

Maternal Mortality in Nigeria: Examination of Intervention Methods

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Abstract

Nigeria has been mentioned by the United Nations as having one of the highest rates of maternal mortality in the world. Reducing high maternal mortality ratio is not just a technical and medical challenge but largely a political one which requires the attention and commitment of political leaders. This study brought together some of the determinants of maternal mortality mentioned in extant literature and used simultaneous multiple regression on fourteen variables for maternal mortality modelling in Nigeria. Stepwise regression was then applied to identify, from among the fourteen variables, the major determinant factors that appear to affect maternal mortality ratio more than the others. Narrowing down attention to a small number of the major determinants of high maternal mortality should help gain the focused attention of government since maternal mortality is just one among hundreds of issues competing for the attention of political leaders at any given time. Data on the 36 states of the federation and the FCT Abuja was obtained from the Nigeria Demographic and Health Survey 2008, the Annual Abstract of Statistics of the National Bureau of Statistics and the Society of Obstetrics and Gynaecology of Nigeria. The study found that delivery by a skilled health professional and educational attainment of women had more effect on maternal mortality ratio than the other factors. The implication of this finding is that advocates of maternal mortality reduction in Nigeria will need to focus more attention on developments in the educational sector and not just on making direct improvements to the healthcare system.

Keywords: maternal mortality, stepwise regression, maternal mortality ratio.

1. Introduction

Maternal mortality, also known as maternal death, continues to be the major cause of death among women of reproductive age in many countries and remains a serious public health issue especially in developing countries (WHO, 2007). As explained in Shah and Say (2007), a maternal death is defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. Globally, the estimated number of maternal deaths worldwide in 2005 was 536,000 up from 529,000 in 2000. According to the WHO Factsheet (2008), 1500 women die from pregnancy or pregnancy-related complications every day. Most of these deaths occur in developing countries, and most are avoidable. Of all the health statistics compiled by the World Health Organization, the largest discrepancy between developed and developing countries occurred in maternal mortality. Ujah et al. (2005) noted that while 25 percent of females of reproductive age lived in developed countries, they contributed only 1 percent to maternal deaths worldwide. A total of 99 percent of all maternal deaths occur in developing countries. More than half of these deaths occur in sub-Saharan Africa and one third in South Asia. The maternal mortality ratio in developing countries is 450 maternal deaths per 100,000 live births versus 9 in developed countries. Fifteen countries have maternal mortality ratios of at least 1000 per 100,000 live births, of which all but Afghanistan and India are in sub-Saharan Africa: Afghanistan, Angola, Burundi, Cameroon, Chad, the Democratic Republic of the Congo, Guinea-Bissau, India, Liberia, Malawi, Niger, Nigeria, Rwanda, Sierra Leone and Somalia (WHO, 2008).

Nigeria has one of the highest maternal mortality rates in the world, second only to India whose population is eight times larger than that of Nigeria.

Mairiga et al. (2008) expressed the view that the world's maternal mortality ratio (the number of maternal deaths per 100,000 live births) is declining too slowly to meet Millennium Development Goal (MDG) 5 target, which aimed to reduce the number of women who die in pregnancy and childbirth by three quarters by the year 2015. While an annual decline of 5.5 per cent in maternal mortality ratios between 1990 and 2015 is required to achieve MDG 5, figures released by WHO, UNICEF, UNFPA and the World Bank show an annual decline of less than 1 per cent. Gains in reducing maternal mortality have been modest overall. While average global infant mortality and under five mortality have been reduced by more than half in the past 40 years, and average global life expectancy at birth has increased enormously during the same period there has been no visible progress in maternal mortality (MMR) reduction at the global level. Shah and Say (2007) noted that the trend in developing countries is much worse, as studies from various countries of sub-Saharan Africa indicate that maternal mortality has not only continued to be high, but is indeed increasing after the launch of the Safe Motherhood Initiative (SMI) in Kenya in 1987.

1.2 Maternal Health in Nigeria: The Present Position

Nigeria has one of the worst records of maternal deaths in the world and this situation is worsening with time.

Table 1: Reproductive Health Indicators in Nigeria for the year 2007

Average number of children per woman	6
Maternal deaths per 100,000 deliveries	1100
Antenatal coverage	47%
Institutional delivery	33%
Infant deaths per 1000 births	97
Birth registration	33%

Source: UNICEF.

The problem of poor organization and access to maternal health services has always been a major challenge in Nigeria. Omo-Aghoja et al (2008) asserted that maternity care in Nigeria is organized around three tiers: primary, secondary and tertiary care levels. Primary health centres are located in all the 774 local government councils in the country. Pregnant women are to receive antenatal care, delivery and postnatal care in the primary health centres nearest to them. In case of complications they are referred to secondary care centres, managed by states, or tertiary centres, managed by the federal government.

The Nigerian health system as a whole has been plagued by problems of service quality, including unfriendly staff attitudes to patients, inadequate skills, decaying infrastructures, and chronic shortages of essential drugs. Electricity and water supply are irregular and the health sector as a whole is in a dismal state. In 2000, the World Health Organization ranked the performance of Nigeria's healthcare system 187th among 191 United Nations member states. A 2003 study revealed that only 4.2 percent of public facilities met internationally accepted standards for essential obstetric care (Harrison, 2009). Approximately two-thirds of all Nigerian women deliver outside of health facilities and without medically skilled attendants present. The weak performance of the health system must be understood in the context of the country's long-standing problems with governance. Corruption in the political system is endemic while social development, including the promotion of the health of Nigerian citizens, has been more a rhetorical than a real aim of the state.

1.3 Maternal Health in Nigeria: Historical Perspective

In the 1940s, the Church Missionary Society, the Native Administration and the colonial government undertook to raise the standard of midwifery work in eastern Nigeria. The effort combined community health education on a massive scale with the setting up of maternity homes manned by trained midwives under rigorous supervision. Affordable fees were charged. By 1949, in the 31 maternity homes that handled 6500 deliveries yearly, the maternal mortality ratio became 46 per 100,000 births, comparable to the standard at that time in England and other countries (Harrison, 2009). Also, beginning in 1945, Katsina province in Northern Nigeria ran a reliable system of compulsorily obtaining and keeping records of all births and deaths.

The excellence of the quality of this source of data is attested to by the publication of good papers based on them. Harrison goes on to note that In the Ilesha area of Western Nigeria the Methodist Church of Nigeria introduced the concept of a base hospital with linkages between the base hospital and all the maternity centres in the area at urban and village levels. Close to perfection, it offered a good opportunity for replication in the rest of the country but this did not happen.

1.4 Causes of Maternal Mortality

The WHO Factsheet (2008) indicates that globally, about 80 percent of maternal deaths are due to four major causes- severe bleeding, infections, hypertensive disorders in pregnancy (eclampsia) and obstructed labour. Complications after unsafe abortion cause 13% of maternal deaths. Among the indirect causes of maternal death are diseases that complicate pregnancy or are aggravated by pregnancy, such as malaria, anaemia, hepatitis, anaesthetic death, meningitis, HIV/AIDS, sickle cell anaemia, anaemia and acute renal failure, which could be a complication of eclampsia. Women also die because of poor health at conception and a lack of adequate care needed for the healthy outcome of the pregnancy for themselves and their babies.

Omoruyi (2008) estimated that in Nigeria, more than 70 percent of maternal deaths could be attributed to five major complications: haemorrhage, infection, unsafe abortion, hypertensive disease of pregnancy and obstructed labour. Also, poor access to and utilization of quality reproductive health services contribute significantly to the high maternal mortality level in the country.

As explained in Mojekwu (2005) the causes of maternal deaths can be classified into medical factors, health factors, reproductive factors, unwanted pregnancy and socioeconomic factors. According to the author, medical factors include direct obstetric deaths, indirect obstetric deaths and unrelated deaths. Direct obstetric deaths result from complications of pregnancy, delivery or their management. Indirect obstetric deaths result from worsening of some existing conditions (such as hepatitis) by pregnancy. Health service factors include deficient medical treatment, mistaken or inadequate action by medical personnel, lack of essential supplies and trained personnel in medical facilities, lack of access to maternity services and lack of prenatal care. Other risk factors for maternal mortality in Nigeria include maternal age, illiteracy, non-utilisation of antenatal services and grand multiparity (Ujah et al. 2005)

As explained in the WHO Factsheet (2008), drugs already exist (oxytocin) which, if administered immediately after childbirth, can reduce the risk of bleeding very effectively. Sepsis – a very severe infection – is the second most frequent cause of maternal death. It can be eliminated if aseptic techniques are respected and if early signs of infection are recognized and treated in a timely manner. The third cause, eclampsia, emerges as pre-eclampsia, a common hypertensive disorder, which can be detected during pregnancy. Although pre-eclampsia cannot be completely cured before the delivery, administering drugs such as magnesium sulfate can lower a woman's risk of developing convulsions (eclampsia), which can be fatal. Another frequent cause of maternal death is obstructed labour, which occurs when the fetus' head is too big compared with the mother's pelvis or if the baby is abnormally positioned. Skilled practitioners can now use the partograph (a simple tool for identifying problems early in labour) to recognize and deal with slow progress before labour becomes obstructed, and, if necessary, ensure that Caesarean section is performed on time to save the mother and the baby.

For women to benefit from these cost-effective interventions they must have antenatal care in pregnancy, in childbirth they must be attended by skilled health providers and they need support in the weeks after the delivery (WHO, 2008). Whereas in many developed countries almost all pregnant women receive antenatal and postnatal care and are attended by a midwife and/doctor at childbirth, available data show that less than two thirds receive similar services in developing countries. Many pregnant women in Nigeria do not receive the care they need either because there are no services where they live, or they cannot afford the services because they are too expensive or reaching them is too costly. Some women do not use services because they do not like how care is provided or because the health services are not delivering high-quality care. Further, cultural beliefs or a woman's low status in society can prevent a pregnant woman from getting the care she needs. To improve maternal health, gaps in the capacity and quality of health systems and barriers to accessing health services must be identified and tackled at all levels, down to the community.

1.5 Current Efforts to Reduce Maternal Mortality in Nigeria

Although attempts have been made in the past aimed at reducing maternal mortality in Nigeria, such attempts, especially by the Federal and state governments, have generally not proved very successful in achieving the desired results. Some promising results however have recently begun to be recorded through some policy initiatives by a few state governments. In Anambra state, the state house of assembly approved a bill in 2005, guaranteeing free maternal health services to pregnant women (Shiffman and Okonofua, 2007). The state commissioner of health, who is an obstetrician and gynaecologist, played a central role in its development and adoption. In Kano state, the state government included in its budget a line item for free maternal health services. The former state commissioner of health together with a senior obstetrician and gynaecologist, played central roles in creating this positive environment for maternal health. In Jigawa state, state and local budgets have provided funds for the upgrading of obstetric care facilities in hospitals, the recruitment of obstetricians and gynaecologists and the provision of ambulances at the local level to transport pregnant women experiencing delivery complications to health facilities. The former executive secretary for primary health care, who subsequently became state commissioner for health, stood behind these initiatives.

A common trend to these initiatives is that they were championed in each case by a state commissioner of health who obtained political commitment from the governor, state assembly and other relevant government officials, thus lending credence to the view that the battle to combat high maternal mortality is not just a medical or technical matter but rather requires high level political commitment.

Another thing common to these initiatives is the attempt to introduce free maternal care, usually through user-fee waivers. However, these policies mostly do not seem to be adequately planned for and are consequently unsustainable. The main challenge to the introduction and implementation of user-fee waivers is the provision of adequate number of skilled health care personnel to handle the huge influx of pregnant women who come to avail themselves of the free maternal care services. A second challenge is that large amounts of drugs are used up in very short periods of time. Also, an overwhelming amount of clerical work is required to account for the distribution and use of medicines. Hence there is need for adequate planning before the introduction of user-fee waivers.

The Lagos State Government, in an effort stem the tide of maternal and child deaths recently set up five Maternal and Child Care centres (MCCs) fully equipped and well staffed to provide a wide spectrum of care including family planning, ante- and post- natal care to facilitate safety of women during child delivery. The MCCs are located in surulere, Ikorodu, Isolo, Ifako-Ijaiye, and Ajeromi. Other locations include Alimosho, Ibeju-Lekki, Epe and Badagry among others (Sunday Punch, 2012).

One recent initiative that seems to be successful is the Ondo State Government initiative known as Abiye. This initiative in the rural communities in Ondo State, uses mobile phones to save lives of indigent pregnant women. According to the World Bank (2008) 51.6 Percent of Nigerians live in rural areas, most of whom are cut off from modern medical facilities, making pregnant women vulnerable to readily preventable adverse outcomes. Most of these adverse outcomes result from delay in seeking care, getting to health centres when care is sought, receiving care on getting to the health centre, and referring patients to more advanced centres when necessary.

In the Ondo State initiative, pregnant women go for antenatal care at primary health care centres where each one is given a mobile phone. The pregnant women are put in government prepaid, caller-user groups and tracked by trained personnel so the pregnancy is monitored. Calls to the healthcare personnel are toll free. The Pilot scheme is in Ifedore Local Government Area of Ondo state (Sunday Punch, 2011). Primarily because the lines are toll-free the delay in seeking care is minimised to almost zero. The programme also takes care of the delay in reaching health centres since ambulances are stationed to bring in the pregnant women when they call. In emergencies, the health personnel go on motorcycle with a First Aid box. If it is something they can't handle, the women are taken to the general hospital.

A major shortcoming of all these efforts is that they are disjointed and uncoordinated, with each state working according to its own dictate and vision. What is required is an integrated approach to replicate successful programmes in other states of the country. The disjointed nature of these efforts is indicative of overall failure in leadership and governance in the healthcare sector and, indeed in other spheres of Nigerian life.

The resulting chaos manifests in inconsistent, contradictory, ill-thought-out, and ever changing policies. For instance, one stop-gap initiative introduced to address the issue of low proportion of births attended by skilled health personnel is the Midwives Service Scheme. Under this scheme the three tiers of govt are to share the costs of engaging midwives on a massive scale. It is not clear, however, where the midwives are to come from since the relevant regulatory bodies, the Nursing and Midwifery Council of Nigeria and the Federal Ministry of Health appear determined to drastically restrict the number of midwives and nurses that may graduate each year. As a result of regulations aimed at achieving such ends, many states do not have enough nurses and midwives to effectively meet the basic demand for maternal care, let alone handling things on a massive scale.

Not helping matters also is the unwillingness of governments in Nigeria to reveal how they spend money. It is difficult to comprehend the rationale behind the phenomenon of unspent funds whereby funds are usually returned as unspent at the end of each budget period even as 52,000 Nigerian women are consigned to early graves owing to failure of the government to provide facilities to assist in pregnancy and childbirth. A recent report by the Centre for Reproductive Rights (CRR), notes that in 2008 Nigeria gave about 5% of its annual budget to the health sector. This amounts to just one third of what it promised in a regional treaty. And without public access to fiscal information, it is difficult to find out who received the money and how it was spent.

1.6 Policies and Declarations on Maternal Mortality Reduction in the Past

The issue of maternal deaths emerged as a world health concern through the United Nation's launching of the Safe Motherhood Initiative (SMI) in Kenya in 1987. The Safe Motherhood Initiative, whose target was the reduction of the estimated yearly world maternal mortality figure of 500,000 by 50 percent by the year 2000 was formally launched in Nigeria in 1990. Other international conferences that established similar targets of reducing the 1990 levels of maternal mortality by fifty percent include the Beijing Conference held at the instance of women activists from across the globe back in 1995 (Daily Independent, 2010), the World Summit for Children (WSC) in 1990, the International Conference on Women in 1994, the Fourth Conference on Women in 1995 (Mojekwu, 2005), and the United Nations Millennium Summit in 2000, which developed the Millennium Development Goals (MDGs) to enable the poorest countries improve the quality of life of their citizens, and resolved to achieve these goals by 2015. The fifth MDG requires all member states to improve maternal health and, in order to achieve this goal, a number of targets were set, including reducing maternal mortality by three quarters (75%) between 1990 and 2015 (U.N. 2008).

Regional Treaties, Policies and Declarations include the African Charter (O.A.U, 1982), the Maputo Protocol (CRR and WARDC, 2008), and the 2001 Abuja Declaration in which African Union governments pledged to allocate at least 15% of their annual budgets towards improving the health sector (O.A.U, 2001).

National Policies and Strategies include the 1988 National Health Policy and Strategy to Achieve Health for all Nigerians, which was Nigeria's first comprehensive health policy (Federal Ministry of Health, Nigeria 1988). The 2004 Revised National Health Policy replaced the 1988 National Health Policy. Reproductive Health Policies include Nigeria's National Reproductive Health Policy and Strategy of 2001 (Federal Ministry of Health Abuja, 2008), the Integrated Maternal, Newborn and Child Health Strategy in 2007 (2007 IMNCH Strategy) and the National Millennium Development Goals Report (2004).

1.7 Statement of the Problem

In spite of all the policies, declarations, conferences and other efforts aimed at reducing the scourge of maternal deaths across the globe, only modest gains in maternal mortality reduction appear to have been achieved in many countries in the past 20 years (Shah and Say, 2007). Countries in Africa may have actually lost ground while many developing countries have fallen far short of the standards set by the World Health Organisation's initiative on Safe Motherhood. In Nigeria, the Federal Ministry of Health had set Year 2006 as the target year that maternal mortality would have been reduced by 50 percent. However, not only were these targets not achieved but also the maternal health situation in Nigeria is now much worse than in previous years (Ujah et al, 2005).

Past efforts to reduce maternal mortality ratio in Nigeria were concentrated on making direct improvements to the health system. These efforts have not involved enough resources to successfully reduce maternal mortality in the country.

In view of this lack of success, Shiffman and Okonofua(2007) noted that the high maternal mortality in the country will have to be tackled by generating sufficient political priority to make governments deploy enough resources to successfully reduce maternal mortality in Nigeria. This study brings together some of the factors responsible for the high maternal mortality in the country, and uses stepwise regression to select the ones that appear to have more effect on maternal mortality ratio in Nigeria. Narrowing down the range of factors to be considered by political office holders should help bring focus to the challenge of generating political priority, since maternal mortality is just one among hundreds of issues competing for the attention of political leaders at any given point in time.

1.8 Objective of the Study

The objective of this study is to:

- (i) Bring together some of the risk factors mentioned in the past as responsible for high maternal mortality in Nigeria. These include whether or not the woman received antenatal care, whether delivery was assisted by a health professional, whether delivery took place in a health facility, the educational attainment of the woman, income distribution etc.
- (ii) Identify the factors that seem to have more effect than the others on maternal mortality in Nigeria.

2. Literature Review

Different analytical frameworks have been used in studies on maternal mortality. Mojekwu (2005) categorized the causes of maternal deaths into medical factors, health factors, reproductive factors, unwanted pregnancy and socioeconomic factors. Ibe (2008) employed a multistage sampling technique while Okaro et al. (2001) carried out retrospective comparative analysis of maternal deaths for two ten-year periods.

Okonofua, Abejide, and Makanjuola (1992) examined the background factors that predisposed women to maternal mortality at the Obafemi Awolowo University hospital in Nigeria. The study investigated their socio-demographic characteristics, their use of prenatal care, and the incidence of delay in clinical management. The results showed that the maternal deaths involved women who were younger and of poorer socioeconomic status than the women in the control group. Both groups showed an equal lack of prenatal care. However, a higher incidence of delayed treatment was found in the management of the cases of maternal deaths. The study also found that maternal mortality in the study population can be reduced through improved transportation and institutional management, and, on a long-term basis, through the adoption of measures to improve the socioeconomic status of women.

Ni and Rossignol (1994) in a community-based maternal mortality surveillance study in Sichuan, China assessed the impact of family planning status on maternal mortality. They found that the leading causes of death for both planned and unplanned pregnancies were the same: hemorrhage, postpartum infection, pregnancy-induced hypertension, cardiac diseases, and pulmonary diseases. As among women with "planned" pregnancies, about 40% of maternal deaths among women with "unplanned" pregnancies occurred at home, and 20% occurred en route to a hospital. After controlling for the confounding effects of gravidity and education, with additional control for the effect of prenatal care visits the study indicates that women with "unplanned" pregnancies have a higher risk of maternal death, which is only partially attributed to less prenatal care.

Garenne et al. in a 1997 case control study to analyze risk factors for maternal mortality in three leading hospitals in Dakar, Senegal identified the leading causes of death as puerperal sepsis and other infections, haemorrhage, eclampsia, ruptured uterus, and anaemia. Results of the case-control study revealed the major risk factors associated with health system failure as medical equipment failure, late referral, lack of antenatal visit, and lack of available personnel at time of admission. Various indicators of maternal status at time of admission (complications, blood pressure, temperature, oedema, haemoglobin level) and of health history prior to admission (previous complications, previous C-section, lack of treatment) were also strong predictors of survival. Lastly, socio-demographic factors also appeared as correlates of maternal mortality, in particular: first pregnancy, pregnancy of high birth order, rainy season, being unmarried, and low level of education. Okaro et al. (2001) carried out retrospective comparative analysis of maternal deaths at the University of Nigeria Teaching Hospital, Enugu for two ten-year periods (1976-1985 and 1991-2000) in order to evaluate the effect of Safe Motherhood Initiative on maternal mortality in the hospital.

The main finding of the study was that since the launching of the Safe Motherhood Initiative, maternal mortality ratio increased five-fold as a result of institutional delays and deterioration in the living standards of Nigerians. During the period under review, the health sector, like all other sectors, suffered from underfunding, industrial unrest, inconsistent policies, and mass exodus of health care personnel from the public sector to either the private sector or foreign countries. Liljestrand and Pathmanathan (2004) presented a model to guide analyses of national health systems based on evidence from case studies from Sri Lanka and Malaysia and seven other developing countries. The study largely confirms recent recommendations of the major multilateral agencies that improvement of maternal health standards requires focused prioritization, planning and implementation over many years. The study found no visible progress in maternal mortality reduction at the global level.

Ujah et al. (2005), in a seventeen-year review of factors contributing to maternal mortality in North-Central Nigeria found a bimodal pattern of maternal deaths occurring at both extremes of the reproductive age range. They found that the greatest risk of maternal death was among early teenagers and older women. They also found that ethnic group of the women was also an important risk factor for maternal mortality.

Mojekwu (2005) explained that due to complexity in measuring maternal mortality, even countries with complete vital registration systems find it a daunting task to measure it accurately. Assessing levels of maternal mortality is complex because it requires knowledge about deaths of women of reproductive (15-49) years, the cause of death and also whether or not the women were pregnant at the time of death or had recently been so. Yet, few countries record births and deaths, even fewer register the cause of death and fewer still systematically note pregnancy status on the death form. Misclassification of maternal deaths could arise for a variety of reasons such as under-reporting, illiteracy and cultural norms. Where vital registration systems are absent or inadequate, it is possible to estimate maternal mortality using survey techniques. Usually, high mortality counties have neither adequate systems of registration nor the resources to rely on surveys. Shah and Say (2008) recommend careful evaluation of data and periodic measurement by multiple methods in order to obtain accurate estimates. Because of huge variation across countries in sources of data, type and completeness of information available and extent of missing information, the estimates are sometimes based on reconciliation of data from different sources. Some data could be derived from vital registration-with good or poor and uncertain attribution of cause of death; some data from the direct sisterhood methods used in Demographic and Health Surveys of households; some other data could be obtained from Reproductive Age Mortality Studies (RAMOS); and some from disease surveillance, sample registration, censuses or special studies.

Lawoyin et al. (2007), carried out a cross-sectional, community-based study to assess men's perception of maternal mortality in Nigeria and found that efforts were required to improve men's attitudes and knowledge in order to make them active participants in the fight to reduce maternal mortality. Maternal deaths in this study were blamed on healthcare workers not being skilled enough, financial barriers, failure to use family planning, emergency, antenatal, and delivery care services. Factors associated with knowledge and attitude to preventing maternal mortality are discussed. Healthcare reforms must be coupled with socio-economic improvements and efforts made to improve men's attitudes and knowledge in such a way as to make them active stakeholders, more supportive of preventing maternal mortality. Curiously, this study found that several African countries where facility delivery is quite high show that maternal mortality remains high also, informing that facility delivery alone is not enough to significantly reduce maternal deaths implying that workers had to be trained in emergency care or the benefits of facility delivery will not be appreciated

Alves (2007) in a study titled *Maternal Mortality in Pernambuco, Brazil: What has changed in ten years?* examined changes in levels and patterns of maternal mortality in Pernambuco, Brazil, in 1994 and 2003. The research was carried out in five sub-regions of Pernambuco using the Reproductive Age Mortality Survey (RAMOS) method. The study found that the illegal status of abortion in Brazil remains an important contributory factor for abortion-related deaths. Approximately 94% of the maternal deaths were judged to be avoidable with improvements in health care. Maternal mortality declined by 30% over the ten-year period.

Shah and Say (2007), reproductive health researchers with the WHO, produced a paper on *Maternal Mortality and maternity care*. The authors showed that gains in reducing maternal mortality between 1990 and 2005 have been modest and uneven, and that countries with high maternal mortality ratios shared problems of high fertility and unplanned pregnancies, poor health infrastructure and low availability of health personnel.

Shiffman and Okonofua (2007) assessed the state of political priority for maternal mortality reduction in Nigeria and identified the challenges that advocates face in promoting political priority. They found that priority is as yet in its infancy and that advocates need to coalesce into a potent political force in order to be able to push government to take appropriate action to reduce maternal mortality.

Abe and Omo-Aghoja (2008) in a ten year retrospective study of maternal mortality at the central hospital in Benin City, Nigeria documented the number and pattern of obstetric deaths at the Central Hospital, Benin City, over a ten year period and identified common causes of maternal deaths. The leading direct causes of maternal deaths were sepsis, hemorrhage, obstructed labor and pre eclampsia/eclampsia, while the major indirect causes are institutional difficulties and anaemia. The study also found that low literacy, high poverty levels, extremes of parity and non-utilization of maternity services were associated with maternal mortality. The overall maternal mortality ratio (MMR) was 518/100,000. MMR was 30 times higher in unbooked as compared to the booked patients, while 60% of maternal deaths occurred within 24 hours of admission.

Ibe (2008) conducted a study in Anambra state of Nigeria on care utilization and poor mortality index. A multistage sampling technique was employed in a cross sectional study to assess the use of maternal services in Anambra state and found that the problem of maternal mortality in the country may not necessarily lie with utilization but with the quality of services. This finding tends to support Taiwo et al. in the view that the problem of maternal mortality in Nigeria may not necessarily lie with failure to utilize maternal care but that the health care system probably needs to be repositioned to meet the challenges of modern obstetric care.

Mairiga et al. (2008) conducted a population- based qualitative study in two urban and two rural communities in Borno state, Nigeria to find out community's knowledge and perceived implications of maternal mortality and morbidity as well as the community members' perception on ways to prevent the scourge. Through focus group discussions the study demonstrated that maternal mortality and morbidity is common and well known in the communities studied and that the implications are well appreciated. The study found that the communities perceived the causes of maternal death to be medical, cultural and socio-economic but that there were serious misconceptions with dire consequences for maternal mortality.

Harrison (2009), argued that attempts to reduce the high maternal mortality ratio in Nigeria have failed. Such attempts had been focussed on transforming the health system by directly applying expertise and resources on high maternal mortality and its surrounding elements. He argues that the complexities and uniqueness of Nigeria's situation call for a fundamental remedy based on stamping out the chaos in the country by the country getting its politics and governance structures right.

3. Material and Methodology

3.1 Data

The study mainly used data extracted from the Annual Abstract of Statistics of the National Bureau of Statistics (NBS) 2009 and the Nigeria Demographic and Health Survey (NDHS) 2008. Data on xxx variables of interest from the 36 states of the Federation and the Federal Capital Territory, Abuja were extracted from these sources. Data on maternal mortality ratios were obtained from hospital data from studies in each of the 6 geopolitical zones of Nigeria carried out by the Society of Obstetrics and Gynaecology of Nigeria (SOGON) as well as other recent published studies.

The Annual Abstract of Statistics is a standard source of statistical information on organisations and agencies in Nigeria. It summarizes socio-economic and other important data about Nigeria. The Nigeria Demographic and Health Survey (NDHS) 2008 is a national sample survey which provides up-to-date information on basic demographic and health indicators and other background characteristics of the respondents. The NDHS 2008 was implemented by the National Population Commission (NPC) and was fielded from June to October 2008. It is a follow-up to the 1990, 1999 and 2003 NDHS surveys.

3.2 Measures of Maternal Mortality

The definition of maternal death cannot be applied when the precise cause of death is not known. Therefore, maternal deaths are generally under-reported, even in countries with relatively good vital registration systems and record-keeping. Deaths in early pregnancy are especially more likely to be missed.

Maternal Mortality Ratio (MMR), defined as the number of maternal deaths per 100,000 live births, is the most commonly used measure to illustrate maternal mortality. It is also one of the measures used to monitor progress towards the achievement of the goal of improving maternal health in Millennium Development Goal 5 (MDG 5). Alternative measures include the maternal mortality rate, which refers to the number of maternal deaths per 1,000 women of reproductive age, and the adult lifetime risk of maternal death, which takes into account both the probability of becoming pregnant and the probability of dying as a result of that pregnancy, cumulated across a woman's reproductive years.

Maternal Mortality Ratio (MMRatio)

By expressing maternal deaths per live birth, rather than per woman of reproductive age, the MM Ratio is designed to express direct or indirect obstetric risk:

$$\text{MMRatio} = \left(\frac{MD}{LB}\right) * 100000$$

where MD is the number of maternal deaths in a period, and LB is the number of live births occurring in the same period

Maternal Mortality Rate (MMRate)

The MM Rate is a cause-specific death rate:

$$\text{MMRate} = \left(\frac{MD}{PYL}\right) * 1000$$

where MD is the number of maternal deaths in a period, and PYL is the person years lived by women of reproductive age (normally 15 to 49) in the same period.

How Are the MMRatio and the MMRate related? *

Defining MMRatio and MMRate per unit (not per 100,000 births or 1,000 person-years):

$$\begin{aligned} \text{MMRatio} &= \left(\frac{MD}{LB}\right) = \left(\frac{MD}{PYL} * \frac{PYL}{LB}\right) \\ &= (\text{MMRate} * \frac{1}{GFR}) = \left(\frac{\text{MMRate}}{GFR}\right) \end{aligned}$$

where GFR is the General Fertility Rate, births per woman of reproductive age.

Characteristics of the MM Ratio

Risk is per 100,000 events.

Cause-specific death indicator

More demanding data-wise than other summary mortality indicators routinely used

Ignores the fact that women will face this risk per birth several times over lifespan

Changes in the MMR are a result of changes in any or all of the following:

Risk of maternal deaths

Distribution of births by risk factors

Age distribution of women

Reproductive Lifetime Risk of Maternal Death

LTR reflects the risk that a woman who survives to age 15 will die of maternal causes at some point during her reproductive lifespan, given current rates of maternal mortality and fertility Calculation of LTR requires consideration of competing risks, and thus level of overall mortality

$$\text{LTR} = \frac{T_{15}-T_{50}}{l_{15}} * \left(\frac{\text{MMRate}}{1000}\right)$$

Where T15, T50 are life table person-years lived above ages 15 and 50 (taken as being the starting and ending ages of reproduction) respectively, and l_{15} is survivors to age 15.

3.3 Measurement of Variables

Educational attainment is categorized into two parts: those without formal educational and those with formal education. Women aged 15-49 years who have completed at least primary education are considered to be educated while the rest are categorized as having no education.

Exposure to mass media describes women of age 15-49 years who are exposed to specific media on a weekly basis in Nigeria in 2008. Women who read at least one newspaper a week, those who watch television at least once a week, and those who listen to radio at least once a week. These are categorized into two: those who are exposed to no media in a week and those who are exposed to at least one medium at least once a week.

Other factors include total fertility rate, percentage of women age 15-49 currently pregnant, percentage of women age 15-19 who are pregnant with their first child, percent distribution of women age 15-49 by occupation, percent distribution of women age 15-49 with a live birth in the five years preceding the survey who had no postnatal check-up, women age 15-49 who received antenatal care for their most recent birth in the past five years who were informed of the signs of complications in pregnancy, percentage who received two or more tetanus toxic injections during their last pregnancy, percentage delivered by a skilled provider, percentage not using contraceptives, percentage who delivered in a health facility, percentage who faced transportation challenges, percentage treated for malaria, percentage involved in major household decisions, number of government owned health facilities and percentage distribution of household monthly income/allowances.

3.4 Methods

Multiple regression analysis was used with the natural logarithm of the fourteen independent variables of interest regressed simultaneously on the natural log of the maternal mortality ratio. This is based on the exponential distribution consistent with the assumption of constant force of mortality, which is one of the widely used assumptions in actuarial science. This regression served as baseline regression to indicate the relationship between the determinant factors and maternal mortality. Stepwise regression model was then applied for robustness and also for the purpose of selecting the most effective determinants of the level of maternal mortality. The model was checked to confirm that the underlying assumptions were met.

3.5 Outline of Stepwise Regression

Different types of multiple regressions are distinguished by the method for entering the independent variables into the analysis. In standard (or simultaneous) multiple regression, all of the independent variables are entered into the analysis at the same. In hierarchical (or sequential) multiple regression, the independent variables are entered in an order prescribed by the analyst. In stepwise (or statistical) multiple regression, the independent variables are entered according to their statistical contribution in explaining the variance in the dependent variable.

Stepwise regression is designed to find the most parsimonious set of predictors that are most effective in predicting the dependent variable. Variables are added to the regression equation one at a time, using the statistical criterion of maximizing the R^2 of the included variables. The process of adding more variables stops when all of the available variables have been included or when it is not possible to make a statistically significant improvement in R^2 using any of the variables not yet included. Since variables will not be added to the regression equation unless they make a statistically significant addition to the analysis, all of the independent variable selected for inclusion will have a statistically significant relationship to the dependent variable.

Stepwise regression includes regression models in which the choice of predictive variables is carried out by an automatic procedure. Usually, this takes the form of a sequence of F-tests, but other techniques are possible, such as t-tests, adjusted R-square, (Hocking, 1976). Stepwise methods select a subset of variables entirely by statistical criteria. It is always best to select variables for possible inclusion in a regression on the basis of theoretical or practical considerations. A stepwise method is usually a useful way to identify some promising candidate variables for further consideration. The main approaches are:

Forward selection: Forward selection starts with the independent variable that is the best predictor of the dependent variable and checks that the coefficient is significantly different from zero, at the 5% level. Then it adds the one that improves the prediction the most, subject to a criterion, usually that the coefficient is significantly different from zero at the 5% level. The process continues until no more variables pass the criterion.

Backward elimination: Backward elimination starts with all independent variables in the regression, then removes the one with the smallest t statistic, provided that its p value is at least 0.10. The process continues until no more variables are removed. Again, the criterion can be adjusted.

Stepwise regression: Stepwise regression combines forward selection and backward elimination. At each step, the best remaining variable is added, provided it passes the significant at 5% criterion, then all variables currently in the regression are checked to see if any can be removed, using the greater than 10% significance criterion. The process continues until no more variables are added or removed. This is the one we shall use.

Selection criteria: One of the main issues with stepwise regression is that it searches a large space of possible models. Hence it is prone to overfitting the data. In other words, stepwise regression will often fit much better in sample than it does on new out of sample data (Foster and Edward, 1994).

Model Accuracy: A way to test for errors in models created by step-wise regression, is to not rely on the model's F-statistic, significance, or multiple-r, but instead to assess the model against a set of data that was not used to create the model. This is often done by building a model based on a sample of the dataset available (e.g. 30%) and use the remaining 70% dataset to assess the accuracy of the model. Accuracy is then often measured as the actual standard error (Se), or mean error between the predicted value and the actual value in the hold-out sample. This method is particularly valuable when data are collected in different settings e.g. time (Jonathan and Goldberg, 2001).

4. Results

4.1 Multiple regression was carried out to obtain the linear equation of the factors for predicting maternal mortality. The result is presented in table 2 below,

Table 2. Multiple Regression of factors that determine maternal mortality

Variables	B	SEB	Beta	t	p-value
Constant	8.306	4.638		1.791	0.087
X3	-0.181	0.144	-0.344	-1.255	0.223
X4	0.053	0.265	0.046	0.201	0.843
X5	-0.231	0.806	-0.081	-0.287	0.777
X6	0.492	0.245	0.606	2.005	0.057
X7	-0.782	1.343	-0.188	-0.583	0.566
X8	3.267	2.66	3.011	1.228	0.232
X9	-7.744	8.812	-2.031	-0.879	0.389
X10	-0.175	0.507	-0.188	-0.346	0.733
X11	-0.201	1.05	-0.3	-0.192	0.85
X12	-0.759	1.194	-1.087	-0.636	0.532
X13	0.582	0.418	0.221	1.393	0.178
X14	0.079	0.18	0.074	0.441	0.664
X15	-0.184	0.262	-0.163	-0.703	0.489
X16	0.137	0.155	0.175	0.882	0.387

R-Square=0.737

The variables are the natural logarithms of the factors that affect maternal mortality listed below:

X3=Percentage of women not currently using contraceptives

X4=Reported malaria cases in pregnant women

X5=Total fertility rate

X6=Percentage of women who received anti tetanus injection

- X7=Percent distribution of women who received ante natal care
- X8=Percent distribution of women age 15-49 without formal education
- X9=Number of government owned health facilities
- X10=Percentage distribution of household monthly income/allowances 2007
- X11=Percentage delivered by a skilled health professional
- X12=Percentage of women who do not participate in major household decisions
- X13=Women who received ante natal care and were informed of the signs of complications
- X14=Women who had at least one problem in accessing health care
- X15=percentage of women aged 15-19 who are pregnant with first child
- X16= Percentage of women who had no postnatal check-up

From the model summary R square=0.737. This tells us that 73.7% of the variance of maternal mortality ratio was explained by the regression. The adjusted R-square is 0.569 The ANOVA table shows that for the overall regression, F=4.396 with 14 degrees of freedom, and probability (.001 in the sig column) well below 0.05. Therefore the regression is significant.

The table of coefficients gives the estimated values of the regression and their standard errors. Predicted MMR=8.306-0.181X3+0.053X4-0.231X5+0.492X6-0.782X7+3.267X8-7.744X9-0.175X10-0.201X11-0.759X12+0.582X13+0.079X14-0.184X15+0.137X16

Higher values of X3, X5, X7, X9, X10, X11, X12 and X15 predict lower values of maternal mortality ratio. The standardized beta coefficients and beta weights show that X8 and X11 are the main factors contributing to maternal mortality reduction.

Collinearity statistics show that x7 and x8, with tolerance values close to zero, have linear relationships that could cause computational problems (the two independent variables depend linearly on each other).

The Normal probability plot shows that our residuals are a good approximation to a straight line from the origin to the top right. We can thus infer that the assumption of normality is correct and that the residuals form a random sample from a standard normal distribution. We can thus have confidence in the ANOVA and t tests on the regression coefficients.

The final model obtained by stepwise regression has only the percentage of women who had no formal education and the percentage delivered by a health professional as selected predictors of maternal mortality ratio. Delivered by a health professional was the best predictor of maternal mortality ratio followed by No formal education. The proportion of the variance of maternal mortality explained by this model is 0.627. The ANOVA table shows that the stepwise regression is significant (p much less than 0.05) with F=46.572 and 1 degree of freedom. The table of coefficients gives the coefficients for the stepwise regression with only No education and Delivered by Health Professional as independent variables. The results are presented in table 3 below.

Table3. Stepwise Regression of Natural Logarithms of Factors that Determine Maternal Mortality

Model	Variables	B	SEB	B	t	p-value
1	Constant	7.99	0.257		31.074	0
	X11	-0.507	0.074	-0.756	-6.824	0
2	Constant	6.671	0.63		10.582	0
	X11	-0.859	0.17	-1.28	-5.041	0
	X8	0.625	0.276	0.576	2.268	0.03

R-square model 1=.571

R-square model 2=.627

4.2 Discussion

From our findings, two crucial issues require priority attention in the fight to reduce maternal mortality in Nigeria: how to dramatically improve education, especially of women, and how to provide affordable skilled professional attendants for an increasing number of births with back-up for complications and emergencies.

These findings are in line with previous literature which indicates that literacy level correlates closely with maternal mortality reduction (Harrison, 1985; Onwuhafua et al., 2000; Okaro et al., 2001; Adamu et al., 2003; Liljestrand, 2004; Ujah et al., 2005). The proportion of births attended by trained personnel has also been indicated in previous studies as significantly affecting maternal mortality (Robinson and Wharrad, 2001; Kurjak and Bekarac, 2001; Ghosh, 2001; and Ibeh, 2008).

Because education of women does not come under the ambit of the Ministry of Health, any effective advocacy for the reduction of maternal mortality in Nigeria will have to collaborate to an appreciable extent with interests outside the health ministry in order to achieve success. This is a very important consideration as past efforts to reduce maternal mortality have tended to focus primarily on medical interventions. Delivery assisted by health professionals was identified in this study as one of the main factors for the reduction of maternal mortality. Over the years the proportion of births attended by skilled health personnel has not changed much.

Table 4. Percentage of births attended by skilled health personnel.

	1990	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2015 target
%	45	42	42	37.3	36.3	36.3	43.5	43.5	43.5	38.9	NA	100

Source: MDG Report 2010.

Against the backdrop of government's not-too-encouraging disposition towards funding higher education and recent moves by the Nigeria Medical Association (NMA) to further restrict student intake into medical schools in the country, the statistics on proportion of births attended by skilled professionals can only get worse. Citing what it referred to as over-admission, the NMA claims that facilities in medical schools are overwhelmed and therefore restricts student intake into colleges of medicine. But this is tantamount to putting the cart before the horse. Nigeria's record of one medical doctor to 6,000 persons is scandalous, to say the least, when juxtaposed with the World Health Organisation's prescribed ratio of one medical doctor to 1,000 persons. Cuba has a doctor population of one to 165, while South Korea has one to 337 (The Punch Newspaper, 2011). The correct approach to address this deficiency would be to adequately fund and equip medical schools to train enough doctors (in relation to the prescribed ratio) while at the same time enhancing efficiency in medical training by providing standard education in medicine. The problem has its roots in the general underfunding of education in the country predicated on lack of vision and inadequate planning to meet the future manpower needs of the country. The current practice of limiting admissions by prescribing fixed number of medical students to each college of medicine without taking into consideration the exploding population of the country, and failing to link admissions into medical schools with the future needs of an increasing population can only widen the identified gap and worsen the doctor/population ratio.

One surprising result was that the use of prenatal care was not statistically significant in reducing maternal mortality. This runs contrary to results of some previous studies (Ogunniyi and Faleyimu, 1985; Harrison, 1985; Walker, 1986) which suggest that non use of prenatal care is a strong high-risk factor in maternal mortality. However, our result is in line with Okonofua et al. (1992) which saw no significant difference between use and non use of prenatal care. Okonofua inferred that while the use of prenatal care may reduce the rates of pregnancy related complications, the prior use of prenatal care is unlikely to affect the outcome once complications have actually set in at home. What becomes important, at this point, is how quickly the patient gets to an appropriate health care facility as well as the quality of care she receives on arrival at the centre.

5. Conclusion and Policy Recommendation

One of the main factors affecting maternal mortality ratio, as determined by this study, is the availability of skilled professional birth attendants providing care during childbirth. A second important factor is the absence of formal education, especially education of women.

The MDG maternal mortality reduction objectives will be achieved only if the governments devote more resources to the training of medical professionals and also make the education of women a national political priority. In Nigeria a network of capable safe motherhood champions exists. However, this network has yet to capitalise on its potential power, and political priority remains low.

Given the acknowledged failure of SMI and the fact that MDG goal 5 is practically not attainable, creative and effective solutions for reducing maternal mortality rates should be put in place to include all stakeholders especially the men who are the primary decision makers in culturally driven, male dominated societies (Lawoyin, 2007). Husbands should allow their wives to attend antenatal clinic and to deliver in the hospital. Women folk should avoid delay in seeking medical attention, attend antenatal clinic and deliver in hospitals. Parents need to invest in girl child education. Health personnel should desist from harassing their patients and show more concern. Government should assist by providing skilled health professionals, improving healthcare facilities and promoting awareness of the importance of antenatal care. Health workers must be trained and provided the wherewithal for optimal practice. Government and community leaders should inform, educate and sensitize people on maternal health through the mass media. Increased funding of the health sector is absolutely essential. Exemption of pregnant women from paying user fees will also make a world of difference. Equipping primary health centres for essential obstetric care should be of importance. Above all, education must be given top priority and must be properly funded, especially education of women. Advocates of maternal mortality reduction will have to pay a lot of attention to developments in the education sector, especially development of manpower in the medical and nursing professions. As the year 2015 inexorably approaches, all indications are that Nigeria is still a long way from achieving the targets set for maternal mortality reduction in the Millennium Development Goals.

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