

IDENTIFYING CRITICAL PROXIMATE DETERMINANTS OF MATERNAL MORTALITY IN SUB-SAHARAN AFRICA: A CROSS-COUNTRY ANALYSIS

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Abstract

Maternal mortality in developing countries is affected by complex socio-economic and cultural variables whose individual impact is difficult to isolate. The main thrust of this paper is to examine the relative contributions of some of selected proximate variables to the level of maternal deaths in Sub-Saharan Africa (SSA). Dictated by the availability of data, these factors are measured by varying proxy variables and analysed using relevant a multiple linear regression of the Ordinary Least Square (OLS) method. To standardise the data obtained from various statistical reports, data were transformed to log base 10 with a view to reducing absolute values to same units. The result shows that contraceptive use, births attended by skilled personnel and proportion of women reporting anemia are critical in the occurrence of maternal deaths. The study underscores the fact that the use of contraceptives must be emphasised as a critical family planning programme so as to reduce the number of women at risk during pregnancy, among other suggestions.

Keywords: MMR, Fertility, Sub-Saharan Africa, Anemia, proximate determinants.

Background

Adult death represents about three quarters of all deaths that occur globally. Up to 76.5 percent of these deaths occurred in developing countries in 1993 (WHO, 1995). This shows that poor countries had three times more deaths than rich ones. Of all these deaths, communicable and respiratory diseases, maternal, Perinatal and neonatal conditions account for about 40 percent of global deaths; 99 percent of these are also

in developing world (WHO, 1995). Hence, up to half a million women die annually as a result of complications either during pregnancy or childbirth. Mortality from this source is also not evenly distributed in all world nations and regions as some regions carry heavier burdens than others. For instance, in the year 2000, 95 percent of all deaths from this source occurred in Asia and Sub-Saharan Africa alone with about 253 000 and 251 000 deaths respectively (see Fig

1 below.). Four percent occurred in Latin America and the Caribbean; the remaining 1 percent occurred in all developed countries put together (WHO, 2000). The variation is sharper when viewed against the backdrop that although Asia and Sub-Saharan Africa had almost equal absolute share of the occurrence of maternal mortality, the risks are highest in Africa because of her smaller population compared to Asia. Thus, while there is a 1 in 94 chance of a woman in Asia dying in pregnancy or childbirth in her lifetime, only 1 in 16 of such chances exist for her in Africa. Even in Europe where the chance is 1 in 2 400 pregnant women (Collymore, 2005), women rarely die in pregnancy or through pregnancy related in Sweden as there is only one chance in 29 800 (see WHO, 2003).

More so, the 'critical factors' that determine the safety of mothers and infants and children vary across these regions. For example, up to 35 percent of women in developing countries receive no prenatal care while almost half give birth without skilled attendance, and 70 percent receive no care in the six weeks after delivery (Saving Women's Lives Fact Sheet, 2004). One other factor suspected to contribute to this geographical variation is the average number of children per woman. In Africa, this is close to six while in most parts of Europe, it is less than two (see Ashford and Clifton, 2005). In most cases, major causes of pregnancy related deaths result from excessive bleeding, infections, hypertensive disorder, obstructed labour, or complications from unsafe abortions. However, knowledge of the remote causes of maternal deaths is dearth beyond the above clinical manifestations and obstetric diagnosis. In poor urban communities and remote rural areas of Africa for example, couples may delay their

decision to seek care, spend hours getting to the facility and a long spell to be attended to at the facility. This is also a result of several factors which makes predicting individual instances of these complications difficult even when the United Nation agencies estimate that up to 15 percent of all pregnancies result in complications (WHO, 1994, Collymore, 2005). Among other factors in the high level of maternal mortality in developing countries include limited access to health facilities, lack of skilled personnel, poverty, malnutrition, the low status of women and high illiteracy rates.

The main thrust of this paper therefore is to examine the relative contributions of some of the factors identified above and some others to the level of maternal deaths in Sub-Saharan Africa (SSA). Dictated by the availability of data, these factors are measured by varying proxy variables and analysed using relevant multivariate statistics.

Maternal Mortality in Sub-Saharan Africa: Issues and Challenges

Maternal mortality is a very simple concept to define but with a notoriously complex and difficult measure. Thus reliable estimates of the phenomenon of maternal deaths are generally not available which makes progress assessment difficult. According to WHO/UNICEF/UNFPA (2001), maternal death refers to the "death of a woman while pregnant or within 42 days of the termination of pregnancy, irrespective of the duration or site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes". This definition includes deaths resulting from direct obstetric complications, indirect obstetric deaths resulting from previous existing disease, or disease that developed during pregnancy and which were though not due to direct obstetric causes, but were

aggravated by the physiological effects of pregnancy. It excludes incidental deaths such as which may occur, though during pregnancy or the puerperium but from causes that are not related to the pregnancy. One fact is clear irrespective of the variables and proxies that might have been used to arrive at the maternal mortality figures published for each country and region, that even in the 21st century,

safe motherhood remains elusive for many developing countries. According to Graham and Hussein (2003), “the obstacles to progress in reducing the burden of avoidable maternal mortality... include both old and new challenges”. The older challenges include such factors as the nature of the health systems, prevalence of poverty and low status of women. A major new challenge is the ravaging HIV/AIDS.

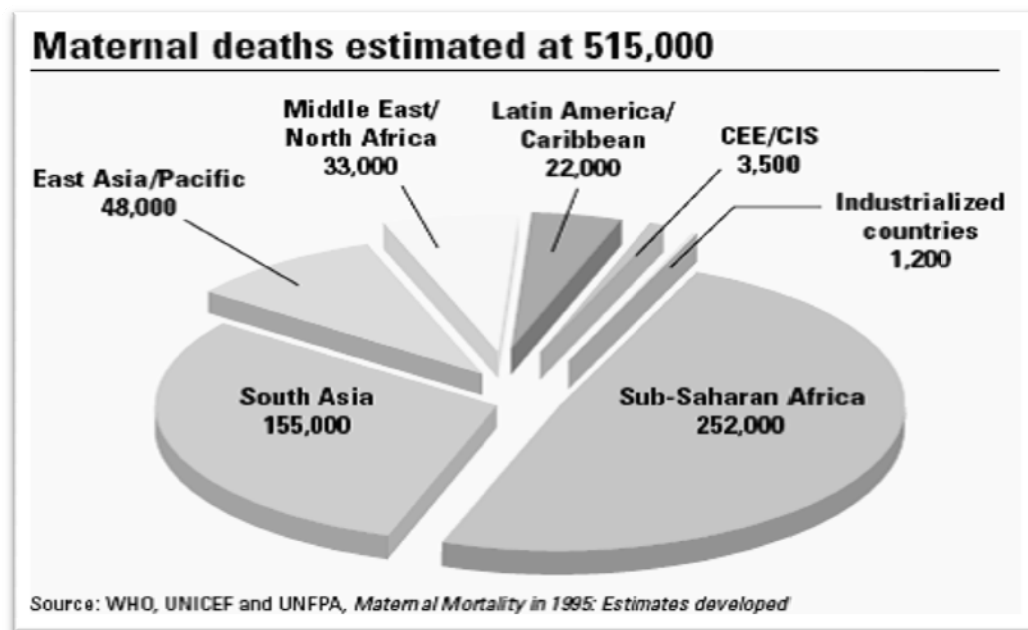


Figure 1: Geographical Pattern of Maternal Mortality.
Source: WHO, (2000).

The array of old challenges subsist due to the importance attached to fertility among men and women particularly in Africa. More often, fertility is allowed to take natural course without deliberate control either through abortion or contraceptive practice. In a woman's life course, pregnancy is expected each time there is mating even when such expectation also could amount to attempted suicide. Thus reproduction is only regulated by biological factors as age,

fecundability, the time required for gestation, miscarriages and postpartum amenorrhea. Demographers have also recognised the influence of social and behavioural factors like marriage patterns, duration and intensity of breastfeeding as well as cultural/ religious rules for sexual behaviour. Some of these and related factors are contained in Bongaarts' (1982) framework which attempts to quantify the effects of seven proximate determinants of

fertility; namely the proportion of women of reproductive age who are married, the use and effectiveness of contraception, induced abortion, postpartum infecundability, the frequency of intercourse and the onset of permanent sterility (menopause). These factors are collapsed into exposure factors, deliberate marital control, and natural marital control factors.

The aggregate opinion in empirical research is to the effect that the factors having the strongest effect on levels and differentials in fertility are proportion of women married (exposure to intercourse), contraceptive practices (exposure to contraception), abortion and postpartum infecundability (duration of postpartum amenorrhoea being a measure of exposure to contraception) (see Davis and Blake, 1956, Bongaarts, 1982, Reinis, 1992, Cleland, 2001). The fertility background to maternal deaths as provided is crucial so as to underscore the fact that as long as the phenomenon of fertility is treated as sacred and as a lifetime desire of couples and singles in any society, 'accidents' from such practice - miscarriages, still birth, and maternal deaths - may be taken for granted as inevitable companions, even if tragically. The tendency is that fertility is left at its natural state uninterrupted through deliberate controls of induced abortion or contraceptive use (Graham and Hussein, 2003). Thus, natural fertility in this paper is treated as one of the critical variables that may pose significant influence on the rate and pattern of maternal mortality. This also gives credence to our a priori expectation that a direct and positive relationship exists between total fertility in any country and the number of maternal deaths in such country.

Another opinion prominent in the social scientific research on fertility and maternal mortality is the child survival hypothesis. Often, families require specific number of children rather than number of births. If the postulations of the demographic transition were regarded as sufficient explanations, then fertility becomes a function of child mortality; i.e. how many of the number of births survive? If on comparison, the numbers of survival lag behind the intended number of births, couples are likely to increase the number of births thus, increasing the exposure to maternal death (see Scrimshaw, 1978; Preston, 1978). This also justifies the inclusion of infant and child mortality as one of the critical factors in this paper.

Maternal mortality has thus become an issue for concern on the international health agenda. The issue has aroused both policy and scholarly attention over the years. For instance, the Platform for Action of the United Nations' Fourth World Conference on Women, Beijing, calls for a strengthening of efforts to achieve the goal of reducing maternal deaths by 50% by the year 2000 and by another one half by the year 2015 (see UN, 1995)

Materials and Method

A number of scholars have tried to examine the proximate determinants of maternal deaths in developing countries (Oxaal and Baden, 1996, Buor and Bream, 2004) and have come to the conclusion that maternal mortality is better understood from the perspectives of the general women's reproductive and sexual rights as well as the complex social, economic, political and cultural factors underlying women's health. It must be noted that the nature of medical complications leading to maternal deaths

may be understood, the underlying social, cultural and economic milieu under which maternal morbidity and hence deaths occur are poorly understood and acknowledged. This study relies on secondary analysis of existing data obtained from the UNDP, World Bank and other similar reports of various years. Based on a cross-country data obtained from these sources, the study designed a regional model that used maternal mortality ratio (MMR) as the dependent variable and selected social, demographic and economic variables as independent variables. The variables were selected following the framework proposed by McCarthy and Maine (1992). The framework proposed that maternal mortality operates through three outcomes namely;

- The likelihood that a woman gets pregnant;
- Likelihood that a woman will experience serious complications of pregnancy and childbirth; and
- The outcome of the complications for women.

Analytical variables were thus selected to capture several intervention variables that may produce substantial and immediate effects by intervening in the morbidity process or by ensuring safe delivery. Hence, nine variables were used for the study based on the above. These are contained in table 1 below:

Table 1: Selected Determinants of Maternal Mortality in Sub-Saharan Africa.

SN	Variable name	Definition and measurement
	Maternal Mortality Ratio (Y)	Ratio of the number of maternal deaths to the number of live births in a given year expressed per 100 000 live births.
1	Prevalence of Contraceptive use (X ₁)	Percentage of women of reproductive age 15-49 who are using, or whose partners are using any modern or traditional form of contraceptive
2	Population below poverty line (\$1.25 a day) (X ₂)	Percentage of the population the international poverty line of \$1.25 in purchasing power parity terms a day.
3	Clean Energy Use(X ₃)	Percentage of households using clean energy for cooking food.
4	Adolescent Fertility Rate(X ₄)	Number of birth to the women aged 15-19 yrs per 1000 women aged 15-19 yrs.
5	Births attended by skilled personnel (X ₅)	Percentage of deliveries attended by personnel including doctors, nurses and midwives trained to give the necessary care, supervision and advice to women during pregnancy, labour and post-partum; to conduct deliveries on their own and to care for newborns.
6	Antenatal Visit (X ₆)	Percentage of women who used antenatal care provided by skilled health personnel for reasons related to pregnancy at least once during pregnancy, as a percentage of live births.

7	Years of Schooling (X ₇)	Average number of years of education received by people aged 25yrs and older converted from education attainment levels using official duration of each level.
8	Prevalence of Anemia (X ₈)	Percentage of pregnant women aged 15-49 yrs with anemia.
9	Intensity of deprivation (X ₉)	Defined as the average percentage of deprivation experienced by people in multidimensional poverty

Source: UNDP Reports, 2011

Table 2 below is a summary of the information for twenty five SSA countries.

Countries	MMR	Contraceptive prevalence	population below Poverty line \$1.25	% of clean energy used	Adolescent FR	% of Birth attended to by skilled staff	Prevalence of Anemia % Women	Mean years of Schooling	At least one Antenatal Visit	Intensity of Deprivation
Angola	610	2.1	54.3	7.6	171.1	47	57	4.4	80	58.4
Benin	410	17	29	0	111.7	74	73	3.3	84	57.4
Bolswana	190	23.9	47.3	0	52.1	77	21	8.9	94	44.4
Cameroun	600	29	32.8	4.5	127.8	63	51	5.9	82	53.9
CAR	850	19	62.4	2.4	106.6	53	33	3.5	69	59.3
DRC	670	71.3	59.2	3.9	201.4	74	67	93.5	85	53.7
Cote D'ivoire	810	13	23.3	1.8	129.4	57	55	3.3	85	57.4
Guinea Bissua	1000	54.3	38.4	1.4	111.1	42	58	2.3	67	61.3
Ethiopia	470	4	39	1.3	72.4	6	63	1.5	28	63.5
Garbon	260	12	4.8	4.4	89.9	32	46	7.5	94	45.5
Ghana	350	13	30	5.1	71.1	50	65	7.1	90	46.2
Kenya	530	27	19.7	5.9	104.2	42	47	7	92	48
Lesotho	530	23	43.4	2.5	73.5	55	25	5.9	92	44.1
Madagascar	440	17	67.8	3.2	134.3	51	50	5.2	86	53.3
Mauritius	336	75	10	14.4	35.4	22	22	7.2	76	62.3
Mozambique	550	58.7	74.7	14.4	149	48	52	1.2	92	64.6
Nambia	180	29	49.1	8.8	74.4	81	31	7.4	95	47.2
Nigeria	840	6	64.4	0.6	118.3	35	38	5	58	57.3
Senegal	410	42	33.5	0.7	105.9	52	58	4.5	87	57.4
S/Africa	410	57	26.2	2.7	69.2	92	22	8.5	92	42.3
Tanzania	790	10	88.5	0.6	130.4	43	58	5.1	76	56.3
Togo	350	34	38.7	0.3	65.3	62	50	5.3	84	52.4
Uganda	430	5	51.5	1.4	149.9	42	41	4.7	94	50.7
Zimbabwe	790	43	66.5	5	64.6	69	40	7.2	93	45.3
Zambia	470	15	64.3	11	146.8	43	41	6.5	94	51.2

Source: UNDP, 2008, 2011.

Model Specification

Using a multiple regression analysis of the Ordinary Least Square (OLS) the study hypothesised that maternal mortality is a function of surrogate variables in the social, economic, political and cultural environments which are measured by selected proxies. The OLS regression method is specified as follows:

MMR = *f* (critical Social, economic, political and cultural factors).....(1)

By substituting variables defined in Table 1 into equation 1

Critical factors = $f(X_1-X_{10})$ (2)

Again substituting equation 2 into equation 1

MMR = $f(X_1-X_{10})$ (3)

Using this for a multiple linear regression model:

MMR = $a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + \dots + \theta$ (4)

Where

MMR = maternal mortality Rate

X_1-X_9 = variables defined in table 1

θ = extraneous residual error term indicating variables not captured in the model.

To standardise the data obtained from various statistical reports, data were transformed to log base 10 with a view to reducing absolute values to same units. The result was fed into a regression model in order to reflect the explanatory nature of each of the variables. The study adopts two estimation criteria to verify the validity of the model. The first is the a-priori expectation criterion which expresses the expected behaviour of each variable in real life and in relation to maternal mortality. In other words, the higher the deprivation suffered by pregnant women or with increasing number of pregnant women reporting anemia the higher is the maternal

mortality expected to increase. This is also expected for adolescent fertility rate and population below poverty line. All these variables are expected to show positive signs in the regression outcome. On the other hand, birth attended by skilled staff, use of clean energy, antenatal visits and mean schooling years are expected to show negative values on the regression outcome because their impact are expected to reduce maternal mortality; *ceteris paribus* ($\chi_1, \chi_3, \chi_5, \chi_7, \chi_8 < 0$ while $\chi_2, \chi_4, \chi_6, \chi > 0$).

The second estimation criterion is the First Order Least Square Test (OLS) which consists of the R^2 , F-statistics and T-test. The R^2 is the overall explanatory power of the variables; the F-statistics is used to test overall significance of the regression model while T-test is used to test the significance of the contribution of each of the independent variables on the dependent variable (Green, 2003, Ijaiya, et al 2009). A 5% level of significance is adopted for the test.

Results and Discussions

The results of the analysis shows that the variation in the dependent variable (maternal mortality) explained by the totality of independent variables in the model is 58% ($R^2=0.58$) while about 42% of maternal mortality is not captured by the model. This proportion forms the residual explanation that may be obtained from further studies. At 5% significant level, the F-statistics shows that the model is useful in determining whether our selected variables have significant influence on the maternal mortality as the F-calculated is greater than the table value of F ($F_{-cal} 2.42 > F_{-tab} 1.67$).

The coefficient estimate of the independent variables also fulfilled the a-priori expectation on the behaviour hypothesised

for them. For instance, contraceptive use, clean energy use, birth attended by skilled staff and mean schooling years showed inverse relationship with maternal deaths. Similarly, adolescent fertility rate and prevalence of anemia were shown to possess positive linear relationship with maternal deaths. In three variables, namely;

our two measures of poverty-population below poverty line and population in intense deprivation as well as proportion of pregnant women using antenatal at least once during pregnancy or for child birth contradicted the a-priori expectation on them (see Table 3).

Table 3: Regression Summary of Proximate Determinants of Maternal Mortality in Sub-Saharan Africa.

<i>Variables</i>	<i>Coefficients Estimates</i>
<i>Intercept (t)</i>	<i>2.18 (2.82)</i>
<i>Contraceptive use (X₁)</i>	<i>-0.51 (0.06)</i>
<i>Population below Pov Line (X₂)</i>	<i>-0.49 (-0.92)</i>
<i>Clean Energy (X₃)</i>	<i>-0.17 (1.54)</i>
<i>Adolescent fertility Rate (X₄)</i>	<i>0.32 (1.69)*</i>
<i>Birth attended by skilled staff (X₅)</i>	<i>-0.73 (-0.88)*</i>
<i>Prevalence of Anemia (X₆)</i>	<i>0.57 (-2.03)*</i>
<i>Mean Schooling year (X₇)</i>	<i>-0.63 (-1.85)*</i>
<i>Antenatal Visit (X₈)</i>	<i>0.23 (0.68)</i>
<i>Intensity of Deprivation (X₉)</i>	<i>0.05 (-0.44)</i>
<i>R-Square</i>	<i>0.58</i>
<i>Adjusted R²</i>	<i>0.20</i>
<i>F-Calculated</i>	<i>2.42</i>
<i>F-tabulated</i>	<i>1.67</i>

(t-Values in Parentheses)*Significant at 5% Level

The finding in this study that contraceptive use has a tendency to steam down on maternal mortality corroborates earlier studies by USAID (2008) and Stover and Ross (2010) that suggested that family planning contributes to reducing maternal mortality through the pathway of reducing the number of births that expose women to mortality risks. This study predicts a 51% reduction in maternal mortality that may be associated with contraceptive use. In other words, increase contraceptive use may help

in reducing at-risk births, particularly high parity births that are associated with high risk of maternal deaths. Moreover, the inverse correlation obtained in the study for clean energy use and maternal mortality ($r=-0.17$) is justified when viewed against the backdrop that women are disproportionately affected by Indoor Air Pollution, lack of clean energy for daily household chores and major contributors to poor maternal health in both rural areas and native areas of African cities. This is because in Africa, women, including the

pregnant ones are exposed to large amounts of smoke and particles from indoor fires resulting in a number of respiratory diseases (Gender and Energy, 2000 and Hunter, 2008). This study found a 73% association between maternal mortality rate and the number of births attended by skilled health personnel. UNICEF (2011) also indicated that insufficient maternal care during pregnancy and delivery is largely responsible for a significant proportion of maternal deaths.

Prevalence of anemia may be directly related to 57% of maternal deaths ($r=0.57$) in SSA. This is consistent with the work of Brabin et al. (2001) which also found a correlation of 51% which was also found to be significant at 1% between anemia and maternal mortality. It is important that their study (Brabin et al.) cautioned on the possibility of obviating household level reality because of the impression conjured by a large number of data points from a cross country data. Moreover, it is also recognised that the impact conveyed by prevalence of anemia may have been reinforced by the autocorrelation of many other variables outside the model including prevalence of malaria, poor obstetric care, geographic access to maternal care, among other confounders of maternal health. Nevertheless, the association obtained in this study is of interest for its value in national programmes aimed at reducing maternal deaths.

The study found that maternal mortality may be reduced by up to 63% depending on the number of years of education received by women. Earlier, Karlsen, et al. (2011) also found that compared with women that have 12 years of education, women without education are 2.7 times as likely to die from pregnancy or pregnancy related ailment while those with one and six years of

education are 2 times as likely. This shows that maternal mortality is likely to reduce as female education increases. This includes education of the girl child and improved maternal education.

The proportion of women with at least one antenatal visit during pregnancy or child birth did not fulfill our a-priori expectation of the behaviour of this variable with respect ($r=0.23$). This result shows a positive relationship between this variable and maternal mortality whereas an inverse relationship was expected. This probable reason may be related to the quality of care at the antenatal clinics as well as the frequency and duration and number of visits. The WHO (2011) puts this simply that “receiving antenatal care during pregnancy does not guarantee the receipt of interventions that are effective in improving maternal health”. Moreover, the WHO recommends at least ‘four times’ antenatal visits whereas the information available for this analysis was the proportion of pregnant women who visited antenatal clinic at least once during pregnancy or for childbirth.

Conclusions

This paper canvasses, through a multivariate analysis of proximate variables, for the understanding of the critical factors determining maternal mortality in SSA. This was to identify variables that can be emphasised in the effort to reducing maternal mortality. The results indicate that maternal mortality operates within a complex social and cultural environment that may be difficult to be isolated. With this complexity however, the study underscores the fact that the use of contraceptives must be emphasised as a critical family planning programme so as to reduce the number of women at risk during pregnancy. Aside this,

two most critical interventions for safe motherhood are to ensure care during delivery by skilled health personnel and refer the mother for emergency care as needed. Skilled health workers must be able to handle deliveries safely and recognise the onset of complications which are beyond their capacity. This is because complications during pregnancy and childbirth are the leading cause of death and disability among women of reproductive age in developing countries, killing more than 500 000 women each year (WHO, 1995). Finally, expansion of female education, improved financial

access for women and the poor are essential to reducing maternal mortality. This is also canvassing for a greater focus on processes of decision making for reproductive health behaviour, access to maternal health care and services as well as a consideration of household and community power relations in terms of women education and economic independence. The pathways to these are complex and daunting but achievable in the face of a decisive government with adequate political will in a corruption free policy environment.

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