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Research Article
Causes of Maternal Death During Childbirth in Tehran-Iran in 2011-2015

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Abstract

Background and Objective: The occurrence of maternal death would threaten the family foundation and children's health. The aim of this study was to determine the causes of maternal deaths during childbirth in Tehran province, Iran in 2011-2015. **Materials and Methods:** All Maternal Mortality Ratio (MMR) in Tehran province from 2011-2015 were considered in this cross-sectional study. Data were recorded for demographic characteristics, autopsy findings, medical and obstetric histories. The data were then analyzed with a z-test to identify differences in the rate of MMR during the study period. **Results:** The mean MMR was 15.8 in 100,000 live births (95% CI, 1.076-13.546) during the 5 years study period and the highest MMR was 19.1 in 2011 and the lowest proportion was 13 in 2015. Most deaths (23.6%) occurred in the preeclampsia-eclampsia period and the lowest autoimmune disease and addiction (1.8%). High-risk mothers accounted for 79.2% of maternal deaths. Among the mothers who died, 50.45% received satisfactory prenatal care and at least 2 years elapsed between successive pregnancies in 23.8%. Vaginal bleeding was the main cause of death (33.8%). **Conclusion:** The MMR has been declining over the years, due to the identified factors associated with maternal death, proposed strategies, such as improving the quality of hospital services.

INTRODUCTION

An estimated 300,000 women died globally in 2015 as a result of pregnancy-related conditions[1]. Although maternal mortality ratios remain elevated in many areas, the maternal mortality ratio has decreased by 1.3% per year globally since 1990, with the greatest annualized rate of reduction in developed countries (1.3% versus 1.4% in developing countries)[2]. During the same time period, however, the maternal mortality ratio in the United States increased[2]. Globally, reduction in maternal mortality has been attributed to reduction in the total fertility rate, increase in maternal education and increased access to skilled birth attendants[2]. Other factors associated with maternal mortality reduction include the promotion of policies to reduce anemia and malnutrition, prevent malaria in pregnancy, provide calcium and micro-nutrient supplementation, encourage delivery in facilities properly resourced for emergency obstetric care, discourage early motherhood and reduce unsafe pregnancy termination[3].

World Health Organization (WHO) in version 10 of International Classification of Diseases (ICD-10) defined maternal mortality as maternal death during pregnancy or within 24 h after delivery irrespective of the duration and place of delivery from any cause related to pregnancy or aggravated by the pregnancy or its management[4]. Maternal Mortality (MM) is a term used when a mother dies due to complications of pregnancy within 42 days after delivery[5]. It is estimated that over 500,000 maternal deaths occur annually, i.e., approximately one death per minute[6,7]. Overall, 15% of all pregnancies are complicated by mostly preventable and manageable obstetric conditions[8]. The main contributing factors of nearly 75% of maternal deaths are hemorrhage, infections, hypertensive disorders, obstructed labor and unsafe abortion[6,7]. Other no obstetric disorders that play a role in MM include severe anemia, sickle cell disease and cardiovascular diseases[7]. Aside from medical causes, several non-medical issues also play key roles in MM such as socioeconomic, cultural, religious and biological factors (age and parity)[7]. The risk of MM is 200 times higher in developing countries compared to develop ones[8]. This is equal to 1 death in every 18 pregnancies, compared to 1 in every 2228 conceptions in developed countries[9]. Disparities in MM between developed and developing countries have highlighted the need for global attention to this important issue; therefore, the goal to achieve a 75% reduction in MM in all countries by the end of 2015 has been set as part of millennium development goal number 5[8]. Since then, some progress has been made in developed countries; however, the problem persists in Asia and Africa, where the status is more hazardous[10,11]. In Iran, a developing country in the Middle East region, MMR has fluctuated from 47.2 per 100,000 live births in 1993 to 34.3 per 100,000 in 1995, 45.7 per 100,000 in 1997, 34 per 100,000 in 1999, 38.7 per 100,000 in 2004 and 34 per 100,000 live births in 2008[12]. Despite some overall progress in MMR trends, the rate is far from ideal and needs to be lowered. The MM refers to deaths due to complications from pregnancy or childbirth. From 1990-2015, the global MMR declined by 44% from 385 deaths to 216 deaths per 100,000 live births, according to UN inter-agency estimates (Fig. 1). This translates into an average annual rate of reduction of 2.3%. While impressive, this is less than half the 5.5% annual rate needed to achieve the three-quarters reduction in maternal mortality targeted for 2015 in millennium
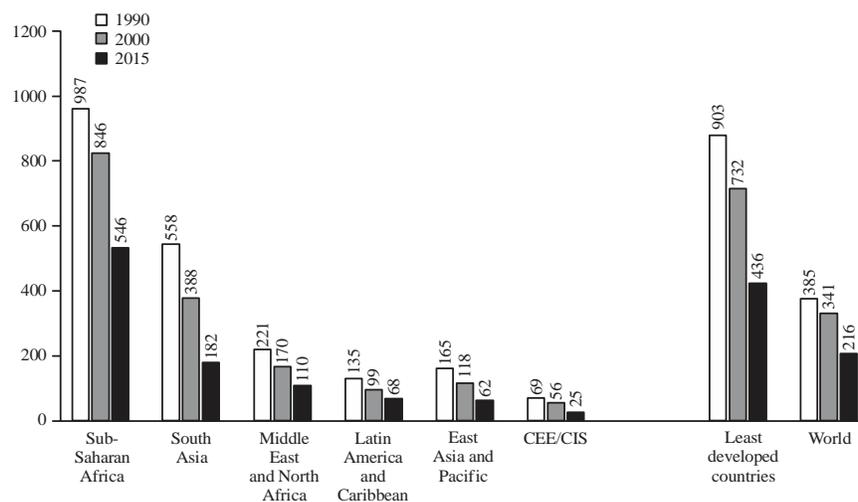

Fig. 1: Causes of MMR fell by almost half between 1990, 2000 and 2015 in the world[12-15]

Table 1: Trends in estimates of MMR, maternal deaths per 100,000 live births in Iran1990-2015[12-15]

Years	1990	1995	2000	2005	2010	2015
MMR	123	80	51	34	27	25

MMR: Maternal mortality ratio

Table 2: Causes of maternal mortality fell by almost half between 1990 and 2015 in Iran[12-15]

| | Years (%) | |
| | --- | --- |
Causes of reduce MMR in Iran	1990	2015
Births attended by skilled health staff (Percentage of total)[16]	78	93
Maternal mortality ratio (modeled estimate, per 100,000 live births)	216	140
Pregnant women receiving prenatal care	58	93
Mortality caused by road traffic injury (per 100,000 people)	24	24
Diabetes prevalence (Percentage of population ages 20-79)	10.1	10.1
Improved sanitation facilities (Percentage of population with access)	71	90
Improve	80	88
Improved sanitation facilities, urban (Percentage of urban population with access)	92	90

Table 3: Causes of decrease MMR in Iran 1990-2015[12-15]

Years	Maternal mortality ratio (Per 100,000 live births)	Maternal deaths (No.)	AIDS-related indirect maternal deaths (No.)	Live births (Thousands)	Proportion of maternal deaths among deaths of female reproductive age (PM%)	Annual rate of reduction	Percentage
1990	123 (98-171)	2300	0	1836	7.5	1990-2015	6.4 (5.3-7.8)
1995	80 (66-100)	1200	0	1457	4.1	1990-2000	8.9 (7-12)
2000	51 (43-60)	620	0	1234	2.2	2000-2015	4.7 (3.1-6.1)
2005	34 (30-38)	420	1	1247	1.6	2005-2015	3 (0.8-4.8)
2010	27 (24-31)	370	2	1366	1.6		
2015	25 (21-31)	340	3	1350	1.5		

development goal 5[13]. In Iran causes of maternal mortality fell by almost half between 1990 and 2015[12-15] (Table 1-3).

Every region has advanced, although levels of MM remain unacceptably high in sub-Saharan Africa. Almost all maternal deaths can be prevented as evidenced by the huge disparities found between the richest and poorest countries. The lifetime risk of maternal death in high-income countries is 1 in 3,300, compared to 1 in 41 in low-income[1]. Given the importance of identifying the causes, prevention and the need to continue the process of reducing the MMR, this study was conducted the causes of MMR in Tehran-Iran from 2011-2015 to identify and prioritize the factors affecting MMR by presenting the results and providing it to the authorities and planners which took a step to further reduce MMR.

MATERIALS AND METHODS

The present study was a descriptive-analytic cross-sectional study of maternal deaths was conducted in Tehran province during 5 years from 2011-2015. This study was approved by the Ethical Committee of Tehran University of Medical Sciences (TUMS) (Approval code: IR.TUMS.REC.1394-1561).

The cause of death for each case was recorded from the autopsy report and verbally from the woman's family. After a verbal explanation of the aims of present study verbal consent to use this information was obtained from the woman's next of kin. Information regarding each case of Maternal Mortality (MM) was recorded by a team of trained experts who were members of the Maternal Mortality Committee. This team consisted of a gynecologist, an anesthesiologist, a midwife, a nurse, a coroner, a representative of the University Clinical Affairs section and a representative of the Vice Chancellery of Health. They recorded the cause of death based on a review of available documents, i.e., prenatal care records, hospital admission files, verbal reports and pathological autopsies.

Data collection form consisted of two parts: Demographic and obstetric. In the demographic part information such as the mothers 'first and last name, date of death, hospital file code, residential area (Urban, rural and nomadic), age and underlying diseases were recorded. Obstetric information consisted of past and present obstetric histories. Information, regarding the number of pregnancies, number of living children and number of abortions were recorded from the past history. The present obstetric history comprised date of death, delivery or postpartum period, type of previous delivery (normal vaginal delivery, cesarean delivery or abortion), quality of prenatal care according to the attached prenatal care card, quality of care during labor (by reviewing the hospital file) and time between the two previous pregnancies in multiparous mothers. Prenatal care was considered appropriate when it matched the standard of care,

quantitatively and qualitatively. At least 14 care events during pregnancy are required for women with no medical or obstetric problems. Quality of care was categorized into appropriate or inappropriate according to follow-up, appropriate administration of drugs (if needed), supplements such as folic acid, iron and multi-vitamins and acceptable par clinical interventions (lab tests and ultrasound examinations). Care during labor and in the recovery room was considered appropriate if the type of drug, dosage and time of administration were suitable and if vital signs were recorded and acceptable measures were taken for those women who were unstable.

Checklist for evaluating care during puerperium had two parts: Quantity and quality. Mothers with no postpartum complications should be visited by an obstetrician or a midwife at least 3 times: The day after delivery, 1 week later and in the following 6 weeks. In these visits, mothers should be evaluated for any abnormal bleeding, infection, quality of married life, appropriate training for breast-feeding and appropriate administration of supplements.

The Maternal Mortality Committee categorized deceased mothers into two groups: High-risk and low-risk. Mothers were considered high-risk if they met at least one of the criteria related to their age (younger than 17 or older than 35 years), presence of underlying diseases or poor obstetric history. The poor obstetric history category included mothers with four or more previous deliveries, <2 years between pregnancies or antenatal vaginal bleeding in the previous or present pregnancy. Statistical analysis the data were analyzed with a z-test to identify differences in the rates of MM that occurred between 2011-2015. Differences with a $p < 0.05$ were considered statistically significant. The data are reported as Mean±SD. All data were analyzed with SPSS v.22 software.

RESULTS

Maternal deaths (109) were reported in Tehran province from 2011-2015. The ratio of maternal deaths was 15.8 in 100,000 of live births during this period. The highest MMR was 19.1 in 2011 and the lowest proportion was 13 in 2015.

Table 4 showed there were significant relationship between age, place of residence and maternal deaths ($p > 0.05$). Most deaths occurred during the postpartum period (71.3%) and 23.7% occurred in the antepartum period. Analysis of the quality of care revealed that almost 50.45% of the mothers who died had received appropriate prenatal care. According to the delivery room quality of care checklist, most mothers (90%) received appropriate quality of care during

Table 4: Frequency distribution the causes of maternal death during childbirth in Tehran-Iran in 2011-2015 (N = 109)

Criterions	N	%
Gestational age		
17-26	17	15.59
27-35	31	28.44
36-57	61	55.96
Total	109	100.00
Residential area		
Urban	61	55.96
Rural	39	35.77
Nomadic	3	2.75
Total	109	100.00
Level of education		
Elementary	22	20.18
diploma	33	30.27
Bachelor and higher	54	49.54
Total	109	100.00
Job type		
Employed (teacher+others)	32	70.64
Unemployed (housewife)	77	29.35
Total	109	100.00
Type of insurance		
Public social security	55	50.45
Public health service	37	33.94
Private	17	15.59
Total	109	100.00
Supplemental insurance		
Yes	29	26.6
No	80	73.39
Total	109	100.00
Economic status		
High	27	24.77
Medium	10	9.17
Low	72	66.05
Total	109	100.00

labor. Because no medical records were generated for postpartum care, so this period could not be evaluated. Results of the present study revealed that 79.2% of the mothers who died were at high-risk during the perinatal period. Table 5 compares demographic and clinical factors between high-risk and low-risk mothers. Table 6 revealed that 70.64% of the mothers died during childbirth due to "Wrong in treatment" and 55.04% of the mother died during childbirth due to "Delays in treatment".

DISCUSSION

This study was undertaken to determine the causes of maternal mortality in Tehran province, Iran from 2011-2015. According to the findings, 109 pregnant women in Tehran in this study period, with an average of 15.8 deaths per 100,000 live births have died and the highest maternal mortality ratio in 2011 was equal to 19.1 and the lowest proportion was 13 in 2015 which is the same as the calculated MMR index over the years.

Table 5: Comparison of high-risk versus low-risk mothers in different subgroups (N = 109)

Criterions	N (%)	
	High-risk mother	Low-risk mother
Number (%)	80 (79.2)	21 (20.8)
Age groups		
17-26	4 (5)	0
27-35	48 (60)	29 (100)
36-57	28 (35)	0
Residential area		
Urban	41 (51.2)	10 (33.33)
Rural	36 (45)	10 (33.33)
Nomadic	3 (3.8)	10 (33.33)
Wanted pregnancy	59 (73.8)	18 (60)
Unwanted pregnancy	15 (18.8)	2 (6.66)
Indeterminate	5 (6.3)	10 (33.33)
Death occurred in		
Pregnancy	19 (23.75)	8 (27.58)
Delivery	4 (5%)	6 (20.68)
Post-delivery	57 (71.3)	15 (51.72)
Death occurred		
In the hospital or health facility	68 (89.47)	33 (100)
At home	2 (2.63)	0
During transportation	6 (7.89)	0
Spacing		
24 months or less	19 (23.75)	11 (37.93)
Over 24 months	61 (76.25)	18 (62.06)
Gravidity		
3 or less	50 (60.24)	11 (52.38)
More than 3	33 (39.75)	10 (47.61)
Vaginal bleeding	14 (14.43)	9 (75)
Infection	83 (85.56)	3 (25)

Table 6: Causes of maternal death during childbirth in Tehran-Iran in 2011-2015 (N = 109)

Place of death	N	%
Death occurred		
At home	2	1.80
During transportation	6	5.50
In the hospital or health facility	101	92.66
Total	109	100.00
Kind of hospital		
Treatment-teaching	55	50.45
Treatment	28	25.68
Private	17	15.59
Social	9	8.25
Total	109	100.00
Death occurred		
Pregnancy	27	24.77
Delivery	10	9.17
Post-delivery	72	66.05
Total	109	100.00
Delay in referral		
Yes	29	26.60
No	80	73.39
Total	109	100.00
Delays in treatment		
Yes	60	55.04
No	49	44.95
Total	109	100.00
Wrong in treatment		
Yes	77	70.64
No	32	29.35
Total	109	100.00
Kind of treatment		
Appropriate	17	15.59
Inappropriate minor bugs	31	28.44
Inappropriate egregious bugs	61	55.96
Total	109	100.00
Autopsy		
Yes	55	50.45
No	54	49.54
Total	109	100.00
Cause of infection		
Preeclampsia-eclampsia*	26	23.60
Bleeding	23	21.10
Cardiovascular disease	12	11.00
Infection	10	9.17
Embolism	10	9.17
Cerebrovascular	9	8.25
Lung disease	5	4.58
Anesthesia	4	3.66
Addiction	2	1.80
Autoimmune disease	2	1.80
Cancer, kidney disease and illegal abortion**	6	5.50
Total	109	100.00
Kind of delivery		
Vaginal	47	43.11
Cesarean	62	56.88
Total	109	100.00
Delivery agent		
Local midwife	9	8.25
Educated midwife	23	21.10
Obstetrician	77	70.64
Total	109	100.00
Appropriate prenatal care		
Yes	55	50.45
No	54	49.54
Total	109	100.00

*Preeclampsia is a condition of pregnancy characterized by high blood pressure (hypertension) and protein in the urine (proteinuria)[16]. **Abortion is the ending of pregnancy by removing a fetus or embryo before it can survive outside the uterus[16]

Generally, maternal mortality has declined during these years indicating an improvement in the services provided to the mother. But according to the conducted studies in Sistan-Baluchistan province from 2002-2009, maternal mortality was 82.6[16]. In Hormozgan province from 2005-2011, maternal mortality was 39.7[17], in Kermanshah province from 2001-2012, maternal mortality was 25.9[18]. In Fars province from 2003-2010, maternal mortality was 22.18[19] and this shows better situation in Tehran in the field of maternal health as compared to other provinces.

In relation to maternal age and death, the findings showed that 55.96% of women who died were 36-57 years old, while 15.59% were 17-26 years old. Maternal mortality rate was higher in Iran than in some developed countries; however, the gap seems to be narrowing[20]. For example, the MMR in England was estimated at 15 per 100,000 deliveries during 2003-2005[20] and a study conducted by Schutte *et al.*[21] showed that in the Netherlands, MMR was approximately 12.1 per 100, 000 live birth during 1993-2005.

Iran's MMR is much lower than in other developing countries in Asia and Africa[9]. For example, in India MMR was estimated at about 519 per 100,000 live births[8] and in

Northern Nigeria the figure was reported to be about 2849 per 100,000 deliveries over 5 years period from 2003-2007[9]. Differences in MMR between developing countries can be attributed to several factors including local topography, cultural factors, health resources and quality of obstetric care[8,7,22].

Between 2011 and 2015 the trend in MMR in the studied population was generally downward clinically, with the lowest rate appearing in 2015, followed by a slight upward trend. At the end of the study period, MMR was lower than at the start of the present study period. This tendency of MMR to fluctuate has been observed in other countries, such as the Netherlands and the UK[21]. According to Schutte *et al.*[21], changes in MMR may reflect better registration and data recording along with demographic changes, with age and parity playing the largest roles. A correlation between MMR and maternal age is consistent with findings reported by Maharlouei *et al.*[19], who have shown that older mothers need higher rates of assisted reproduction, which might contribute to higher MMR. Pregnancy-related complications, another important factor are more frequent in older women who are more often considered at high-risk[23]. The highest MMR was seen in mothers who were 35 years of age or older, where as the rate in women aged between 18 and 35 years was much lower. Kullima *et al.*[9] found significant differences in mortality rates among different age groups; however, Kullima *et al.*[9] and Schutte *et al.*[21] found no such differences. In the studied population most deaths occurred during the postpartum period, followed by pregnancy and were less frequent during labor. Although Bashour *et al.*[24] found labor to be the most critical time followed by the postpartum period, other studies found the postpartum period to account for the most maternal deaths[6]. One of the most important reasons may be the lack of adequate follow-up care during puerperium, a phase as important as pregnancy or labor. In this survey, care during puerperium was not documented in the medical record, so the quality of care in comparison to pregnancy and labor could not be evaluated. This was a potential limitation in the analysis of the present study. Good care during the prenatal period and labor did not necessarily result in a better delivery outcome. Almost all mothers who died (50.45%) received the full package of prenatal care. Based on the results of this study it is suggest that the quality of postnatal care is as important as care during pregnancy and labor in preventing maternal deaths.

The present study identified hemorrhage to be the main cause of maternal death, followed by eclampsia and sepsis.

Few studies have identified other main causes of maternal death in developed countries[9,21]. For example, Schutte *et al.*[21] and Kullima *et al.*[9] reported that the most common causes of MM were preeclampsia and eclampsia, respectively. Overall, results of the present study were congruent with most studies in developing countries[6,24]. In some settings, the main cause of death and the order of relative contributions of different causes were the same as in the studied population. Similarly, Gupta *et al.*[8] and Tsu and Coffey[25] found postpartum hemorrhage and eclampsia to be the two leading causes of maternal mortality. Cesarean delivery was involved in more than half (56.88%) of maternal deaths in our setting. This was not unexpected, because in Tehran province as in other developing areas, more than half of all deliveries are cesarians[26]. In addition, cesarean delivery is the procedure of choice in most high-risk pregnancies[23]. In this study, 79.2% of the mothers who died were identified as high-risk. In the study by Schutte *et al.*[21], 49% of the mothers who died had undergone cesarean delivery, although this mode of delivery was the direct cause of death in only four cases[21]. Several limitations might affect the studied data and analysis. The most important limitation of the present study was retrospective design and use of previously recorded data. Because, design of the present study was cross-sectional, therefore, predictors of maternal mortality could not be identified. On the other hand, using community-based data for the entire Tehran province helped ensure the reliability of the data analysis. All maternal mortality cases were recorded by an expert team and the Maternal Mortality Committee, thus the likelihood of information bias was reduced. The prolonged study period ensured that the trends observed in MMR were accurate. The size, demographic and ethnic diversity of this study population mean that findings of the present study may be applicable, with appropriate reservations, to the general population of Iran.

CONCLUSION AND FUTURE RECOMMENDATIONS

Maternal mortality has been declining over the years, due to the identified factors associated with maternal death, proposed strategies, such as improving the quality of hospital services in the field of obstetric emergencies, improving the quality and coverage of prenatal care, avoidance of selective cesarean sections, identifying high-risk pregnancies and referrals to specialized centers, training of experienced and expedite forces and facilitating the process of efficient and professional services to reduce maternal mortality should be used. This study will help in:

- Improving skills and knowledge of doctors, midwives and nurses and strengthening educational programs for the illiterate are the most effective measures to reduce maternal mortality
- Improving the quality and coverage of prenatal care
- Safe delivery by trained individuals
- Identification of high risk pregnancies and referrals to specialized centers
- Efficient and experienced personnel and speeding up the process of education services by increasing equipment such as blood products used to reduce the mortality rate of pregnant women
- Also, due to constraints, such as lack of some records, lack of access to families to complete information and in some cases illegible answers in the case

SIGNIFICANT STATEMENTS

This study identifies several points that are critical for health policy makers who aim to decrease MMR. The present study also highlight the need to focus on and document the quality of postpartum care, which is as important as prenatal care. Efforts to decrease MMR should focus on high-risk mothers not only during pregnancy and delivery but also during the postpartum period. Because preeclampsia-eclampsia were the most frequent cause of death in our setting, closer postpartum surveillance to detect this potentially worrisome complication is warranted.

This study discovers the possible synergistic effect of intervention in improving the quality of hospital services has a significant effect on the reduction of the number of maternal deaths and since more >99% of the deliveries take place in hospitals of the province, it is necessary to pay attention to hospital services and the part they play in maternal death.

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