

Original article

Maternal Mortality Rate and its Causes in the South of Iran

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SUMMARY

The maternal mortality rate (MMR) often reflects the development status of one country. This study calculates the incidence rate of maternal mortality and examines the related risk factors in Fars Province, located in South of Iran.

Using the surveillance system of Shiraz University of Medical Sciences, we reviewed all childbirth records from 2002 to 2012 in which maternal mortality occurred. Of 747,077 pregnancies, the average MMR was 21.28 per 100,000 live births per year, with a decreasing but non-significant trend.

In rural areas, the MMR was more than twice as high as in urban areas. The most common cause of maternal death was maternal hemorrhage (27%), followed by pre-eclampsia (15.7%) and infections (13.2%). Although the MMR gradually decreased, this decrease was not significant. Based on the higher MMR in rural areas, maternal and specialty post-partum care in rural areas should be improved and promoted.

Hemorrhage is still the main cause of maternal mortality in Fars Province. Since high percentage of these cases are preventable, increased healthcare during pregnancy, reduction of cesarean sections, more well-equipped facilities, and hemorrhage-control teams in maternity hospitals would likely have a significantly positive impact on MMR.

Key words: maternal mortality, postpartum hemorrhage, developing countries, prenatal care, postpartum care

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INTRODUCTION

The maternal mortality rate (MMR) is one of the most important criteria that indicate the development status and health system of a country. Maternal death is defined as death of the mother during pregnancy, during labor or up to 42 days after delivery for any reason, excluding accidental or incidental causes (1). According to published statistics, the number of maternal deaths in the world was estimated at 342,900 in 2008. In 1980, this figure was 526,300 (2).

The MMR refers to the number of maternal deaths per 100,000 live births. According to the World Health Organization (WHO) statistics published in 2007, based on information collected in 2005, the MMR was 9 in developed countries, 450 in developing countries, and 400 worldwide. The high MMR in developing countries is mainly due to lack of appropriate therapeutic and diagnostic facilities in rural areas, weakness of referral systems, inadequate education, disregard for expert advice, and poor economic conditions (3). According to the WHO statistics published in 2012, 800 women die every day as a result of preventable events during pregnancy and childbirth, among which 99% occur in developing countries. Appropriate care by trained healthcare workers before, during, and after childbirth can save mothers' and newborns' lives.

Worldwide, from 1990 to 2010, the MMR decreased by approximately 50% (4). However, in poor countries, such as Afghanistan and Sierra Leone, the rate of maternal deaths due to pregnancy complications is one in 6 (5). To improve the lives of impoverished populations, in 2000, the United Nations member states adopted the Millennium Development Goals (MDGs). The fifth MDG is to improve maternal health, and, specifically to reduce the MMR by 75% between 1990 and 2015 (6).

According to the statistics published by the WHO in 2005, the most frequent causes of maternal death were hemorrhage (25%), infections (13%), unauthorized abortions (13%), preeclampsia (12%), blocked labor (8%), other direct causes (8%), and indirect causes (20%) including malaria, anemia, HIV/AIDS, and cardiovascular problems. In developed countries, the main cause of maternal death is thromboembolism, while in developing countries, bleeding and deep vein thrombosis are the first and second most common causes of maternal death, respectively (7). Despite all the advances and re-

search achieved in the past 100 years, the most common causes of maternal death have not significantly changed. In certain geographic areas, other main causes of maternal death may be found. For instance, in South Africa and sub-Saharan Africa, HIV/AIDS is an important cause of death during pregnancy (8). One of the major risk factors for maternal mortality in developed countries in the last three decades is cesarean section. Today, cesarean section is one of the most common surgical procedures in hospitals in developed countries (9). In Ghana, where the MMR is much higher than the worldwide average, a similar study was conducted to investigate the MMR from 2008 to 2010, and 1,004 maternal deaths per 100,000 live births were reported. The most common cause of maternal death reported was eclampsia. Other common causes included hemorrhage, genital tract infections, and premature births (10). In a study entitled, "A 10-year investigation of pregnant mothers' deaths in Kohkiluyeh and Boirahmad Province from 1997 to 2007," the average MMR was 57.7. Hemorrhage was the most prevalent cause of maternal death (41%) (11). In 2012, the MMR in Semnan (in North Iran) was 53, and the most prevalent cause was hemorrhage (12). Iran has succeeded in a significant decrease of MMR over the past few decades, and in 2010, Iran's MMR was 22.4. Improving maternal health is of great importance, as this Index brings Iran closer to reaching its population health goals. According to the fifth MDG, Iran must reach an MMR of 15 (13). The present study was conducted in the Fars Province, which is located in the South Iran and has an area of 122,608 km² and a population of 4,770,000. This study is aimed at determining the trends in maternal deaths in that region as well as the factors affecting maternal deaths from 2002 to 2012 (14).

MATERIALS AND METHODS

The present study is an investigation of trends in MMR from 2002 to 2012, in those parts of Fars Province that are under the coverage of Shiraz University of Medical Sciences. This study was approved by the Local Research Ethics Committee of Shiraz University of Medical Sciences. To calculate the MMR numerator, we reviewed various records to determine the number of maternal deaths, including deaths during pregnancy, at delivery, and up to 42 days after childbirth, due to factors caused

directly by pregnancy and labor complications or diseases intensified by pregnancy. The data of 159 cases were collected from death registries in maternal mortality surveillance systems, vital records in rural areas, and records of maternal deaths in hospitals and forensics. To determine the MMR denominator, we used the number of live births from 2002 to 2012, which was obtained from Iran's registration administration site (15). To estimate the effects of each risk factor on maternal mortality, the frequency of that factor in all mothers was needed. Hence, the results of two national surveys including IrMIDHS (Iran's Multiple Indicator Demographic and Health Survey) in 2010 (16) and an IMES (Integrated Monitoring and Evaluation System) in 2007 (17), as well as several scientific articles, were used. A data collection form including all required variables was applied to the records reviewed.

Regression models

and statistical tests such as Chi square were used for investigating MMR changes over time and analyzing the data. P-values lower than 0.05 were considered significant.

RESULTS

The total number of maternal deaths during these 11 years in centers under the coverage of Shiraz University of Medical Sciences in Fars Province was 159. The changes in MMR during these 11 years are shown in Figure 1. Although the graph in Figure 1 shows a downward trend, based on linear regression, the decrease was not significant.

The mean and standard deviation of the deceased mothers' age, gestational ages and gravidity are shown in Table 1.

Table 1. Mean and standard deviation of the age of mother, gestational age and gravida, among maternal deaths in South Iran from 2002 to 2012*

	Frequency	Min	Max	Mean	Standard deviation
Age (year)	155	16	44	29.97	6.71
Gestational age (month)	153	7	42	32.9	9.1
Gravida	155	1	9	2.87	1.9

* The calendar year in Iran begins on March 21 of the Gregorian calendar.

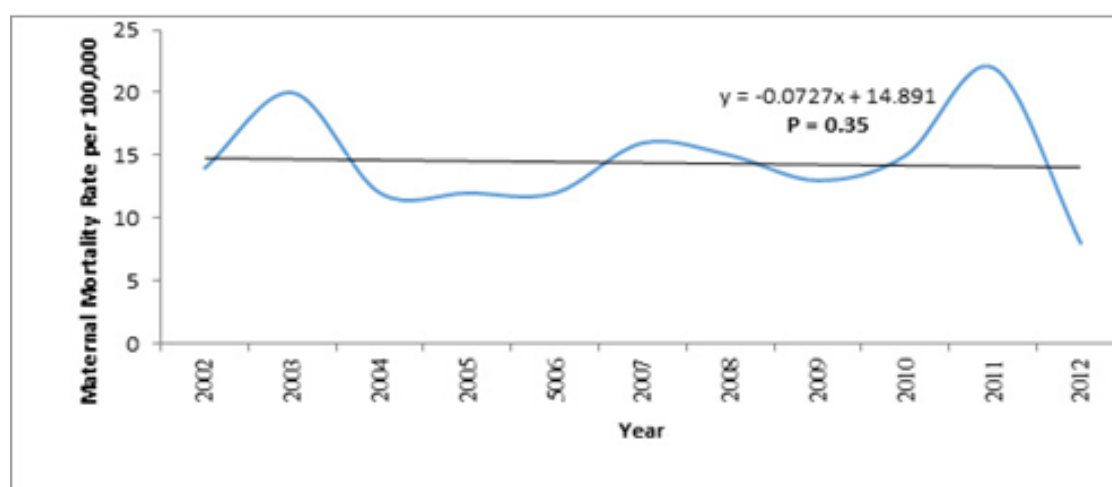


Figure 1. Trend in maternal mortality rate in South Iran from 2002 to 2012

Table 2. Frequency of selected maternal and pregnancy characteristics among maternal deaths in South Iran from 2002 to 2012

Characteristic		Frequency	Percent
Parity	1	46	28.9
	2 - 4	82	51.6
	≥ 5	27	17
	Unknown	4	2.5
Age group (years)	≤ 18	9	5.7
	19-35	109	68.6
	≥ 36	37	23.3
	Unknown	4	2.5
Place of birth	Hospital	112	70.4
	Delivery facilities unit	1	0.6
	House	6	3.8
	Other	5	3.1
	Pre-delivery maternal death	31	19.5
	Unknown	4	2.5
Time of death	During pregnancy	29	18.2
	During delivery	12	7.5
	Post delivery	114	71.7
	Unknown	4	2.5
Type of pregnancy	Intended	130	81.8
	Unintended	25	15.7
	Unknown	4	2.5
Labor assistant	Obstetrician	90	56.6
	Midwife	22	13.8
	Untrained midwife	8	5
	Other doctor	3	1.9
	Rural midwife	1	0.6
	Unknown	4	2.5
	Pre-delivery maternal death	31	19.5
Delivery type	Vaginal delivery	51	32.1
	Cesarean section	77	48.4
	Pre-delivery maternal death	31	19.5

Among the mothers who had died, 28.9% were experiencing their first pregnancy, and the highest frequency of maternal mortality was at ages 19 to 35. Among 159 cases of maternal deaths, 126 cases occurred during and after childbirth. Of these 126 cases, 112 (70.4%) maternal deaths occurred in hospitals. Among 159 cases of maternal deaths, 130

cases involved intended pregnancies and 25 involved unintended pregnancies. In 90 out of 159 maternal death cases, obstetricians delivered the infants. In 115 out of 159 death cases (72.3%), the number of prenatal care visits was appropriate for gestational age; for 39 (24.5%) mothers, the number of visits was not appropriate; and for 5 (3.1%)

subjects, the number was unknown (Table 2).

Among 159 mothers who died, 85 were residents of urban areas, and 70 were living in rural areas. Approximately 25% of births, but 44% of maternal deaths, occurred in rural areas. The MMR was higher in rural areas than in urban areas (Table 3).

Table 3. Maternal mortality rate based on location of birth in Fars province from 2002 to 2012

Area	Maternal deaths	Live births	MMR ($\times 100,000$)
Urban	85	560,838	15.5
Rural	70	186,239	38.54
Total	155*	747,077	21.28

*For 4 deaths, the area was not identified (total = 159)

According to the IrMIDHS, 53.87% of deliveries were performed by an obstetrician; additionally, having an obstetrician perform the delivery was a significant death risk for mothers (Table 3). According to a systematic review study, the prevalence of unintended pregnancies is estimated to be 30.6% (18). This study revealed a surprising, significantly inverse relationship between unintended pregnancy and maternal mortality. According to the

IrMIDHS, 47.83% of births occurred via cesarean section, while the IMES study indicated that the percentage was 41.4%. In both studies, cesarean section was considered a risk factor for maternal death. Based on the results of the IrMIDHS and the IMES studies, the percentage of pregnant mothers who obtained prenatal care was 83.6% and 95.4%, respectively. In both investigations, prenatal care throughout the pregnancy was a protective factor against maternal mortality (Table 4).

Of the 159 maternal deaths, the cause of death was not clear from the medical records in 19 cases (11.9%). In those cases, no coroner's report was found for various reasons, including lack of family satisfaction with the autopsy and file incompleteness. Moreover, the maternal mortality committee did not reach a clear conclusion about the cause of death in these cases. In the other 140 cases, the most prevalent causes were as follows: pregnancy and labor hemorrhage (27%), pre-eclampsia and its complications (15.7%), and sepsis and infections (13.2%). Other types of hemorrhage accounted for 9.4% of the cases and included post-operative hemorrhage, iatrogenic hemorrhage, and hemorrhage of organs unrelated to pregnancy or delivery procedures. If we consider all hemorrhage cases together, 36.4% of deaths are due to hemorrhage and its consequences (Figure 2).

Table 4. Association between the selected risk factors and MMR in Fars Province from 2002 to 2012^a

Risk factor	Condition	Estimated OR ^b , p-value
Type of delivery	Cesarean <u>vs.</u> normal	IrMIDHS: OR = 1.64 (1.15 – 2.35), $p < 0.01$ IMES: OR = 2.14 (1.5 – 3.05), $p < 0.001$
Person who performed the delivery	Obstetrician <u>vs.</u> non-obstetrician	IrMIDHS: OR = 2.26 (1.53 – 3.6), $p < 0.001$
Pregnancy care appropriate for gestational age	Appropriate (≥ 6 times) <u>vs.</u> inappropriate (< 6)	IrMIDHS: OR = 0.58 (0.4 – 0.83), $p < 0.01$ IMES: OR = 0.142 (0.1 – 0.2), $p < 0.001$
Type of pregnancy	Untended <u>vs.</u> intended	OR = 0.426 (0.28 – 0.65), $p < 0.001$ [18]
Area where residing	Rural <u>vs.</u> urban	NSSFH: OR = 2.48 (1.8 – 3.4), $p < 0.001$

^aExternal parameters were from reports by IrMIDHS (16), IMES (17), and Moosazadeh et al. (18) and data from the national surveillance system of family health (NSSFH)

^bOddsRatio

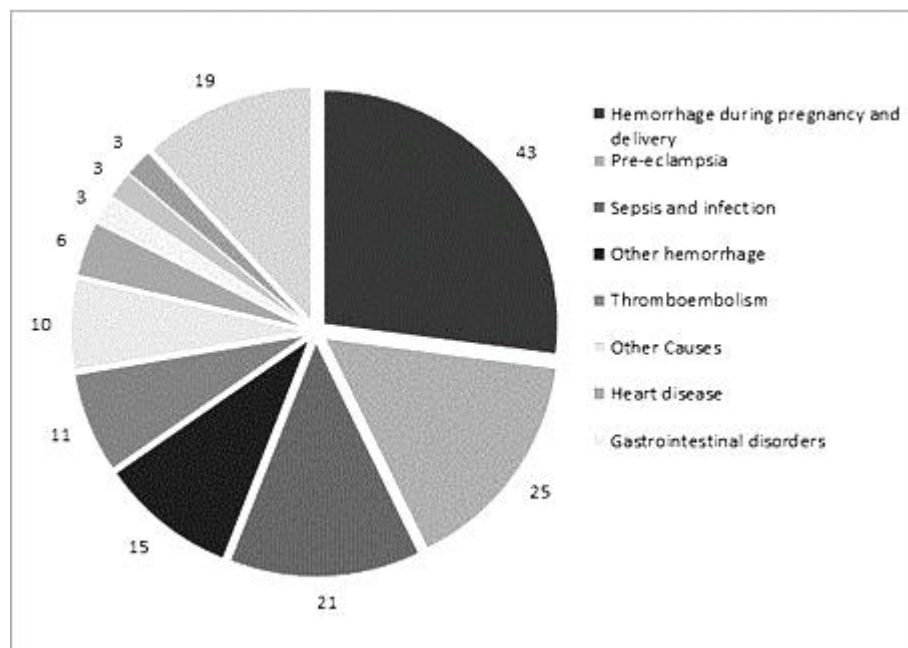


Figure 2. Frequencies of causes of maternal mortality in Fars province from 2002 to 2012

DISCUSSION

Investigating the incidence and causes of maternal mortality is important because the rate of maternal mortality very closely reflects the effectiveness of health services, especially prenatal care. Approximately 50% of these deaths are preventable, and improving medical care could have a profound impact on the MMR (19). According to the results of this study, 159 maternal deaths occurred in Fars Province and areas under the coverage of Shiraz University of Medical Sciences from 2002 to 2012. During that time, the MMR decreased gradually, but this decrease was not significant. Moreover, based on data from international organizations, if we assume that Fars Province is like the country of Iran as a whole, Fars Province has already reduced its MMR by 75% since 1990. These organizations declare that among low and middle income countries, Iran was one of the top 10 countries with the lowest MMR in 2010 (20). However, Iran as a whole has been successful in reducing maternal deaths, with a decrease in MMR from 101 in 1980 to 28 in 2008 (2), which reflects a decrease of more than 70% (21). Other countries have also been successful in reducing MMR. For example, Qatar reached the fifth MDG before 2015 by reducing its MMR from 48 in 1990 to 9 in 2012 (80% reduction) (22). On the other hand, many poor and underdeveloped countries, such as Afghanistan, have reduced the MMR, but

not significantly (5). The results of the present study showed that some factors, including cesarean section, living in rural areas and post-partum hemorrhage were the main factors of maternal death.

In rural areas, lack of health facilities, equipment and well-trained staff are the principle factors that threaten the health of pregnant women during pregnancy and the post-partum periods, but data from the present study show that more maternal deaths occurred in the hospital and in the presence of an obstetrician. Thus, the data reveal two factors. Perhaps the pregnant patients who were referred to the hospital were in the end stage of hemorrhage or the obstetricians were not well trained in the management of severe bleeding. The training of staff who provide health services for pregnant women during pregnancy and post-partum in rural areas, as well as of specialists for severe bleeding management, should be a high priority.

Lack of suitable and adequate pre- and post-natal care and delivery by obstetricians are significant risk factors in maternal deaths. In villages, the lack of well-equipped centers and skilled health care workers, and especially the lack of persons trained to manage hemorrhage, may be the biggest problems (23, 24). Compared to urban areas, many studies have reported increased MMRs in rural areas and have revealed that living in rural areas could play a role as a risk factor for maternal death (24, 25)

In rural areas, pregnant mothers are encouraged to have two ultrasounds performed during pregnancy. Having an ultrasound performed not only imposes high costs on rural families but also lacks important effects on pregnancy outcomes for mothers and fetuses (26). Moreover, because these ultrasounds must usually be performed in urban areas, the travel to cities creates additional risks to the mother and fetus. More importantly, this procedure increases the contact between pregnant mothers and obstetricians and more likely leads to cesarean section (26). If we look at this issue from another view, the temporality of cause and effect in a causality inference is very important. In the other words, we conducted the correct analysis, but our inferences and conclusions could be incorrect because more high-risk pregnant women are referred to obstetricians. Additionally, risky pregnancies and difficult deliveries are solely managed by obstetricians. For control of this confounder, we need to have temporal data by date for each maternal death, but the data in this case were not available. As this study revealed, the lack of pre- and post-natal care of pregnant women in public or private centers may be considered a serious risk factor in maternal death because the pregnant mother does not receive the necessary examinations and screenings that could detect preventable problems (27, 28). Two surveys conducted by Iran's Health Ministry in 2005 and 2010 indicated that prenatal care visits have decreased (16, 17).

The increase in unnecessary cesarean sections during the last decade is also problematic because of the increased risk of complications associated with the procedure, such as hemorrhage, anesthesia complications, longer recovery times, infections and embolism (29, 30). Cesarean section may also increase the risk of placenta previa, placenta accreta, and maternal death in subsequent pregnancies (31). However, some studies have shown that the increase of cesarean section has not affected maternal mortality (32), and well-designed educational literature could be important for decreasing unnecessary cesarean deliveries.

That most of the maternal deaths in this study occurred after childbirth suggests that postpartum maternal care needs to be improved. Because hemorrhage was shown to be such a significant cause of maternal death, mothers should be better monitored postpartum for the signs of this complication (33). Similar to results from other studies, in this study,

after hemorrhage, other prevalent causes of maternal mortality were pre-eclampsia, infections and thromboembolism (34). Most of these factors can be associated with surgeries or cesarean section. However, in a WHO report, the same factors were stated to be the prevalent causes of maternal mortality in other developing countries (7).

One of the limitations of this study was a lack of a uniform data-collection and record-keeping system in the region under review. Some records contained incomplete information. Additionally, some information about deaths that occurred more remotely in time was lost. However, these are not problems unique to Fars Province or even to Iran. Accurate determination of the MMR, especially in developing countries, is difficult due to absent, inadequate, or inconsistent local data-collection and record-keeping systems (35). Calculating an accurate MMR requires a valid, constant, active registry system with uniform coding of pregnant mothers' information (36). Lack of adequate information about all pregnant mothers (demographics, pregnancies and risk factors) caused additional difficulties. To obtain the rates and determine the effects of each risk factor, we needed to use information from other scientific articles and surveys (16 - 18). For example, relative risk and odds ratio estimations were obtained from two populations in two different time periods, but we assumed that there was no secular trend or disparity between two populations and two time periods. If there were more studies such as IRMIDHS and IMES, we could conduct sensitivity analyses and provide a confident magnitude of effect for each of the probable risk factors with high precision.

CONCLUSION

In summary, although the MMR in Fars Province for 2002 to 2012 decreased only slightly, Iran's MMR has significantly decreased during the last few decades. Iran has nearly reached the fifth MDG by reducing its MMR by almost 75% from 1990. However, this study has shown that mothers in the postpartum period need to be monitored more carefully, and especially for hemorrhage, by health care workers who are properly trained in postpartum care, particularly in handling hemorrhage. Moreover, maternal healthcare needs to be improved in rural areas by ensuring that women living in these

regions have access to well-equipped facilities and well-trained professionals for their prenatal and postpartum care.

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Stopa i uzroci smrtnosti majki u južnom Iranu

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SAŽETAK

Stopa smrtnosti majki obično odražava stepen razvoja jedne zemlje. U ovoj studiji prikazana je incidencija (stopa) smrtnosti majki i razmatrani su povezani faktori rizika u provinciji Fars, na jugu Irana.

Primenom sistema za nadzor Univerziteta medicinskih nauka u Shirazu, pregledani su kartoni novorođene dece u periodu od 2002. do 2012. godine, kada je zabeležena i smrtnost majki. Od 747.077 trudnoća, prosečna stopa smrtnosti majki iznosila je 21,28 na 100.000 novorođene dece godišnje, pri čemu je uočen smanjen i nesignifikantan trend.

U ruralnim oblastima, stopa smrtnosti majki bila je duplo veća nego u gradskim oblastima. Najčešći uzrok smrtnosti majki bili su krvarenje (27%), zatim preeklampsija (15,7%) i infekcije (13,2%). Premda se stopa smrtnosti majki smanjila, smanjenje nije signifikantno. Na osnovu povećane stope smrtnosti majki u ruralnim oblastima, trebalo bi poboljšati negu majki, naročito posle porođaja.

Krvarenje je i dalje glavni uzrok smrtnosti majki u provinciji Fars. S obzirom na to da se visok procenat ovakvih slučajeva može sprečiti, pojačana zdravstvena nega tokom trudnoće, smanjenje broja carskih rezova, bolja opremljenost zdravstvenih ustanova, kao i postojanje timova za kontrolu krvarenja u porodilištima, verovatno će značajno uticati na stopu smrtnosti majki.

Ključne reči: smrtnost majki, krvarenje nakon porođaja, zemlje u razvoju, prenatalna nega, nega nakon porođaja