Maternal mortality Ratio in low income developing countries-focusing on Pakistan

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ABSTRACT

Background: Maternal mortality (MM) is a matter of serious concern in low income developing countries (LDCs).

Perspective: A great reduction has been observed regarding the maternal deaths globally after huge efforts since 1990 todate. However, the situation continues to be either stagnant or worsening in developing countries, suggesting that the efforts to cope with this issue are either insufficient or not properly implemented. We need to first diagnose the problem areas that are a great hurdle in the road to success towards the reduction of MM. Postpartum haemorrhage and preeclampsia are one of the most common causes of MM. Malnutrition, neurological dysfunction and cancer are among the non-obstetric causes. Trained medical and paramedical staff can be of great help in this regard by increasing awareness among masses at grass root level. Target set by Millennium Development goal has minimized the MM by 44%. But it has not met the target set by Millenium Development Goals 5 and a lot of measures need to be taken in this regard.

Conclusions

Majority of the MDs are preventable and can be avoided by adopting appropriate frameworks, linked data sets, surveillance, birth attendants training, preparation for births, etc. Delay in decision to get healthcare, access to healthcare center and receiving these facilities are the main factors in MM.

Abbreviations:

Maternal Mortality (MM), Maternal Near Miss (MNM), Maternal Mortality Ratio (MMR), Millenium development goals (MDGs), Sustainable Development Goals (SDGs), Maternal Death (MD), Severe Maternal Outcomes (SMO), Low Income Developing countries (LDC), developed countries (DC), Antenatal Care (ANC), Official Development Assistance (ODA),

emergency obstetric care (EmOC), Community Health Worker (CHW),Traditional Birth Attendants (TBAs), Postpartum haemorrhage (PPH), mortality index (MI), case fatality rate (CFR), total fertility rate (TFR), low-dose, high-frequency (LDHF), Maternal Death Surveillance and Response (MDSR).

Declarations: provided before references

Key words: maternal mortality, Pakistan, Millenium development goals, sustainable development goals, antenatal care

Introduction:

Severe Maternal Outcomes (SMO) comprises of Maternal Near Miss (MNM) or Maternal Death (MD) (1). MD is considered as the most tragic event and can be preventable if the mother is given proper medical aid and facilities. It is considered as an indicator about the quality of medical services of a country (2). WHO defines MD as: “the death of women during pregnancy or within 42 days after termination of pregnancy irrespective to the cause

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of death" (3). Maternal Mortality Rate (MMR) is defined as the number of MDs divided by the number of live births during a particular time period (2). A country's MMR indicates the development, health and medical status (4). Maternal mortality (MM) is divided into direct and indirect deaths: direct death is caused by delivery and complication in 42 days of postpartum and indirect death are those MDs which are caused by any disease which is affected or enhanced by pregnancy's physiological effects. Accidental deaths in which pregnancy has no role is not considered as MD (2, 4, 5).

Trends in Global Mortality Rates:

Though MMR has decreased since 1990 to 2015 (estimated 303,000/ 100 million live births), it still remains a big challenge in many LDCs (6). Some regions of the world have high MMR which is indicative of the poor health facilities and disparities in access. Low Income Developing countries (LDC) contribute to maximum of MMR (99%) (7, 8). Sub-Saharan Africa has the highest MMR(14110/100 million live births) and South Asia (1428 million/ 100 million) is second in world ranking in 2015 while Common wealth Independent States including Armenia, Azerbaijan, Belarus, Georgia, Russia, Tajiskistan etc. has lowest (313/ 100 million live births) MMR. European Union also has second lowest MMR (307/ 100 million live births) (Figure 1). According to WHO report, the MMR in LDCs was 239 per 100 million live births as compared to 12 in developed countries (DC) in 2015. There are inequalities in these ratios between regions, countries, different socioeconomic strata, rural and urban populations (9).

Among South Asian countries, Afghanistan has the highest MMR (396/ 100 million live births) in 2015 while it was 1340/ 100 million live births in 1990, Pakistan is 7th in ranking in this region with 0.178 million/ 100 million live births in 2015 while it was 0.431 million/ 100 million live births in 1990. Srilanka has the lowest MMR (30 / 100 million live births) in 2015 while it was 75/ 100 million live births in 1990 (10) (Figure 2). Siera Leone

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has an estimated MMR 1360/ 100 million live births which is not only highest in Sub-Saharan Afria but also in the world. Although it has dropped from 2630/ 100 million live births in 1990. Finland and Greece have the lowest MMR 3/ 100 live births globally and considered as best countries as far as maternal health is concerned (10) (Figure 3).

Globally the MMR has decreased from 385 in 1990 to 216 in 2015 showing an annual reduction of 2.3%. The yearly number decreased from 532 000 in 1990, to 303 000 in 2015. During 1990 to 2015, the annual reduction rate in Eastern Asia was 5·0% and in Caribbean was 1·8%. MMR of developed countries was 12/100 000 livebirths in 2015 and for Sub Saharan Africa was 546 respectively (8). Globally large decline in different regions of the world has been observed that includes South-East Asia with 69% reduction and Western Pacific with 64% reduction. Least progress in MMR is observed in African with 44% decline and America with 49% decline (7, 8).

Millennium Development Goals and Maternal mortality:

Globally all organizations have focused on reducing MDs by initiating a number of programs since 1980's (5). United Nations (UN) made 8 Millennium Development Goals (MDGs) in September 2000 in which one was about maternal mortality(11). All the goals had to be achieved by the member countries by the end of 2015. MDG called for the reduction of 75% of maternal mortality by the end of 2015 and all countries and international agencies were directed to monitor the progress towards the completion of the goal (between 1990 to 2015) (8). It means that the target would be achieved by maternal mortality decline of 5.5% per year during 25 years time period. However, MMR has decreased by 37 % since 2000, even then 303 million women died across the world in 2015 (7).

Sustainable Development Goals-United Nations:

International and national level political partnership and funding could improve education, socio-economic conditions, gender equality and environment. After end of era of

MDGs a new agenda was announced in 2015 that consists of 17 SDGs (7).According to SDGs the target is to decrease maternal deaths to <70 deaths per live births by 2030 and no country should increase its MMR to 140/100,000 live births (8, 12)). The United Nations (UN) secretary general Banki-Moon has started the global strategy for mothers, meonates, infants, children and Adolescent's health from 2016-2030 (13). This Strategy will be a road map and tries to end all possible causes responsible for maternal mortality (8).

According to Goal 3.1 of Sustainable Development Goals (SDGs) of United Nations, MMR should be reduced to less than 70% per 100 million live births. Tremendous efforts have been made since 2000 and an impressive outcomes have been observed. Goal 3.7.1 focuses on women in their reproductive years, who had successfully adopted the modern family planning methods. Goal 3.7.2 discuss about the adolescent birth rate (10-19 years)/ 1000 women in that age group. MMR in sub-Saharan Africa has reduced by 35% since 2000. The adolescent birth rate in 2018 was 44/ 1,000 women (15-19 years) at global scale while 56 in the year 2000. Its rate is 101 in sub-Saharan Africa which is the highest of all. Target 3.7 addresses the availability and access to reproductive health, its awareness and implementation at national level, all over the world (14)

In 2010, 12% of global population spent approximately /10^{th} of their budgets for health services as compated to 9.7% in 2000. An estimated $9.4 billion was donated from various donars as Official Development Assistance (ODA) in 2016 which is 41% more. All the data available so far indicates that 45% of the world and most of the LDCs (90%) have not even one physician per 1,000 population and approximately 60% have less than 3 nurses per 1,000 (14).

Maternal mortality in Pakistan

The status of MDs in Pakistan is very poor and Pakistan is recognized as a country with high MMR. It is estimated that approximately 30,000 women dies every year due to

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pregnancy-related complications (15). Measuring MMR is also a big challenge due to poor system of record keeping and weak certification of the reason of causality(16). The reduction rate of MMR from 1990-2015 was 3.5% with 431 MDs/ 100 million live births in 1990 to 178 deaths in 2015. 89% of deliveries occur at home that causes 80% of MDs. 80% delivery occurs by the traditional birth attendants (TBAs) and only 1 out of 20 pregnant women reaches hospital or dispensary emergency (17).

In a study conducted in a teaching hospital in Karachi indicated that unsafe abortions carried by untrained health care service providers was the main reason of MDs (18). The most common among all reasons was hemorrhage and then eclampsia and sepsis (19). Pre-eclampsia and eclampsia causes 10.4 % and abortion cause 5.6 % of MDs (16, 19). The main reasons of MDs in another study from Khyber Pakhtunkhuwa (KPK) province of Pakistan were haemorrhage, sepsis,eclampsia, and hepatic encephalopathy. 40% of the overall cases were dealt by TDAs, 33% by lady health visitors, 17 % received no care and 10% by doctors (20). In a ten year study, from January 1995 to December 2004, conducted at Nishtar Hospital, Multan the major causative factors were hemorrhage, eclampsia, sepsis, anemia, and abortion. The study also concluded that increase in mother's age is linked to increased MDs (21). Most of the studies concluded hemorrhage as the leading cause of death while sepsis or eclampsia was the second main cause. In indirect causes, anemia and hepatitis was the main cause of death (4).

Different studies have been conducted in the provinces and hospitals to identify main causes and prevention of MD(22). In 2005, Jokhio *et al.* performed a cluster randomized controlled trial in seven regions (talukas) of a rural district Larkana, Sindh in Pakistan by training TBAs in three talukas known as intervention group and the remaining four talukas, TBAs were not trained (control group). The trained attendants were given sterilized delivery-

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196 kits for deliveries. 30% reduction in the intervention group was found as compared to the
197 control group. This strategy can be applied to improve maternal health in LDCs (17).

198 Ali *et al.*, designed a study to gather information about the health care facilities and
199 emergency obstetric care (EmOC) using unprocessed indicators, in Punjab and KPK. It was
200 found that in Punjab only 16 and in KPK only 6 health care services provides these basic
201 facilities. His study showed that basic Obstetric facilities are very poor in Pakistan and it is
202 extremely necessary to increase access and upgradation of these services. Another important
203 aspect is transportation as most of the hospitals in the study here lack functional ambulance to
204 take patient immediately to a nearby hospital or health care facility. Only 5.7% of deliveries
205 occured in government health care centers that provide EmOC. This shows that women who
206 need basic treatment cannot access government hospitals but either go to private hospital or
207 seek no care (17). Midhat *et al.*, investigated the cause associated with MDs in 16 rural
208 districts of Balochistan and KPK provinces of Pakistan. The study concluded that women
209 under 19 and over 39 years, or those delivering for the first time and those with an earlier
210 record of fetal loss were having a high risk of MD. Essential Obstetric Care (EOC) was
211 linked to MD. Results showed that staffing of peripheral health facilities and the role of
212 health care facility is also linked to MD, which needs to be improved ((17).

213 **Pakistan Demographic and Health Survey**

214 A survey conducted by Pakistan Demographic and Health Survey (PDHS) reported
215 the MMR as 276 during the year 2006-2007. Also, there are differences in MMR between
216 different provinces such as MMR of Baluchistan was 785, Sindh 314, KPK 275 and Punjab
217 was 227. Besides provincial differences, rural MMR (319) is double as compared to urban
218 MMR (175). Pakistan progress towards completing Millenium Development Goals (MDG)
219 was very inadequate due to lack of resources and failure to provide good health care services
220 to pregnant women. According to PDHS, the set targets were not achieved by the end of 2015

(23).. The MMR in 1990 was 385 which dropped to 216 per 100 million live births in 2015. After the end of MDG of 2015, Sustainable Development Goals (SDGs) was stated that targets to reduce MMR by the end of 2030 is 70 maternal mortality per 100 million live births (7, 8). Global MM has decreased between the years 1990-2015 to 44%. Although it did not meet the required target set by MDG5, still a lot of measures need to be done to meet the target(14).

The Three Delays Model

This model was proposed by Thaddeus et al., in 1994. It proposes the contributing factors that lead to the maternal mortalities. According to this model, most of the factors: distance, cost and quality are preventable and can be avoided if the health care is provided intime without any delay. The three factors responsible for MDs are summarized in three delays model (24) (Figure 4).

Risk Factors

Infrequent visits to Antenatal Care (ANC) units contribute substantially to the preventable MM in Sub-Saharan Africa. A home-based Community Health Worker (CHW) intervention in Tanzania significantly improved this situation in a locality with a higher level of facility based delivery. Policies should be devised and adopted to evaluate and design interventions to reduce the economic burden of ANC (25). Inadequate training of midwives (26) and TBAs is a modifieable factor in reducing the MD (27). In a retrospective study in Pakistan, those women who were administered by labour inducing medications by TBAs and lady health workers and susceptible for elongated duration of labour were more prone to uterine rupture and asphyxia while those with hemorrhage at the time of delivery (26) (Figure 5).

Eclampsia and hypertension

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Approximately 42,000 MDs occured in the year 2015, as a result of pregnancy induced hypertension globally (28). A study on 10 LDCs was conducted to evaluate the incidence of eclampsia and hypertension and its association to magnesion sulfate. 0.5% of all deliveries had eclampsia and 6.9% of them died. 0.95%/ 10,000 died from hypertension during pregnancy. These disparities in MDs across different LDCs is evident of inequality of availability and access to healthcare facilities for women with these complications in pregnancy (28) (Figure 5).

Postpartum Haemorrhage (PPH)

Postpartum haemorrhage (PPH) was observed to have an association with MDs in Mozambique and Sub Saharan Africa (29, 30). In 2015, the Mozambican Ministry of Health (MOH) launched a community-level misoprostol distribution program in chosen districts as a plan to decrease PPH. ExpandNet / World Health Organization (WHO) scale-up framework was used to evaluate the organization, evolution and the beneficial effects of misoprostol for the prevention of PPH. Interviews from health care staff and TBAs using the same framework in addition to national policies and 2017 guidelines from National Ministry of Maternal, newborn and childhealth workshop. The obstacles and accelerators associated with this program were highlighted in order to adapt this framework at national level(30). The same causative factor was found to be linked to PPH and SMP in Nigeria. It occurred in 2.2% of the deliveries recorded in 42 tertiary care hospitals in Nigeria during one year period, among which 0.3% of women had an SMO (1). Anaemia may also lead to PPH (31) (Figure 5).

Non-obstetric causes of MDs:

MNM was defined by WHO as an organ-system failure based on clinical criteria to assess the non-obstetric causes of SMO in a one year duration. It was observed that 9.4%

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(9401/100107) women admitted to the 42 tertiary hospitals in Nigeria for maternal complications had non-obstetric reasons. 4% (375/9401) of these complicated cases were MNM in 48 % (183/375) and MD in 51.2% (192/375) (32). Severe anaemia contributed to 61.2% of MNM and 32.8% of MDs. Cancer contributed to the highest MI (91.7%), liver dysfunction (81.8%), HIV (80.4%), neurological (77.1%) and cardiovascular failures (75%). MDs were also associated with lack of awareness, lower and elderly ages. Consequently, it led to poorer pregnancy outcomes (32). Similar findings were observed in another study in which the association of anaemia with maternal and neonatal outcomes was investigated. Worldwide, 24.8% of population is anemic and pregnant women contributes the largest. It may lead to low birth weight, preterm delivery, low APGAR score etc (31) (Figure 5).

Caesarean sections:

MDs following caesarean sections are disproportionately high in LDCs. Timely access to the healthcare center is of utmost importance for a safe delivery. In a meta-analysis, 196 trials from 67 LDCs were analysed. Women with C-section were at higher risk (7.6/1000 procedures). One-forth of all MDs in LDCs in 72 studies underwent C-section (33) (Figure 5).

Prevention of maternal mortality:

MMR is difficult to measure. It is important to know the causes of MD and how it can be prevented. PDHS reports show that MD accounts for 20% of deaths of females of 15-49 years of age 0(16, 23). Most MDs can be prevented by providing care of skilled and trained personnel. All the causes discussed above can be prevented by giving proper diagnosis, management and understanding of childbirth problems (20). Trained health professionals should handle labor complications. Severe bleeding can be stopped by an injection of oxytoxin. Also child birth should take place in hygienic environment. Pre-eclampsia can be prevented by giving drugs such as magnesium sulfate (19).

Main challenge is to provide proper EmOC 24/7. Staff training can increase confidence and skills. It is important to take steps for its implementation and upgrade basic plus comprehensive EmOC services (17).

Linked dataset for maternal outcomes:

Linked dataset across any country or any population for assessing the maternal outcomes. In a recent study conducted in Australia, first national linked dataset was used for this purpose. Although, this data linkage had methodological and jurisdictional challenges, it is valuable source to enhance knowledge about maternal and neonatal outcomes from different settings (34) (Figure 6).

Sisterhood method of maternal mortality Surveillance:

This method os surveillance is useful for estimation of MMRs in circumstances of limited resources, infrastructure and when mother is not available due to sad demise. Relatives, close family provide the information in such case. Based on National Total Fertility Rate (TFR) estimate of 4.88, Tajik Badakhshan had 141 MDs/ 100 million live births. Accurate TFRs are necessary for the actual and precise estimates of MD but certain variations are observed due to varied dempgraphics (35) (Figure 6).

Saving mothers giving life:

Ending preventable MDs is still a worldwide problem that need to be address under the United Nations Sustainable Development Goal targets 3.1 and 3.2.(11). Saving Mothers, Giving Life (SMGL) (Figure 6) was designed in 2011 within the Global Health Initiative as a public-private partnership between the U.S. government, Merck for Mothers, Every Mother Counts, the American College of Obstetricians and Gynecologists, the government of Norway, and Project C.U.R.E. SMGL's. The starting goal was to decrease the MDs in LDCs.

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A pilot project was initiated under this approach (2012-2013) in 8 rural districts in Uganda and Zambia with high morbidity of MD. Later on it was expanded to 13 districts of Uganda and 18 of Zambia. The outcomes of this strategy after its implementation were marvelous. 35% decrease in MMR was observed in just one year, 44% in Uganda and 41% in Zambia during 5 years. Facilitated and assisted deliveries raised from 46-67% in Uganda, 62-90% in Zambia; C-sections increased from 5.3-9% in Uganda and 2.7-4.8% in Zambia; MDs reduced from 11.5-3-5% in Uganda and 10-5-2.8% in Zambia (36).

Simulator-based training:

Simulator-based training may be beneficial and effective for the readiness and preparedness of TBAs and birth attendants in case of rare incidences or complications. It may save precious maternal and neonatal lives by improving the expertise and skills as well as preparing them for such events. Purpose is to establish the facilitators and obstacles in "low-dose, high-frequency" (LDHF) practice (29) (Figure 6).

Train the trainers Model:

This model was adopted to conduct a course (2012-2015) in Cambodia to reduce the MDs. It was a sustainable model to create awareness and knowledge to improve the maternal outcomes. 3 hospitals and 42 health centers in Ethiopia were selected where the trainees collected the data and analysed. A significantly high MMR was observed in cases of PPH, pre-eclampsia, complicated deliveries and C-sections. This ratio decreased from 64.7-40.8%/ 100 million deliveries in 2016 (37) (Figure 6).

Birth preparedness and complication readiness (BPCR):

This strategy helps the women to be aware of all possible maternal health care facilities during pregnancy and get ready for every circumstances including complications(6). Ethiopia has the lowest antenatal care facilities due to low income and resources. Hence, it is creating awareness for BPCR through community services to reduce the MMR. In a study

conducted in Ethiopia, secondary data from 215 women with a recent live birth in 10 health care centers was collected. Purpose of this survey was to get an insight regarding the birth readiness. Four out of six actions: identified a skilled health care provider, health center and transport, arranged the finances and clean delivery materials, prepared eatbles, were indicators of well preparedness of mothers. According to this criteria, two-third of the mothers were considered well prepared for delivery. Delivery in a health care center was practiced by well prepared mothers (57%). Antenatal birth preparedness counselling should be provided as a preventive measure to the mothers during the antenatal visits (38) (Figure 6).

Maternal Death Surveillance and Response (MDSR):

This system was proposed to provide knowledge for the prevention of MM. Evaluation of the MDSR was conducted in Hwange District, Zimbabwe, 2017. 36 respondents were recruited from 11 health care centers, approximately 72% of them were women. Lack of knowledge and awareness of health care workers was found to be main reason for the late notification of MDs. MDSR system is reliable and useful but it is not very simple. Therefore, proper descriptions of the cases and guidelines for declaration of MDs should be taught and adopted by the heath care workers(39) (Figure 6).

Implications for practice and policy:

According to the demand and suppy model to prevent MM, there are 4 needs of a balanced system: Health Promotion, Family planning, income generation and community advocacy. If these are provided, it will help in training of TBAs, upgraded equipents and provision of medicines, training of other health professionals by simulation based or other sessions and improvement in EmOC services. It may ultimately lead to the prevention or reduction in MMR(35) (Figure 7).

There is still a rise in MMR, despite of present stretegies to cope with this issue which is indicative of the insufficient obstetric, gynecological and neonatal care in LDCs (40). Poor health and education in females is a matter of great concern in this regard. No monitoring body at government level is present to address these issues

Strict control of labour/inducing drugs by the regulatory bodies is mandatory along with improved training of the healthcare workers (26). Women with poorer access to the antenatal care facilities and skilled TBAs are at higher risk (41). Efforts for the improvement of EmOC quality should be continued through proper skill-based training, incentives, latest equipment and sufficient drugs (42). Education of females must be improved. Transportation should be improved for pregnant women as recommended in the UN-MDG-5 (43). TBAs should be provided with financial benefits in recognition of referrals to community midwives (27). Skilled TBAs assisted approximately 80% live births from 2012-2017 as compared to 62% from 2000-2005 (7). Perspectives, concerns of different communities and the health care providers should be kept in mind before planning for any strategy, preventive measures, solutions and policies (44).

The rate of cesarean deliveries is alarmingly high in LDCs. Most of the patients go to private hospitals where cesarean deliveries are done just for commercial purposes(33). Government should take strict measures to lower this negative trend. This undue practice is harmful not only for the health of mother but also for future pregnancies and their outcomes. Awareness classes should be compulsory for both parents in the case of first pregnancy as most of the observed mortalities are observed in primiparous mothers. Strategies should be devised for reduction of domestic violence. Laws should be enforced to minimize Intimate partner violence (IPV) during pregnancy. The Government should make policies and guidelines to improve maternal, child care and also for the antenatal care. Early marriages should be prohibited and laws should be enforced. Poor families should be given some

support from government to bear the expenses of delivery, pre and post natal and maternal care. Better nutrition, health care facilities and education are needed to reverse these trends.

EmOC facilities should be improved at grass root scale of health care delivery to prevent avoidable MDs from PPH (1) and pre-eclampsis (45). The adjustable parameters like maternal weight, diet, awareness and access to the health center should be monitored to improve the maternal and fetal situation and avoid MDs (46). Proper implementation of these guidelines along with knowledge and training would guide the health professionals to diagnose the complications, manage them and help in reduction of MDs (45, 6, 47).

Conclusions:

Research on maternal mortality in Pakistan and other developing countries is next to zero and there are no linked datasets, no coherent information. Hurdles are at both ends, Government (due to lack of resources, funds and priority) and people (they are not willing to investigate or provide information, poverty and lack of resources). These issues can be measured by a nation wide surveillance, coherent and linked datasets with all the information, and the models provided in this debate which are adopted by some other countries as well (simulator based training, train the trainers model, saving mothers giving life, birth preparedness, sisterhood method etc) may provide frameworks to the Government and healthcare policy makers to address and prevent this issue of serious concern to achieve the sustainable development goals.

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Figure Legends:

Figure 1: Maternal Mortality Ratio (MD per 100 mllion live births) in 1990 and 2015 in different regions of world

Figure 2: Trends in MMR (1990-2015) in South Asia

Figure 3: Sand Clock of Five countries with highest (Red) and lowest (green) MMR

Figure 4: The Three Delays Model for Maternal Mortality

Figure 5: Risk factors associated with maternal deaths

Figure 6: Frameworks to prevent Maternal Deaths

Figure 7: Demand and Supply Model to prevent Maternal Mortality

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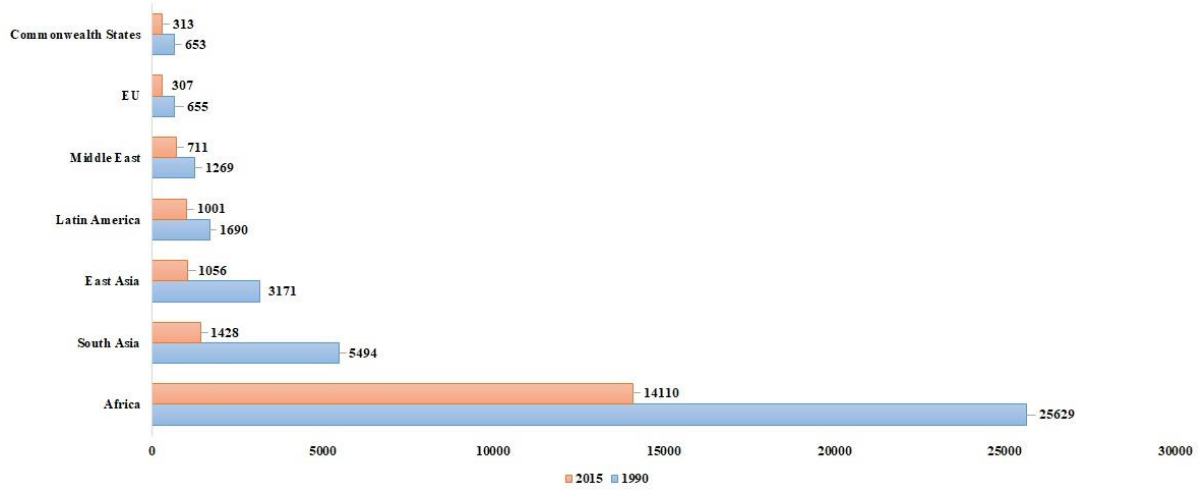

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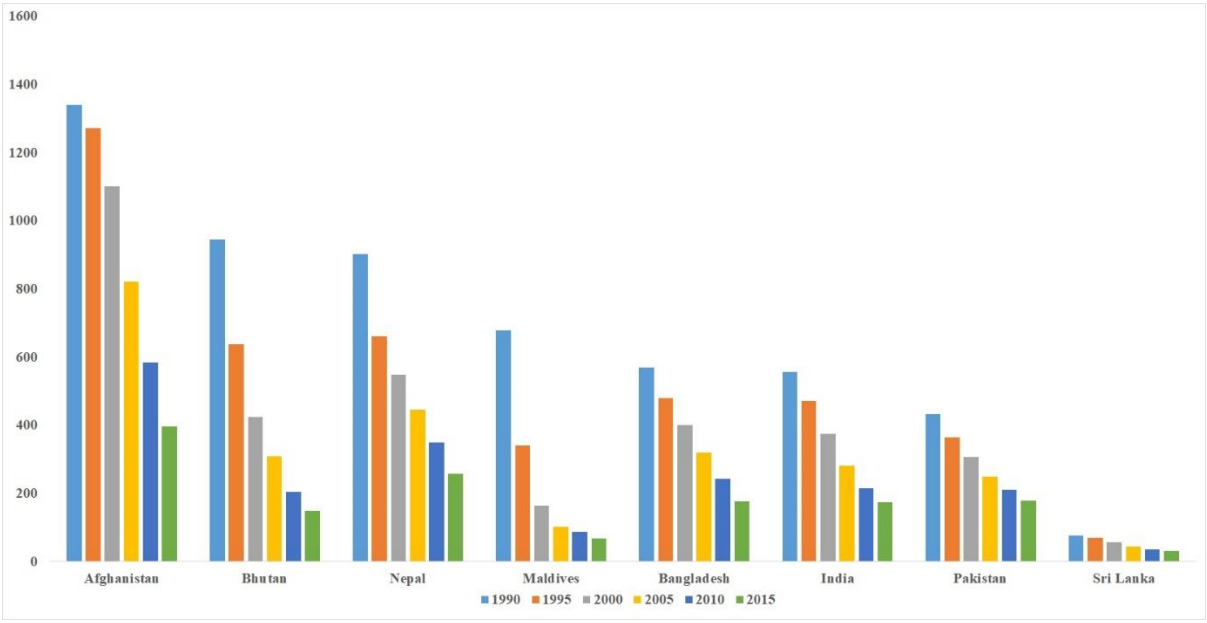

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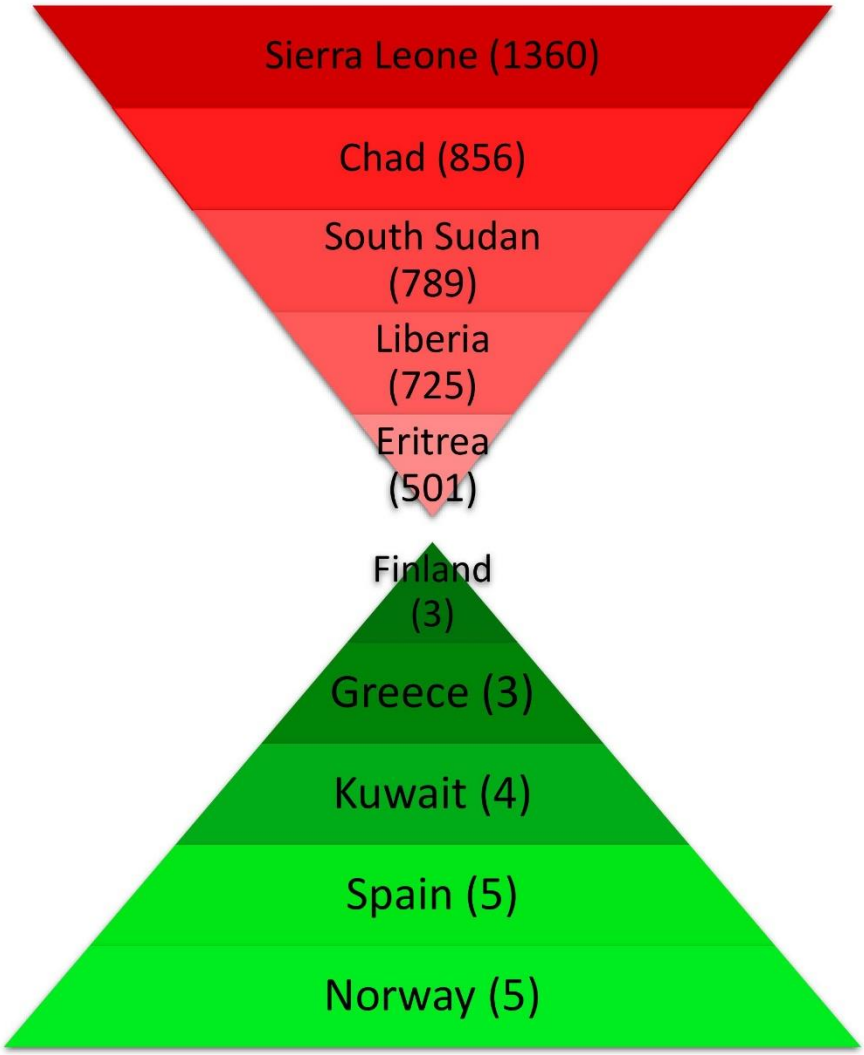

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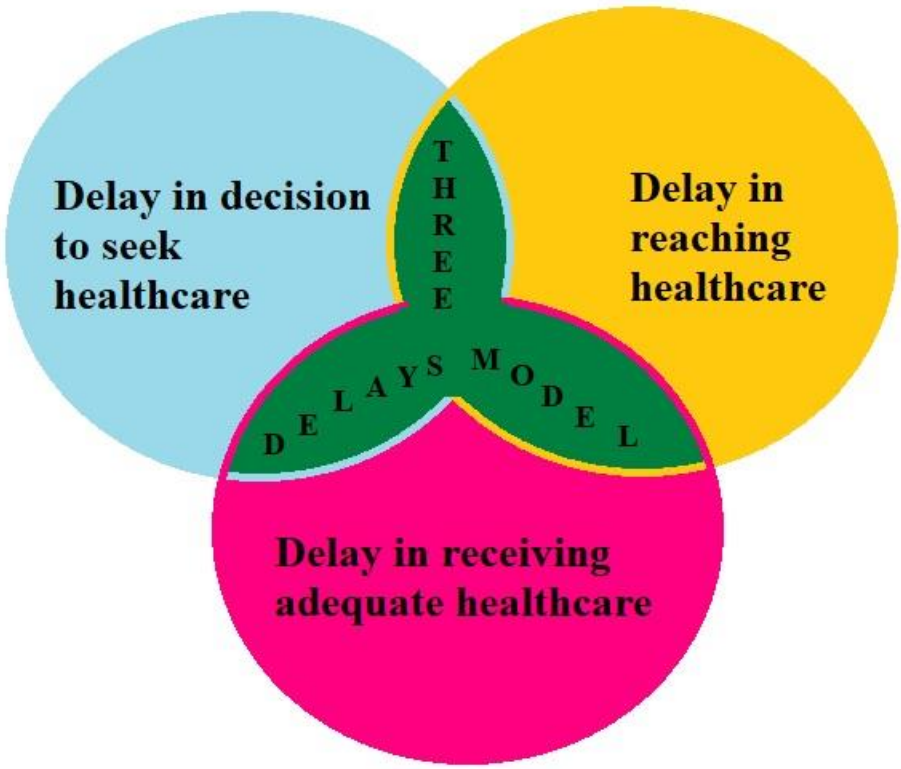

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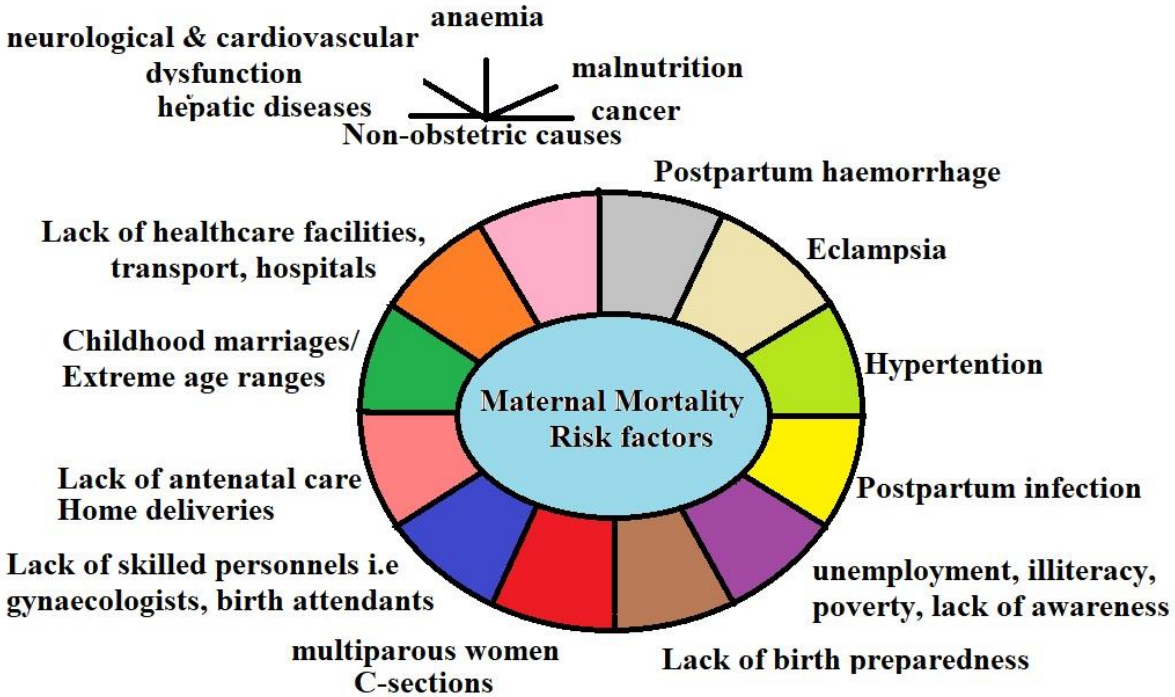

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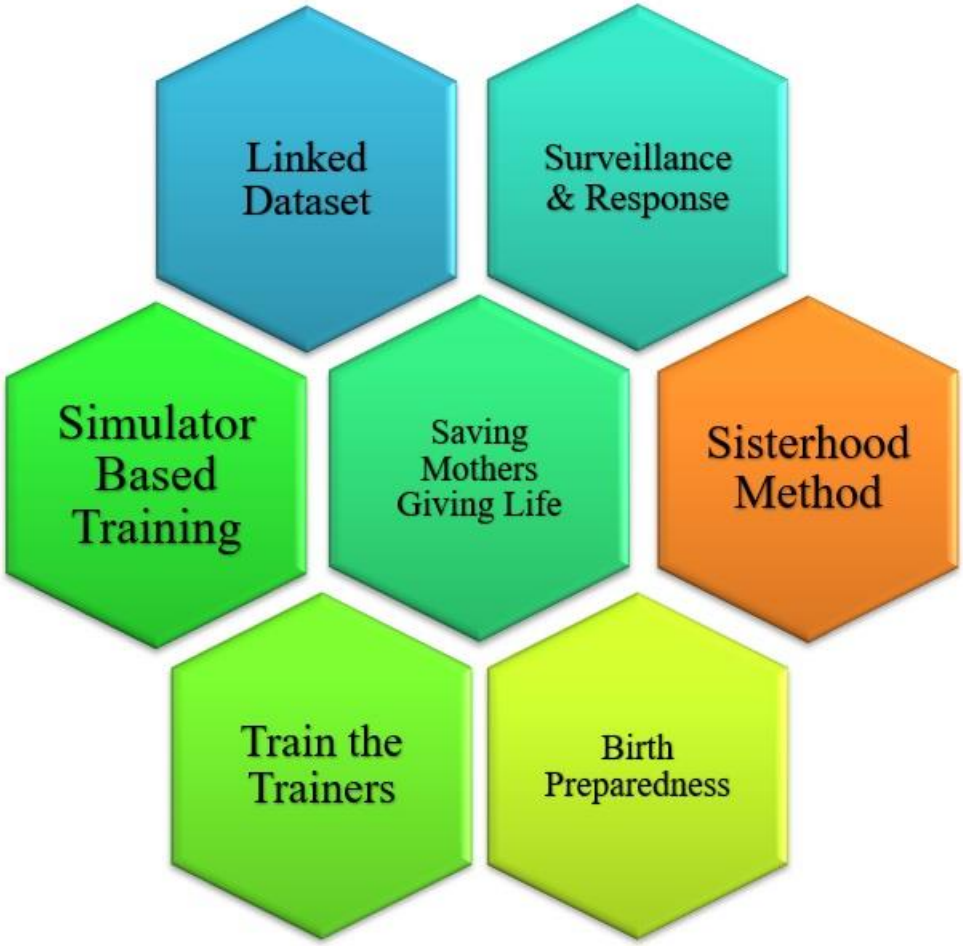

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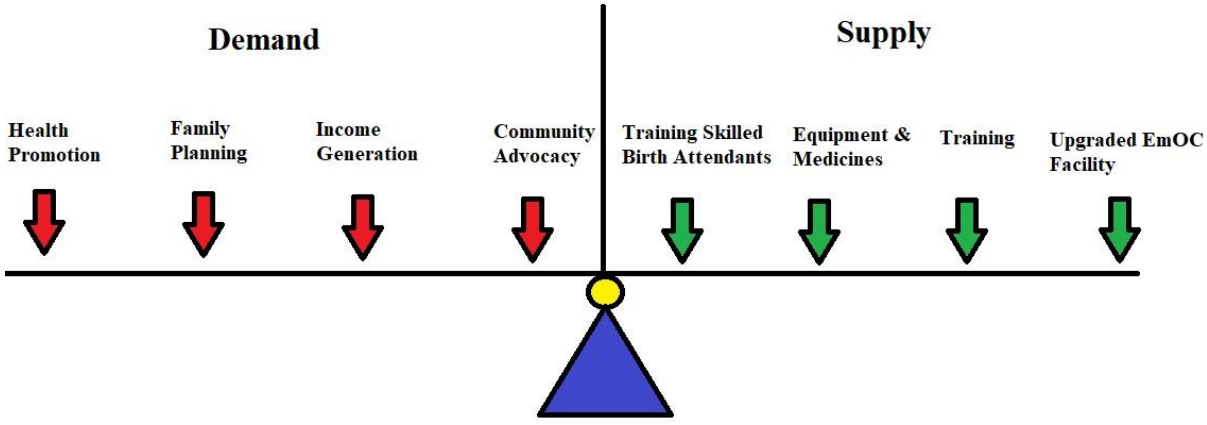

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