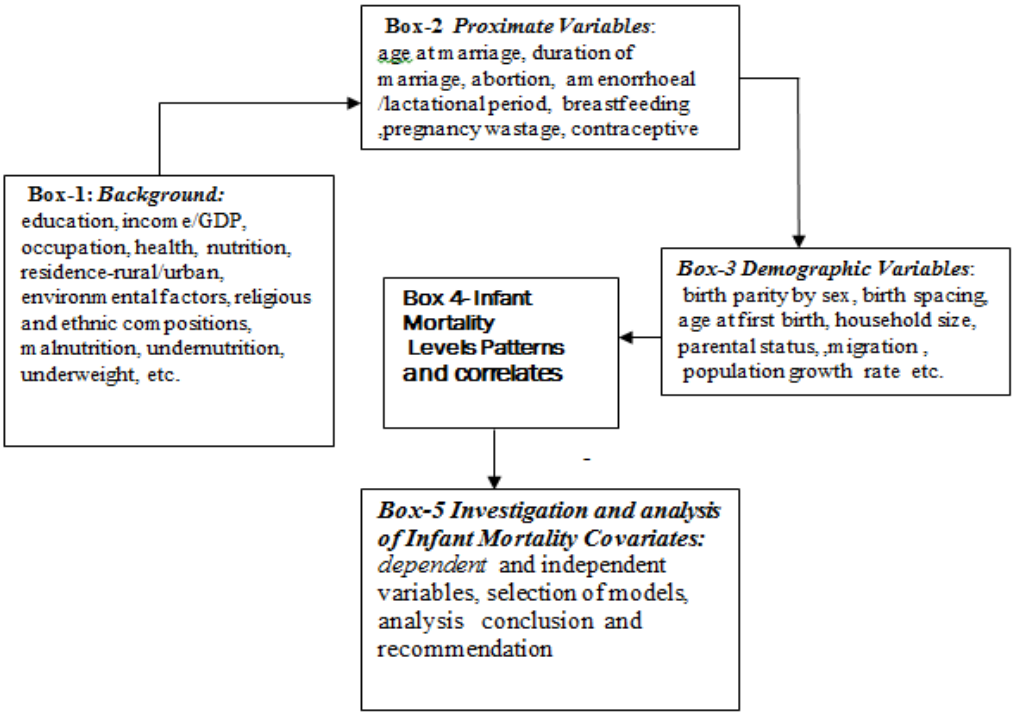
Again, the foregoing background previews, this paper examines the levels and covariates of infant mortality among the 42 Sub-Saharan African countries against 14 background covariates of infant mortality levels, applying appropriate statistical models.

III. Methodological Aspects of the Study

3.1 Theoretical/Conceptual Framework

Figure1 below manifests the complex relationship among the levels and correlates of infant mortality and the factors in-built in the different, labelled as **boxes 1 to 5**
Infant mortality and other health sensitive mortality measures have complex covariates. As can be noted in the general conceptual framework, the background variables are hypothesized to influence the proximate variables, which again instigate Box-3. While Boxes 1-3 generally play the role of acting as independent variables, influencing general manifestation of mortality conditions, the most critical variables which are assumed to influence infant mortality are sieved from the given framework to be the response variable. Here, the unit of observation is each country of SSA. We listed the possible determinant of infant mortality against each country (refer to Annex-A)

Fig.1 General conceptual framework showing the Covariates of Infant Mortality



3.2 Model Specifications

3.2.1 Dependent and Independent Variables:

The unit of observation is each country and all the variables are assumed to be continuous with Infant mortality as dependent variable and the others are assumed to be independent variables or the covariates of the dependent variable. The list of the Hypothetically Identified Community Sensitive Areas influencing Infant mortality (Y) are as follows:

Y= IMR- infant mortality rate per 1000 live births;
$\mathbf{X_1} = e^0_0$ - life expectancy at birth in years;
$\mathbf{X_2}$=TFR- total fertility rate per woman;
$\mathbf{X_3}$= Ideal number of children to be born by women in the childbearing age;
$\mathbf{X_4}$= Population growth rate in percent per annum;
$\mathbf{X_5}$=contraceptive prevalence in percent;
$\mathbf{X_6}$=breastfeeding in percent;
$\mathbf{X_7}$=undernourishment in percent;
$\mathbf{X_8}$= Healthcare Services
$\mathbf{X_9}$=No pure drinking water for households in percent;
$\mathbf{X_{10}}$= female illiteracy rate in percent;
$\mathbf{X}_{11}$=urban population share in percent in each country;
$\mathbf{X_{12}}$=Log (GDP)- per capita income in log. Function;
$\mathbf{X_{13}}$= HDI- human development index ; and.
X_{14}=HPI - human poverty index (in percent),

3.3 Analytical Techniques:

The employed Analytical Techniques include Descriptive Statistics (Basic Frequency), Analysis of Variance(ANOVA), Correlation of Matrix and Multiple Regression Model. Each Country is the unit of observation. These Statistical Models are specified in the following sub-sections, respectively**.**

3.3.1 Descriptive Statistics:

Some commonly used central tendency measures are applied. If $X_1, X_2, X_3, \ldots\ldots\ldots X_n$ are independent continuous variables, say , education, income , nutritional status, contraception etc and $Y_1, Y_2, Y_3 \ldots\ldots\ldots\ldots Y_n$ are the dependent variables of interest, which is infant mortality in this model, then the mean and the standard deviations are generally computed using the following formulae:

Mean of X_i's $= \overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$; Standard Deviation = $\sqrt{\frac{1}{n}\sum_{i=1}^{n}(X_i - \overline{X})^2}$

Mean of Y_i's $= \overline{Y} = \frac{1}{n}\sum Y_i$; Standard Deviation = $\sqrt{\frac{1}{n}\sum_{i=1}^{n}(Y_i - \overline{Y})^2}$

The median values can also be calculated from the given frequency distributions of the observations of dependent and independent variables.

3.3.2. Correlation Coefficient:

A correlation coefficient (r) between $X_1, X_2, X_3 \ldots X_n$ and Y_1,

$Y_2, Y_3, \ldots Y_n$ can be expressed as follows:

$$r = \frac{Cov(X,Y)}{\sqrt{Var(X)}\sqrt{Var(Y)}} = \frac{\frac{1}{n}\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\frac{1}{n}\sum_{i=1}^{n}(X_i - \overline{X})^2}\sqrt{\frac{1}{n}\sum_{i=1}^{n}(Y_i - \overline{Y})^2}}$$

The correlation coefficient " r " determines the strength of linear relationship between the two variables, X and Y. If r= + 1 or r = –1 , there is a perfect positive or negative correlation between the two variables , but r= 0 , shows no linear relationship between X and Y.

3.3.3 Correlation Matrix:

The correlation matrix model then investigates the correlations among the independent variables X_i's on one hand and the Y dependent variable with each of the independent variable on the other hand. Then, the statistical summaries are exhibited in a tabular form showing the interrelationship among the independent variables and partial correlation of the dependent variable with each of the independent variables. The diagonal of the matrix shows the perfect relationship of a variable with itself (Refer to Table-5).

3.3.4 Analysis of Variance- ANOVA

$$\mathbf{R^2} = \frac{Cov(X,Y)^2}{Sx2Sy2} = \mathbf{1-}\frac{SSE}{\sum_{i=1}^{n}(Yi - Y)} = \mathbf{1-}\frac{\sum_{i=1}^{n}(Y - Y)2}{\sum_{i=i}^{n}(Yi - \overline{Y})2} = \frac{SSR}{SST}$$

where S^2_x and S^2_y are sample variance of X and Y

The coefficient of determination R^2 measures the proportion of the variation in the dependent variable that is explained by the independent variables. It is always expressed as $0, \leq R^2 \leq 1$. When values of R^2 are close to 1, this means that the independent variables in the model explain most of the variation in Y, which is the dependent and the sample data tend to lie near the estimated regression equation whereas the values of R^2 close to 0 indicate that a large proportion of the variation in Y is unexplained. Furthermore, if $R^2=1$, then SSE=0, and every observation exactly satisfies the estimated regression.

3.3.5 Multiple Regression

In this model, the IMR (Y) is considered a dependent variable and certain selected background and proximate variables (X_i's) are independent variables. Thus, the functional relationship between the dependent and independent variables is presented as follows:

if we let "X 's " representing all the " socio-economic and demographic variables plus any proximate variables of interest and "Y " be measurable IMR level, then IMR "Y" , as dependent variable, can be expressed as a linear additive combination(function) of the independent /explanatory variables " X " .The regression equation is then expressed as :

$Y = F(X) \Rightarrow Y = \alpha + \sum \beta_i X_i + \in$

where i = 1, 2, 3,…, n; β's = coefficients of determination and α = marginal value and

∈ = error terms

In explicit terms, we have $Y = \alpha + \sum \beta_i X_i \Rightarrow Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots + \beta_n X_n + \in$.

The parameters βi's measure the change in the mean value of Y to a unit (positive/negative) increase or decrease in the value of X_i' s when all other independent variables are held constant. Furthermore, the strength of the linear relationship is measured by the coefficient of determination R^2, which measures the proportion of variation in the dependent variable that is explained by the independent variables entered in the model. The R^2 value always lies between 0 and 1, where R^2 close to 1 implies that the independent variables perfectly explain the variations in the dependent variable of interest. If R^2 is closer to 0 implies that a large proportion of the variation in Y is unexplained by the independent variables which entered in the model. This means that a large proportion in the variation is explained by independent variables which were not included in the model. Thus, the unexplained proportion is 1- R^2 .

4. *Model Outputs:*

4.1 Results of the Central Tendency:

Table-4 presents a summary of the measures of central tendencies: *minimum, maximum, mean and the corresponding standard deviations of the variables of interest.* These results can be compared with **Annex-A** to see countries having the lowest and highest mean values. For example , Seychelles and Sierra Leone reported the lowest and the highest Infant mortality rate, with 13 and 182 infant deaths per 1000 live births , respectively.

Table -4 Measures of Central Tendency by dependent and independent variables:

Variables	N	Minimum	Maximum	Mean	Std. Deviation	
Infant Mortality Rate	42	3.0	182.0	**95.5**	35.0	
Life Expectancy at Birth	42	32.4	75.0	**47.9**	10.6	
Total Fertility Rate	42	1.8	8.0	**5.3**	1.4	

Ideal Family Size	42	2.0	9.0	**5.1**	1.4	
Population Growth Rate	42	1.3	3.3	**2.5**	0.5	
Contraceptive Use	42	4.0	83.0	**23.1**	18.2	
Breastfeeding	42	55.0	100.0	**87.6**	10.1	
Undernutrition	42	0.0	76.0	**30.3**	16.9	
Healthcare Service	42	18.0	100.0	**63.3**	23.1	
No pure drinking water	42	0.0	76.0	**39.7**	18.7	
Female Literacy	41	8.0	94.0	**52.7**	22.5	
Urban Population	42	6.3	82.1	**36.9**	16.0	
Log GDP	41	3.0	4.0	**3.3**	0.412	
Human Development Index	42	0.26	0.77	**0.5**	0.123	
Human Poverty Index	42	11.5	63.6	**39.6**	10.5	

Note: A high value of standard deviation shows large variations in the specified variable among the SSA countries

4.2 Results of the Correlation Matrix :

Data input for this model are shown in **Annex-A** and the outputs are summarized in **Table-5.** This Table shows that IMR appears to be either positively or negatively correlated with all the independent variables at 0.01 or 0.05 significant levels.:

Negatively Correlated are: *Life expectancy at birth* ***(X_1); Contraceptive use (X_5); Healthcare services (X_8); female illiteracy rate (X_{10}); urbanization (X_{11}); Log GDP(X_{12}) and human development index (X_{13}).***

Positively Correlated are: *Total fertility rate* ***(X_2),*** *Ideal number of children* **(X_3)**, *Population growth rate* ***(X_4)***, *Breastfeeding for less than six months* ***(X_6)***, *Udernourishment****(X_7),*** *No pure drinking water* **(X_9)** *and Human poverty index* ***(X_{14})***.

Interestingly, the variables which showed inverse relationship with IMR confirm the findings at household micro-level investigations. For example, countries with low contraceptive prevalence level tend to perform higher IMR. Similarly, higher per capita income, good health services and high urbanization reflect low IMR

In contrast, those manifesting positive relationship are also consistent with empirical evidence where high fertility induces high infant mortality rate due to replacement effect and also true with undernutrition, which is a major manifestation of poverty that motivates high IMR. But, the positive relationship of breastfeeding less than six months with infant mortality is inconsonance with other findings, for breastfeeding for less than six months invite high IMR, for early stoppage of breastfeeding followed by scarcity of appropriate diet during the weaning stages increase childhood mortality.

Table-5 Results of Correlation Matrix Model

Variables	**Y**	**X_1**	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**	**X_7**	**X_8**	**X_9**
Y	1.000									
X_1	-0.400	1.000								
X_2	0.809	-0.358	1.000							
X_3	0.059	-.0.206	0.237	1.000						
X_4	0.557	-.0.354	0.810	0.178	1.000					
X_5	--.793	0.363	-0.824	0.269	-0.671	1.000				
X_6	0.360	-0.562	0.432	0.169	0.496	-0.494	1.000			
X_7	0.525	-0.398	0.499	0.060	0.412	-0.318	0.400	1.000		
X_8	-0.633	0.259	-0.605	-0.180	-0.453	0.589	-0.357	-0.158	1.000	
X_9	0.613	-0.098	0.699	-0.021	0.508	-0.617	0..255	0..375	-0.377	1.000
X_{10}	-0.615	0.062	-0.688	-0.219	-0.530	0.691	-0.229	-0.330	0.581	-0.434
X_{11}	-0.426	0.404	-0.524	-0.234	-0.368	0.428	-0.279	-0.456	0..234	-0.302
X_{12}	-0.675	0.324	-0.699	-0.055	-0.594	0.668	-0.531	-0.593	0.519	-0.543
X_{13}	-0.831	0.345	-.844	-0.131	-0.612	0.838	-0.411	-0.557	0.570	-0.637
X_{14}	0.723	-0.160	0.751	0.062	0.500	-0.681	0.237	0.441	-0.570	0.655

Table-5: Results of Correlation Matrix Model (Cont.)

Variables	X10	X11	X12	X13	X14
X_{10}	1.000				
X_{11}	0.380	1.000			
X_{12}	0.596	0.522	1.000		
X_{13}	0.803	0.569	.852	1.000	
X_{14}	-0.797	-0.417	-0.613	-0.861	1.000

Multicollinearity:

It appears that the output of the correlation matrix suffers by a lot of multicollinearity among the independent variables which can distur**b** the good fit of the dependent variable with the independent variables**.** For example, the very outstanding ones with correlation of more than 0.5 are income per capita, expressed as logGDP (X_{12}), HDI (X_{13}) and the HPI(X_{14}), which respectively have linkages with X_{11}, X_{10} and X_8 other independent variables**(Refer to Table 5).** Attempts of controlling the multicollinearity are made in the multiple regression output.

4.3 Multiple Regression Outputs:

Data input for the model are presented in **Annex-B.** In order to minimize the effects of **multicollinearity**[1] among the independent variables on the dependent variable, we ran seven stepwise regression models and the model which reflected good fit or co-variation at 5 percent significance level with infant mortality is summarized in **Table-6**

Table-6: Regression Ouput

Variables	Unstandardized β-Coefficients	Std. Error	Standardized β-Coefficients	t-Values	Significance Level.
(constant)	112.636	28.509	-	3.951	0.000
Total Fertility Rate	10.785	4.650	0.438	2.319	0.026
Pop.Growth Rate	-20.575	9.742	-0.273	-0.112	0.042
Contraceptive Use	-0.790	0.264	-0.411	-0.987	0.005
Undernutrion	0.525	0.186	0.254	2.819	0.008
Healthcare Services	-0.318	0.150	-0.210	-0.122	0.041

Note: Dependent: Infant Mortality Level

The layout of the linear multiple relationship between the dependent and independent variables can, therefore, be expressed as follows:

IMR = 112.6 +0.438(TFR) – 0.273(Popgrowth rate) -0.411 (contraceptive)
+ 0.254 (underrnutrition)-0.210 (healthcare).

ie., IMR=112.6 + 0.438X_2.– 0.273 X_4 + 0.254 X_7 – O.411X_5 -0.210 X_8

Of all the independent variables in the regression model, the total fertility rate **(positively)** and family planning services **(negatively)** appear to have considerable influences on infant mortality conditions at 5 percent significant level, while others, in ascending order of importance, are population growth rate, undernutrition and healthcare services **(refer toTable-6)**

Model Summary

[1]**Definition of 'Multicollinearity':**

In statistics, the occurrence of several a multiple regression model are closely correlated to independent variables in one another. Multicollinearity can cause strange results when attempting to study how well individual independent variables contribute to an understanding of the dependent variable. In general, multicollinearity can cause wide confidence intervals and strange P values for independent variables.

This problem was overcome by introducing ***" enter"*** and ***"Stepwise"*** techniques of model selection in regression analysis. Accordingly, out of the fourteen assumed explanatory variables of infant mortality, only five were screened to have significant influence at 5 percent level. These variable were found to be Total Fertility Rate**(positive effect),** undernutrition **(positive),** level of contraceptive use **(negative effect)**, population growth rate **(negative)** and the level of healthcare services **(negative effect).** This means that the variables whose β-coefficients are positive can induce infant mortality to increase, while those with negative would tend to decrease infant mortality, though the negative β-coefficient with respect to healthcare services doesn't conform the statistical standard interpretation, being strictly interpreted as ***" low healthcare services would be followed by a decline in infant mortality"***, which sounds unexpected, because low health service is expected to be followed by high infant mortality level .

The collective effects of the independent variables on infant mortality level is reflected by a parameter designated as R^2, which is termed as the coefficient of determination. It measures the magnitude of variability in the dependent variable that is explained by the independent variables entered in the model. If this number is large, it suggests a substantial collective predictive ability
of the independent variables on the dependent variable. Normally, the R^2 increases as we add any independent variables to the model.

However, referring to **Table-7**, the increase in the number of independent variables doesn't change the value of R^2. In fact, we can see that the adjusted R^2 of the five independent variables is generally higher than the rest. Looking at the model summary, the adjusted R^2 of the five selected variables is 0.766. This suggests that *total fertility rate, population growth rate, contraceptive use, undernutrion and healthcare services collectively* explain about 77 percent of total variations in infant mortality which stands at about 113 per 1000 live births (refer to **Table-7).**

This problem was overcome by introducing " enter" and "Stepwise" techniques of model
selection in regression analysis. Accordingly, out of the fourteen assumed explanatory variables of infant mortality, only five were screened to have significant influence at 5 percent level. These variable were found to be Total Fertility Rate(positive effect), undernutrition (positive), level of contraceptive use (negative effect), population growth rate (negative) and the level of healthcare services (negative effect). This means that the variables whose β-coefficients are positive can induce infant mortality to increase, while those with negative would tend to decrease infant mortality, though the negative β-coefficient with respect to healthcare services doesn't conform the statistical standard interpretation, being strictly interpreted as " low healthcare services would be followed by a decline in infant mortality", which sounds unexpected

***Table-7: Model Summary*:**

Number of Variables	R	R^2	Adjusted R^2	Std.Error	IMR
14	0.922	0.850	0.766	17.28	232.00
10	0.901	0.811	0.748	17.71	123.37
9	0.900	0.811	0.756	17.43	125.45
8	0.899	0.809	0.761	17.25	133.27
7	0.898	0.806	0.765	17.10	151.31
6	0.896	0.803	0.770	16.79	151.02
5	0.891	0.794	0.766	16.93	112.64

Analysis of Variance (ANOVA):

The summary results of ANOVA are presented in **Table-8.** Although all the seven models have significant variations of infant mortality level, the last model of five variables has the highest impact of the rest. For example, the ratio of ***computed F-value*** to the ***tabulated F*** is about 12 as compared with about 6 for the model of 14 variables, 7 for 10 variables etc (refer to Table-8).

Table-8: ANOVA-Summary Result

Number of Variables	*Computed F*-Statistic*	*Tabulated F**-Statistic*	*Degrees of Freedom*	*Significance*	*Ratio: F*/ F***
14	10.1	1.7	(14, 574)	0.000	5.9
10	12.9	1.8	(9, 369)	0.000	7.2
9	14.8	1.9	(8, 328)	0.000	7,9
8	16.9	2.0	(7, 287)	0.000	8.5
7	19.6	2.1	(6, 246)	0.000	9.3
6	23.8	2.2	(5, 208)	0.000	10.8
5	27.8	2.4	(4, 164)	0.000	11.6

5. Conclusion and Recommendations :

The main reasons for high Infant Mortality Level are noted to be largely due to the widespread poverty conditions and low level of health services in rural Sub-Saharan Africa. This induces high infant mortality, for women tend to increase their fertility performance in order to compensate the high infant mortality, termed as *" replacement effects".* The reciprocal relationship between high infant mortality and high fertility levels has been such that fertility tends to be superior to the level of infant mortality and follows by relatively high survivors which results again having a youthful population, leading to high dependency ratio (burden) on the productive and reproductive segments of the population as well as producing high growth potentials for subsequent years with significant detrimental effects on developmental endeavours.

African States had expected that the implementation of the 1980's initiated Macro-Level Economic Structural Adjustment Programmes of the World Bank/IMF, environmental management and the political democratization would influence the demographic structure, particularly infant mortality and general mortality conditions of the African populations. However, the situation of most Sub-Saharan African Countries has continued to deteriorate. Consequently, the governments were obliged to enter external bilateral and multilateral borrowing agreements.in order to improve their socio-economic development, particularly to alleviate the prevailing deep-rooted poverty. Instead, almost all SSA countries were eventually trapped by huge quagmire of international indebtedness which aggravated their social and economic hardships and abject poverty which resulted in a *" vicious circle of poverty".* These situations continued inducing mortality levels, particularly infant mortality to remain persistently high.

To make living conditions worst for the populations, the Sub-Continent has been encountered by HIV /AIDS pandemic since the late 1980's. The prevalence and incidence rates of the pandemic and its intimacy with other "opportunistic illnesses " and STD's has appeared to increase and spread quickly, with no sign of slowing down, with narrowing trends in the gap between urban and rural prevalence levels in the countries. Nowadays, every SSA country has been experiencing the effects of the pandemic in varying degrees .

The formulation and implementation of family planning and explicit/ implicit population policies in many SSA countries were expected to mediate any unhealthy demographic dynamics with particular reference to mother and child health (MCH) in the Sub-continent. But, the performance of the programmes remained to be deplorably very low due to the backwardness in all walks of life of the African Societies. Consequently, mortality levels in all segments of the African populations have remained high with high variations among the countries, ranging from 51 infant deaths per 1000 live-births for South Africa to as high as 158 per 1000 live-births in Niger, against maternal mortality, ranging from about 230 per 100,000 live births for South Africa to 1500 per 100,000 in Mozambique. Similarly, childhood mortality, inclusive of infant deaths, reported to range from 52 per 1000 under-five children for Botswana to 275 per 1000 population of the same age ranges for Mozambique.

In order to pinpoint the most important covariates of infant mortality and summarize the same for policy actions, we carried out rigorous analysis applying appropriate statistical analytical models. Among the likely socio-economic and demographic covariates of infant mortality were *life expectancy at births; total fertility rate per woman; ideal number of children to be born by women in the childbearing age; population growth rate; contraceptive prevalence; breastfeeding; undernourishment; healthcare Services; non-existence of pure drinking water for households; female illiteracy rate; level of urbanization; per capita income; human development index; and.human poverty index.* Although all these variables have relative contributions to increase or decrease infant mortality levels in the countries, the degree of their enhancement or depression in infant mortality levels doesn't appear to be significant, except for contraceptive use(negatively); undernutrition (positively); total fertility rate (positively); healthcare services (negatively); and population growth rate (negatively), which appeared to be powerful at 5 percent statistical significance level.

The high infant mortality followed by its direct reciprocal relationship, particularly the positive correlation with fertility and undernutrition, appear to be serious . As the level of infant mortality currently holds in Sub-Saharan Africa., the Millennium Development Goal with respect to infant and childhood mortality (i,e., MDG 4 and 5) by the year 2015 appear to be ambitious unless every SSA state gives high priority to poverty alleviation policies and programmes.

Thus, efforts to reduce poverty, including to reduce /cancel external indebtedness in the Sub-Continent and the struggle towards sustainable development would focus on the following issues:

mediate the high infant mortality conditions and high population growth momentum ;

- ❖ intensify combating HIV/AIDS pandemic and its opportunistic illnesses and other tropical diseases thereby increasing the life expectancy of the African peoples by mobilizing all concerned bodies and resources at all levels;
- ❖ efforts to cancel "Debt Service Payments" which has been dwarfed development. assistance inflows during the past years.

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Annex-A: List of Sub-Saharan African countries by corresponding response variable (MR) and predictor variables (demographic and Socio-economic factors)

Country	IMR	E^0_0	TFR	Ideal	Pop r %	Contra. %	Breast Feed %	Undernur. %	Health Serv.%	No pure water %
Angola	154	40.1	7.2	5.0	2.9	8	93	50	30	62
Benin	94	50.6	5.7	5.7	2.7	19	89	14	18	37
Botswana	80	39.7	3.7	5.7	2.3	40	90	25	89	15
Burkina-Faso	104	45.7	6.7	6.0	3.0	12	98	32	90	40
Burundi	114	40.9	6.8	6.1	2.4	9	92	69	80	55
Cameroon	96	46.1	4.6	2.6	2.8	19	95	29	70	38
Cape Verde	29	70.2	3.3	6.6	2.2	53	95	35	90	26
C.A.R	115	39.5	4.9	8.5	2.0	15	93	41	45	40
Chad	117	44.7	6.7	5.4	2.9	8	91	38	30	73
Comoros	59	60.8	4.9	5.2	2.8	21	87	35	82	4.
Congo	81	41.8	6.3	5.3	2.9	20	89	32	70	55
Cote d'voire	102	41.0	4.7	5.1	2.5	15	81	14	30	23
Equatorial	101	49.1	5.9	5.6	2.6	20	75	25	75	57
Ethiopia	116	45.5	6.1	5.3	2.9	8	96	44	46	76
Gabon	60	56.6	4.1	5.2	2.0	33	81	8	90	30
Gambia	91	54.1	4.7	4.3	2.3	10	76	16	93	38
Ghana	57	57.9	4.1	6.4	2.2	22	92	10	60	36
Guinea	109	49.1	5.8	5.1	2.7	6	70	29	80	52
Guinea-Bissau	130	45.3	7.1	3.8	3.0	8	100	39	40	51
Kenya	78	44.6	4.1	3.5	2.8	39	92	44	77	51
Lesotho	91	35.1	3.8	5.3	2.1	30	90	26	80	9
Madagascar	84	53.6	5.7	5.1	2.8	19	95	40	65	53
Malawi	114	37.5	6.1	6.3	2.9	31	82	76	80	43
Mali	141	48.6	7	6.4	3.2	8	95	32	30	35
Mauritania	120	52.5	5.8	5.8	2.8	8	82	12	63	63
Mauritius	17	72.0	1.9	5.9	1.4	75	55	5	100	0
Mozambique	125	38.1	5.6	5.1	2.4	6	93	55	39	40
Namibia	55	44.3	4.6	8.4	2.3	29	86	9	62	23
Niger	156	46.2	8	6.2	3.3	14	80	46	32	41
Nigeria	110	51.5	5.4	4.6	2.5	15	95	8	64	43
Rwanda	96	39.3	5.7	5.4	2.2	13	97	23	80	59
Senegal	79	52.9	5.0	4.9	2.5	13	91	25	40	22
Seychelles	13	75.0	1.8	1.5	1.3	83	55	0	99	25
Sierra Leone	182	74.2	6.5	2.8	2.0	4	78	43	38	72
South Africa	56	47.7	2.6	2.0	2.0	56	87	24	92	14
Swaziland	106	34.4	4.5	5.6	2.1	21	87	12	55	17
Tanzania	104	43.3	5.1	4.6	2.6	25	90	47	80	46
Togo	79	49.7	5.3	5.1	2.4	24	87	18	61	46
Uganda	79	46.2	7.1	4.8	3.1	23	88	21	49	50
Zaire	129	38.1	6.7	5.3	3.0	8	99	32	26	55
Zambia	112	32.4	5.6	3.9	2.7	25	99	50	75	36
Zimbabwe	76	33.1	3.9	3.9	1.6	54	91	38	61	15

Annex-A: List of Sub-Saharan African countries by corresponding response variable (MR) and predictor variables (demographic and Socio-economic factors): *CONTINUED*

Country	Female Lit. %	Urban Pop.%	Log (GDR)	HDI	HPI %

Angola	**42**	**34.8**	**3.31**	**0.42**	**35.3**
Benin	**23.6**	**43**	**2.99**	**0.42**	**45.8**
Botswana	**79.8**	**49.4**	**3.89**	**0.58**	**25.4**
Burkina-Faso	**14.1**	**16.9**	**3.o5**	**0.32**	**44.9**
Burundi	**40.4**	**9.3**	**2.84**	**0.31**	**50.9**
Cameroon	**69.5**	**49.6**	**3.23**	**0.51**	**31.1**
Cape Verde	**65.7**	**63.3**	**3.75**	**0.71**	**28.9**
C.A.R	**34.9**	**41.7**	**3.11**	**0.37**	**46.1**
Chad	**34**	**24.2**	**3.03**	**0.36**	**53.1**
Comoros	**48.7**	**33.8**	**3.27**	**0.51**	**29.9**
Congo	**74.4**	**66**	**2.99**	**0.43**	**40.2**
Cote d'voire	**38.6**	**44**	**3.17**	**0.43**	**42.9**
Equatorial	**74.4**	**49.2**	**4.18**	**0.61**	**39.9**
Ethiopia	**30.9**	**15.9**	**2.91**	**0.32**	**57.2**
Gabon	**71**	**82.1**	**3.77**	**0.62**	**24.9**
Gambia	**29.4**	**31.2**	**3.31**	**0.40**	**49.6**
Ghana	**62.9**	**36.4**	**3.35**	**0.54**	**29.1**
Guinea	**41**	**27.9**	**3.29**	**0.40**	**40.9**
Guinea-Bissau	**23.3**	**32.3**	**2.99**	**0.34**	**49.6**
Kenya	**76**	**34.3**	**2.99**	**0.52**	**31.8**
Lesotho	**93.6**	**28.7**	**3.38**	**0.54**	**25.8**
Madagascar	**59.7**	**30.1**	**2.92**	**0.46**	**38.6**
Malawi	**46.5**	**15.1**	**2.76**	**0.40**	**43.4**
Mali	**34.4**	**30.8**	**2.91**	**0.38**	**47.8**
Mauritania	**30.1**	**59**	**3.30**	**0.44**	**47.2**
Mauritius	**81.3**	**41.6**	**3.99**	**0.77**	**11.5**
Mozambique	**28.7**	**33.2**	**3.06**	**0.32**	**48.3**
Namibia	**81.2**	**34.1**	**3.85**	**0.60**	**34.5**
Niger	**8.4**	**21**	**2.95**	**0.27**	**63.6**
Nigeria	**55.7**	**44.8**	**2.93**	**0.46**	**36.1**
Rwanda	**60.2**	**6.3**	**3.10**	**0.40**	**44.2**
Senegal	**27.6**	**48.1**	**3.18**	**0.42**	**45.9**
Seychelles	**91**	**64.5**	**4.23**	**0.71**	**29.9**
Sierra Leone	**36**	**37.3**	**2.67**	**0.26**	**60.2**
South Africa	**84.6**	**57.6**	**4.05**	**0.70**	**33.2**
Swaziland	**78.6**	**26.7**	**3.64**	**0.58**	**26.8**
Tanzania	**66.5**	**33.2**	**2.72**	**0.44**	**32.4**
Togo	**42.5**	**33.9**	**3.22**	**0.49**	**38.3**
Uganda	**56.8**	**14.5**	**3.17**	**0.44**	**41.2**
Zaire	**50.2**	**29**	**2.83**	**0.43**	**40.2**
Zambia	**71.5**	**39.8**	**2.89**	**0.43**	**40.3**
Zimbabwe		**36**	**3.36**	**0.55**	**36.2**