Maternal Mortality Ratio and Universal Access to Reproductive Health Care in the State of Qatar between 1990 and 2012: A PEARL Study Analysis

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Abstract: *Study Aim:* The Millennium Development Goal (MDG)- 5 mandates a three quarters reduction in Maternal Mortality Ratio (MMR) and provision of universal access to reproductive health by 2015. Our study aims to analyze Qatar's performance in achieving MDG 5 between 1990 and 2012.

Study Design: A National Prospective cohort-study

Data Source: Qatar Perinatal Registry (Q-Peri-Reg) for 2011 and 2012 data

Methods: National data on total deliveries, total births (live and stillbirths) and maternal mortality (during pregnancy to day 42 post-delivery) was collected from all public and private maternity units in Qatar (1st January 2011- December, 31st 2012) and compared with historical maternal mortality data (1990-2010) ascertained from the database of maternity and neonatal units of Women's Hospital, annual reports of Hamad Medical Corporation and international reports. For inter country comparison, country data was extracted from World Health Statistics 2011(WHO).

Results: The country wide live births were 20583 during 2011 and 22,225 during 2012 with two maternal deaths duringeach year giving an MMR of 9.85/100,000 and 8.99/100,000 live births respectively which was more than three quarters decline from an MMR of 49/100,000 in 1990. During 2011, 74.22% deliveries were normal vaginal (n 15076) and 25.78% (n 5238) by Caesarean section. 99.45 % of deliveries were attended by a trained birth attendant in a maternity facility while 0.55 % (n = 114) took place out of hospital. 100% of mothers had made at least one antenatal visit and 100% of live births were examined by a pediatrician and entered in national birth register. Qatar's 2011 and 2012 MMR is significantly lower than the current global MMR of 260/100,000 and Eastern Mediterranean Region MMR of 320/100,000.

Conclusion: Qatar has achieved its target MDG 5 well before 2015. Qatar's 2011 and 2012 MMR is comparable to most high income countries. Qatar's reproductive health system, with its universal access for all, provides a unique model to study the correlates and associations of maternal survival which can form the basis of global health systems improvement strategies.

Keywords: Maternal mortality, Millennium development goals, Reproductive health, Neonatal perinatal registry, Qatar.

INTRODUCTION

Maternal Mortality has always been an important focus of international social development projects. It had been a specific target for World Health Organization's Millennium Development Goal 5 (MDG-5) which required (1) reducing the maternal mortality ratio (MMR) by three quarters between 1990 and 2015, and (2) achieving universal access to reproductive health by 2015 [1]. Accurate monitoring of maternal mortality at national and regional levels is vital, not only to track progress, but also to influence national policies and resource mobilization. A number of excellent progress reports on Maternal Mortality, published over the last decade [2-9], have shown a dramatic difference in the number of reported maternal deaths which reflects how difficult it is to measure MMR. The widespread perception that progress in maternal mortality has been slow, and in many places non-existent [2-7] has been diluted by the two recent international reports [8, 9], which have shown a 32% and 47% reduction, respectively, in global MMR

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between 1990 and 2011. Both studies were based on complex statistical modeling with wide variability in data sources and methodology [18, 9]. The report published by WHO in 2012 [9], classified State of Qatar among the twenty-seven countries with no good quality national data on maternal mortality. The current study aims to bridge this gap by providing authentic, prospective, research registry based data on Qatar's national maternal mortality ratio during 2011 and 2012. The study also analyzes Qatar's progress in achieving universal access to reproductive health care as required by MDG-5. Qatar's population during the study period was 2.051 million with 25% females and 75% males. This male preponderance is due to the high number of un skilled expatriate single men who have been employed in the construction industry of this fast growing country.

METHODOLOGY

PEARL Study (Perinatal Neonatal Outcomes Research Study in the Arabian Gulf) is Qatar's prospective National Perinatal Epidemiologic Study. The project has established a National electronic Neonatal Perinatal Registry called Q-Peri-Reg, which is now being used to quantify maternal, neonatal and perinatal mortality, morbidities, and their correlates. PEARL Study has a 30-member multidisciplinary research team comprised of pediatricians, neonatologists, perinatologists, obstetricians, epidemiologists, statisticians and 15 full time physicians (including 1 research fellow, 2 research associates, and 12 research assistants). The team is responsible for daily data collection, data entry, data cleaning and data organization.

PEARL Study involves the collection of data, on pre-designed forms, from all maternity hospitals in Qatar (two public and three private hospitals) where 99.5% of deliveries take place. Data from two new public sector hospitals established at the end of 2012 was also included. Data was also captured on the remaining 0.5% out of hospital deliveries which, under the State of Qatar's mandatory law of birth registration, have to be entered into national birth registry. Hence, the data collected by PEARL Study team virtually represents a national population-based data. The Q-Peri-Reg data is also unique in its characteristic of having been collected in real time, on daily basis including weekends and holidays.

PEARL Study takes an informed written parental consent, on pre-approved forms (printed both in English and Arabic) before ascertaining demographic, socio-economic and family data.

PEARL Study Definitions of Maternal Mortality

PEARL Study uses the ICD-10 definitions [10] to ascertain, analyze and report its maternal outcomes data (Table **1**). The definitions take into account both the timing of maternal deaths and their cause.

Timing of Maternal Death

Deaths during pregnancy or ≤ 42 days after termination of pregnancy are classified as early maternal deaths and those after 42 days up to one-year post termination of pregnancy are classified as late maternal deaths.

Causes of Maternal Death

The causes of maternal deaths are classified into four groups:

1. Direct Obstetric causes *e.g*. those resulting from obstetric complications of the pregnant state (pregnancy, labor, and puerperium), from interventions, omissions, incorrect treatment, or from chain of events resulting from any of the above;

2. Indirect Obstetric causes (those resulting from previous existing disease(s), or disease(s) that developed during pregnancy and were aggravated by the physiologic effects of pregnancy);

3. Maternal deaths due to HIV Infection and

Table 1: Definitions of Maternal Death According to Time and Cause of Death [7, 10]

Time of Death (Y -Axis)/Cause of Death (X - axis)	Direct	Indirect	HIV	Incidental
Early maternal death (Pregnancy to ≤ 42 days post-delivery)	A	B	C	D
Late maternal death (>42 days to ≤ one year)	E	F	-	-

4. Maternal deaths due to incidental causes unrelated to pregnancy such as accidents, homicide, and suicide.

ICD-10 assigns maternal deaths in category A, B, E and F given in Table **1** to its Chapter O (Obstetrics). The ICD-10 manual and the MDG manual [11] recommend that the maternal mortality ratio should include categories A, B and C. PEARL study has followed the recommendations of MDG manual while analyzing Qatar's maternal mortality ratios during 2011 and 2012. Since late maternal deaths (E and F) and deaths from incidental causes other than HIV (D) are not included in international comparisons of MMR, PEARL Study also excluded these causes during inter-country comparison of Qatar's MMR [12].

Data Ascertainment

The data on total deliveries and live births was ascertained from the Q-Peri-Reg database. All babies with a birth weight of ≥ 500 grams who were born with any signs of life were included in birth and death statistics irrespective of gestational age or futility at birth. Number of maternal deaths in a year was evaluated against the ICD-10 and WHO criteria as stated above according to which only the direct obstetric deaths were considered for final maternal mortality ratio calculation.

Statistical Analysis

Since the number of maternal deaths was very low (only two during 2011 and two during 2012), statistical analysis of trends and correlates of maternal mortality was not possible. However, to estimate the overall improvement in Reproductive health care in Qatar a parallel statistical analysis (independent of the current study) of Qatar's trends in neonatal and perinatal mortality between 1975 and 2012 was conducted. An analysis of correlates of neonatal and perinatal mortality was also carried out.

The data was entered into Epi Data version 3.0 and analyzed using SPSS version 20.0. Chi-square test of significance was used to identify any significant differences between categorical variables, which were computed as frequency and percentages. A two-sided P value of <0.05 was taken as significant. In Univariate analysis, Relative Risk (RR) of Neonatal and Perinatal Mortality with 95% CI was calculated using 1975 data as reference. Significance of trends in neonatal mortality between 1975 and 2011 was measured by using trend Chi square statistics. Multivariate analyses of socio-demographic correlates of neonatal and perinatal mortality were carried out using cox regression model.

RESULTS

Obstetric and Perinatal Profile

The total number of country wide deliveries was 20314 during 2011 and 21908 during 2012. The total births were 20725 (20583 live births and 142 still births) during 2011 and 22372 (22225 live births and 147 still births) during 2012.

During 2011, 74.22% deliveries were normal vaginal deliveries (n 15076) and 25.78% (n 5238) Caesarean section while during 2012, 72% deliveries were normal vaginal deliveries (n 15784) and 28% (n 6124) deliveries were by Caesarean section. During 2011, 98.05% deliveries (n 19,919) were singleton and 1.95% deliveries (n 395) were twins and multiples while during 2012, 98.1% deliveries (n 21,493) were singleton and 1.9% deliveries (n 415) were twins and multiples. During 2011, 30% of delivered mothers (n 6093) were Qatari nationals and 70% (n 14221) were Non-Qatari while during 2012, 27.7% of delivered mothers (n 6070) were Qatari nationals and 72.3% (n 15838) were Non-Qatari. During 2011, 8.4% live born babies (n 1742) were preterm (< 37 weeks) and 8.72% (n 1807) were low birth weight (< 2500 grams) while during 2012, 7.1% live born babies (n 1578) were preterm (< 37 weeks) and 7.78% (n 1730) were low birth weight.

During 2011, 99.45% of live births took place in a maternity facility under trained birth attendant (Obstetrician or midwife) whereas only 0.55% (n 114) occurred outside maternity hospitals, either at home or while en route to hospital. The ratio was 99.57% at hospital and 0.43% (n 94) out of hospital births during 2012. All these out of hospital births were, however, registered at Women's hospital under the State of Qatar's law of mandatory birth registration. 87% of live births took place in public hospitals and 13% in private hospitals. All recorded stillbirths occurred in the maternity hospitals (93.75% in public hospitals and 6.25% in private hospitals).

Maternal Mortality (MDG-5-A)

During 2011, a total of 491 women died in Qatar, out of which 172 were in the reproductive age group (15-55 years). According to the ICD-10 and MDG Criteria A, B and C (Table **1**), Qatar had only two maternal deaths during 2011 giving a Maternal Mortality Ratio (MMR) of 9.85/100,000. Both deaths occurred in public sector tertiary care maternity hospital. One of these two deaths occurred in medical ICU secondary to HELPP Syndrome and its complications (fulminate hepatic failure, abdominal

bleeding and multiple organ failure). The second death occurred in the maternity unit due to sudden pulmonary embolism.

During 2012, a total of 446 women died in Qatar, out of which 158 were in the reproductive age group (15-55 years). During 2012, Qatar had three early maternal deaths. One of these was due to sudden cardiac arrest 33 days post-delivery in a woman who was previously completely asymptomatic. Hence, this was classified as category D (incidental) according to ICD-10 classification (Table **1**) and excluded from the calculation of MMR. The other two were classified as category A (direct) and hence included in the calculation. One of these had septic abortion during first trimester and the other one had miliary tuberculosis and septic shock with multi organ failure at 18 weeks of gestation. Based on these two deaths Qatar's Maternal Mortality Ratio (MMR) was 8.99/100,000 live births during 2012.

Between 1990 and 2012 Qatar's MMR dropped by 80% (from 49/100,000 in 1990 to 8.99/100,000 in 2012). Qatar's MMR had been zero for several years between 1995 and 2000; for the rest of the years it had been between 7 and 11/100,000 (Figure **1**).

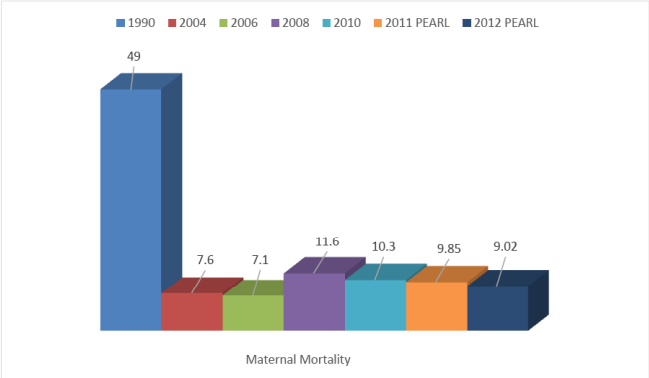

Figure 1: Trends in Maternal Mortality Ratio (MMR/1000,000 live births) in Qatar (1990-2012).

Access to Reproductive Health Care (MDG-5-B)

According to PEARL study data extracted from Q-Peri-Reg, 94% of delivered mothers had at least one antenatal visit to a qualified obstetrician while 100% of live births were examined by a pediatrician and entered in national birth register during 2011. The univariate and multivariate analysis of correlates of Qatar's neonatal and perinatal mortality during 2011 has revealed that the mortality was independent of nationality, gender, maternal and paternal age, maternal and paternal occupation, socio-economic status, living status and life style (P>0.05). During 2011, 89.3% of mothers delivered in Qatar had a literacy level of secondary school and above. Educational level below secondary school had a significant association with neonatal mortality (RR 2.08, 95%CI 1.23-3.53, p=0.009) both on univariate and multivariate analysis. Educational level below secondary school also had a significant association with perinatal mortality (RR 2.82, 95%CI 1.04-7.66, p=0.042) on multivariate analysis.

DISCUSSION

The efforts to reduce global burden of maternal mortality always carried a sense of failure for health strategists and planners; initially due to failure of Save Motherhood Movement over a period of 20 years and then the feeble progress made in achieving MDG-5 [13]. However, the message from recent reports on the progress towards MDG-5 [7-9], for the first time in a generation, is one of persistent and welcome progress. Lozano *et al.* [8], have reported a 32% decline in global MMR between 1990 and 2011, at an average rate of 1.9% per year with the result that global maternal deaths have dropped from 409,053 (uncertainty limits 382,910-437,860) in 1990 to 273,465 (uncertainty limits 256,332-291,693) in 2011. Based on these trends, only 13 developing countries were expected to achieve MDG-5 by 2015 [9]. The combined UNFPA, UNICEF, WHO and World Bank report on trends in maternal mortality, has shown a 47% decline in global MMR between 1990 and 2010 with the result that the global number of maternal deaths has dropped from 543,000 in 1990 to 287,000 in 2010 [9]. According to this report 10 countries which had achieved MDG 5 by 2010 are: Estonia (95%), Maldives (93%), Belarus (88%), Romania (84%), Bhutan (82%), Equatorial Guinea (81%), Islamic Republic of Iran (81%), Lithuania (78%), Nepal (78%) and Viet Nam (76%). Unfortunately, the report produced a mixed and confusing message about Qatar. The report placed Qatar among those 27 countries which had no good-quality national data available on maternal mortality and at the same time has reported a 53% reduction in Qatar's MMR between 1990 and 2010. Our current study has tried to remove this confusion and has bridged the knowledge gap by using Q-Peri-Reg data which not only represents a true population based data; it has been collected over real time; hence, raising it in quality and credibility. Having been ascertained from multiple sources (interviews with newly delivered mothers, medical records, labor room reports, hospital death certificates and mortuary reports) the data passes verification at several stages, therefore, minimizing the chances of any errors. The State of Qatar has a very strong and mandatory

national birth and death registry which is also used by PEARL Study to ascertain and compare its data. This adds to the credibility of our data ascertainment. A limitation to our study is the fact that a women's death certificate in Qatar does not mention her pregnancy status at the time of death or during the preceding 280 days which carries the potential of missing some maternal deaths due to obstetric causes.

The present study has not only shown more than 80% reduction in Qatar's MMR (from 49/100,000 in 1990 to 8.99/100,000 in 2012); it has also shown that Qatar's current MMR is comparable to many high income countries both from the West and East (Figure **2**). In fact, Qatar had achieved most of its MDG's before 2007; half way between 1990 and 2015 [14]. Qatar had met the MDG-5-A requirement by year 2000 when Qatar's MMR had been zero for several years [14,15]. The State of Qatar has reached its goals in achieving better standards of prosperity for its citizens, which can be seen in the fields of health, education, environmental sustainability, global partnership for development, promoting gender equity, and women empowerment [16].

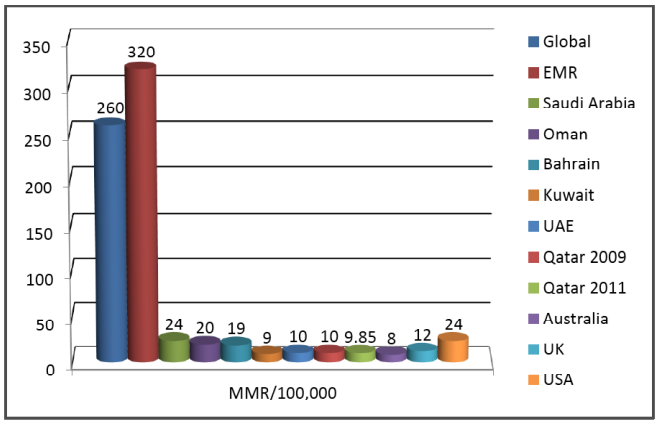

Figure 2: Qatar's Maternal Mortality Rate during 2011 as estimated by PEARL Study compared to Global, Eastern Mediterranean Region (EMR), GCC countries and some developed world countries' Maternal Mortality Rates during 2011 (Source: World Health Statistics 2011 WHO).

Estimating accurate and valid country wide maternal mortality is a daunting task [2-9]. For the State of Qatar, Pearl Study has achieved this goal by using a rigorous scientific research methodology. In addition, the current study has also confirmed that Qatar's MMR has dropped from 49/100,000 in 1990 to 9.85/100,000 in 2011 and 8.99/100,000 in 2012. This constitutes more than 80% reduction in MMR which is above the bench mark of 75% MMR reduction required by MDG-5-A (Figure **1**). The current study has also established that the State of Qatar has already achieved its target of MDG-5-B which requires universal access to reproductive health by 2015 (Table **2**). According to Q-Peri-Reg database, 94% of mothers who delivered during 2011 had at least one antenatal visit to a qualified obstetrician. Q-Peri-Reg has also recorded 99.5% of births taking place in a maternity hospital and attended by a midwife / obstetrician while the postnatal examination of each newborn baby by a pediatrician has been recorded at 100%. This reflects universal access to reproductive health care irrespective of nationality and socio-economic status. Qatar moved to facility based deliveries in 1975 with nationwide deliveries less than 3000 at that time. Since then the system has evolved in parallel with improvement in socio-economic status, rapid urbanization, and heavy investment in health and education systems and social infrastructure. There is a temporal relationship between improvements in these quality of life indicators and reproductive health outcome indicators. PEARL Study project did not have the means and resources to conduct any direct statistical analysis of association between these indicators. The indirect temporal association constitutes a fairly strong evidence that ensuring universal access to reproductive health care with heavy investment in targeted interventions can not only significantly improve Maternal Mortality Ratio (MMR) but also other reproductive health care outcome indicators as well.

The improvement in Qatar's MMR is a part of improvement in all aspects of reproductive, maternal

Table 2: A profile of Maternal and Child Health Care (MCHC) in Qatar 1980-2012

MCHC Indicator	1980	1986	1993	2000	2008	2010	2012
% of pregnancies attended by TBA	100%	100%	100%	100%	100%	100%	100%
% of deliveries attended by TBA	100%	100%	100%	100%	100%	100%	100%
% of babies seen by trained person	100%	100%	100%	100%	100%	100%	100%
Childhood immunization	80%	96-100%	96-100%	96-100%	96-100%	96-100%	96-100%
Cases of Neonatal Tetanus	3	1	0	0	0	0	0

and child health care outcomes in the State between 1975 and 2011 (Table **2**). According to the recently published data from Q-Peri-Reg, Qatar's Perinatal Mortality Rate (PMR) during 2011 was 9.55/1000, while the stillbirth rate was 6.85/1000 (for fetuses >500g birth weight) and 4.76/1000 (for fetuses >1000g birth weight) [17]. These rates are comparable to the stillbirth rates of many high income countries; both from the West and East [17]. Between 1990 and 2011, the Relative Risk of Perinatal Mortality in Qatar decreased by 28% (p=0.002) with a significantly downward trend of Risk Ratio (p=0.0016) [17]. According to another recently published data from Q-Peri-Reg, Qatar's National Neonatal Mortality Rate (NMR) during 2011 was 4.95/1000, Early Neonatal Mortality Rate (ENMR) 2.7/1000, and Late Neonatal Mortality Rate (LNMR) 2.2/1000 [18]. Between 1975 and 2011, the Relative Risk of Neonatal Mortality in Qatar decreased by 87% (p<0.001) though the population increased by 10 fold and the number of deliveries increased by 7.2 folds [18] (Figure **3**). Similarly, the under-five childhood mortality in Qatar has dropped from 17/1000 in 1990 to 8.8/1000 in 2011 and the infant mortality from 12.9/1000 in 1990 to 7.4/1000 in 2011 [16].

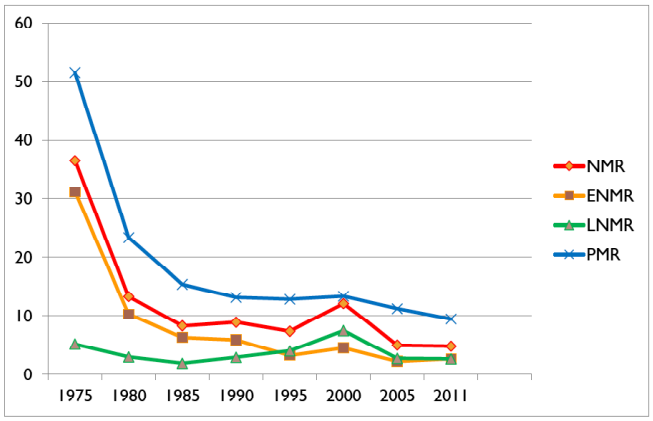

Figure 3: Trends in Qatar's Neonatal (NMR), Early Neonatal (ENMR), Late Neonatal (LNMR) and Perinatal Mortality Rates (PMR) between 1975 and 2011. (Source: HMC Annual statistics).

Maternal Mortality cannot be reduced by any one intervention alone: maternal mortality reduction requires a health systems solution [19]. Similarly, MDG-5 cannot be achieved in isolation. The efforts require a holistic approach to all MDG's. Hogan *et al.* [7], have shown that programs to reduce fertility rates, increase individual incomes, expand maternal education and widen attendance to skilled birth attendants have a measureable effect on reducing maternal mortality. Our current study has shown that, during 2011, 89.3% of mothers delivered in Qatar had a literacy level of secondary school and above which had a significant association with reduction in neonatal mortality (p=0.009) as well as perinatal mortality (p=0.042). This high level of women's literacy is reflective of Qatar's achievement of MDG-2 (achieving universal primary education by 2015) which, in the State of Qatar, had reached 100% by 2008 (Figure **4**) [16].

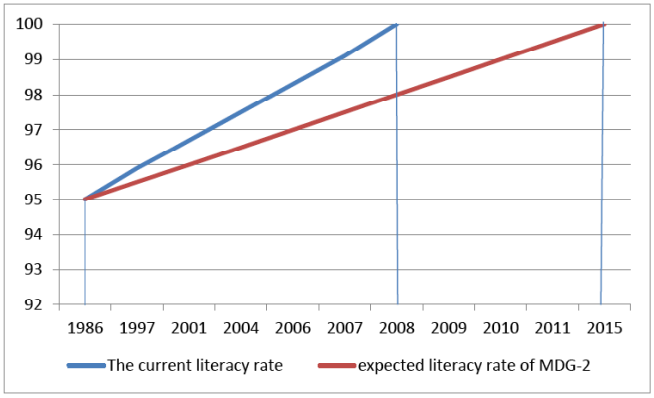

Figure 4: Progress of Literacy Rate in Qatar 1986-2011(Source: MDG in the State of Qatar Report 2012).

Last, but not the least, is the fact that strong country leadership and effective strategic coordination are vital to achieving sustainable health systems [19]. The State of Qatar provides universal access to health care for all its citizens which is mandated by Article 23 of its Constitution which states that: "The State cares for public health and provides the means of prevention and treatment from diseases and epidemics as per the law" [20].The development outlook witnessed by Qatar in the last two decades indicates that the government has managed to achieve most of the MDGs [16].

CONCLUSIONS

Qatar's MMR for 2011 and 2012 is one of the lowest among the regional countries and comparable with the MMR of selected high income countries. In addition, Qatar had achieved both components of Millennium Development Goal -5 before the target year of 2015. However, this achievement should act as a catalyst in developing strategies for further improvement in reproductive, maternal and child health care. Accurate and authentic estimation of maternal mortality will continue to stand as the basic pillar of all progress reports. Hence, PEARL Study recommends that a women's death certificate should include her pregnancy status at the time of death, 42 days and 280 days prior to death in addition to the cause of her death. This will streamline the country, regional and global MMR estimation according to ICD-10 and MDG criteria.

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ETHICAL APPROVAL

PEARL study was approved by the Institutional Research Ethics Committee of Hamad Medical Corporation, State of Qatar (Protocol #9211/09).

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CONFLICT OF INTEREST

None declared.

WHAT IS KNOWN ON THIS SUBJECT

1. Maternal Mortality is an indicator which is very difficult to measure accurately particularly at the country level.

2. Two thirds Reduction in Maternal Mortality and achieving universal access to reproductive health care by 2015 is a global goal which is unlikely to be achieved by many countries.

WHAT THIS STUDY ADDS

1. The current study has been able to accurately estimate Qatar's National Maternal Mortality Rates during 2011 and 2012.

2. Qatar has achieved its target reduction of Maternal Mortality well before the 2015 dead line. An in depth analysis of correlates of this success will help the international community in designing health policy and system to achieve their target reduction in MMR.

STRENGTHS AND LIMITATIONS OF THE STUDY

Strengths

Pearl Study Project has prospectively collected Qatar's Maternal, Neonatal and Perinatal data at a national level using a robust research methodology and ICD-10 definitions. The reported national MMR for 2011 and 2012 is validated and authentic.

Weaknesses

The MMR prior to 2011, extracted from historic reports of Department of Medical Statistics is based on service data. The evolution of reproductive health systems and socio-economic status during the same period seem to have happened as a parallel phenomenon though they are essentially interdependent. The evaluation of these phenomena was beyond the remit of our project. Hence, evaluation of direct statistical correlation was not possible. However, the existence of temporal association between the two outcomes should form the basis of further research to analyze the direct associations between health systems improvement and excellent maternal survival which Qatar has achieved.

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