



Factors Affecting the Maternal Mortality in different Areas of Iran: A Systematic Review

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Abstract

Background: Lowering the maternal death rate is the goal of many health organizations worldwide. The present study aimed to investigate the factors affecting maternal mortality ratio (MMR) in different regions of Iran.

Materials and Methods: In this systematic review, a systemic search of online databases (Medline, EMBASE, Scopus, Web of Science, Cochrane Library, CIVILICA, SID, Magiran, and Google Scholar search engine) was conducted for related studies with no time limit up to July 2022, using the related Mesh keywords. Two reviewers evaluated the quality of eligible studies and carried out the selection procedure.

Results: A total of 21 related studies were selected. The total maternal mortality rate for the studied period ranged from 15.8 (Tehran city) to 384 (Sistan and Baluchestan province) per 100,000 live births. According to the WHO, the MMR in Iran has decreased from 123 to 25 deaths per 100,000 live births between 1990 and 2018. The most common causes of death were bleeding (43.7%), preeclampsia/eclampsia (24.5%), hypertensive disorders (24%), and embolus (22.8%). There was a significant relationship between maternal deaths and pre-pregnancy care, disease during pregnancy, delivery type, maternal education level, maternal age, requiring special care, delivery agent, birth location, maternal socio-economic status, and the time between two pregnancies ($p < 0.05$).

Conclusion: The results showed that maternal mortality rates varied from 15.8 to 384 per 100,000 live births. Although Iran has had a successful record in reducing the maternal mortality rate, there is still a recognizable disparity in MMR among provinces that should be addressed. The most common causes of maternal death were hemorrhage, preeclampsia/eclampsia, hypertensive disorders, and embolus.

Key Words: Causes, Death, Iran, Maternal Mortality Ratio, Pregnant women.

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1- INTRODUCTION

Pregnancy is a natural phenomenon and a special event in the lives of women and families. It can be a time of dreaming and pleasant anticipation but might also coincide with fear, suffering, and even death. The mother is the main pillar of the family and the determinant of the health and success of other members. The death of the mother causes irreparable damage to the family and society (1). The maternal mortality ratio (MMR) is the ratio of the number of maternal deaths during a given time period per 100,000 live births during the same time (2). The MMR index is used to evaluate maternal death. Overall, maternal mortality is an important marker of the overall health of the country and reflects on its health infrastructure (3).

The World Health Organization (WHO) defines maternal death as the death of a pregnant woman due to complications related to pregnancy, underlying conditions worsened by the pregnancy, or management of these conditions. Maternal death occurs when the mother is pregnant or within six weeks after the end of pregnancy (4). The Centers for Disease Control and Prevention (CDC) definition of pregnancy-related deaths extends the period of consideration to include one year from the resolution of the pregnancy (5, 6).

Pregnancy-associated deaths, as defined by the American College of Obstetricians and Gynecologists (ACOG), are all deaths occurring within one year of a pregnancy resolution (3). Statistics show that as of 2017, the worldwide maternal mortality rate had declined by 44% since 1990. However, 808 women die every day from pregnancy or childbirth complications (7). UNFPA has estimated that 303,000 women died of pregnancy or childbirth-related causes in 2015 (7, 8). Also, over 85% of maternal deaths are in low-resource communities in Africa and Asia (7).

Based on the Millennium Development Goals and the latest statement of the World Health Organization, the following indicators have been set for the equitable reduction of maternal death after 2015:

- By 2030, the average maternal mortality ratio in the world will reach less than 70 percent of live births, and in no country will it be more than 140 percent of live births, i.e. more than twice the world rate.
- In the countries where the maternal death ratio was lower than 420 per hundred thousand live births (that is, most of the countries in the world, including Iran) in 2010, the figure of this index should be reduced to at least two-thirds by 2030.
- In the countries where the maternal death ratio was more than 420 per hundred thousand live births in 2010, the reduction of this index should have a downward trend, and no country shall have more than 140 deaths per hundred thousand live births by 2030 (9-12).

World Health Organization reported that maternal mortality in Iran has decreased from 123 deaths per hundred thousand live births in 1990 to 25 in 2015 (13). In every society, mothers have a fundamental role in maintaining the health of the family and, as the guardians of the health of the society, are of special importance. The death of the mother is not the death of a single person but the death and disability of the family and society. Identifying the causes and decreasing factors of maternal mortality has been a primary concern of societies. As the injuries, complications, and deaths caused by pregnancy can be prevented in many cases, their effective factors should be better known to help adopt preventative strategies. The present study aimed to investigate the factors affecting maternal mortality in different regions of Iran.

2- MATERIALS AND METHODS

The Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) checklist was used as the template for this review (14).

2-1. Eligibility criteria

The participants, interventions, comparators, and outcomes (PICO) scale was used to formulate the review objective and inclusion criteria.

2-1-1. Participants: Iranian pregnant women.

2-1-2. Interventions: The included studies were non-interventional, so a comparison group did not exist.

2-1-3. Comparison: Comparison and intervention groups did not exist.

2-1-4. Outcome: Maternal mortality was defined according to the International Classification of Diseases, tenth revision (ICD-10) (15).

2-2. Included studies: This review included studies containing any form of quantitative assessment, measurement, and evaluation of maternal mortality ratio and causes in pregnant women in Iran. The general inclusion criteria were focused on Iranian pregnant women only, published up to July 2022, and written in English or Persian.

2-3. Exclusion criteria: The exclusion criteria were abstracts without the full article, studies on other women, studies with unspecified dates and places of research, suspicion of duplicate reporting or unreported data on maternal deaths, articles not written in English or Persian, review articles, meta-analyses, letters to the editor, editorials, short reports, case reports, and briefs.

2-4. Information sources

A systemic search of electronic databases Medline, EMBASE, Scopus, Web of

Science, Cochrane Library, CAB Abstracts, CINAHL, Index Medicus for the Eastern Mediterranean Region (EMRO)- online database of WHO/EMRO), CIVILICA, SID, Magiran, and Google Scholar search engine) was conducted. In addition, the reference lists of retrieved articles, proceedings, and abstract books of related congresses were investigated. The search was done independently and in duplicate by two reviewers. Any discrepancies were resolved through discussion with a third researcher.

2-5. Search

Medical Subject Headings (MeSH) were searched to identify all relevant terms describing maternal mortality, maternal mortality rate, maternal mortality ratio, and causing factors. Boolean operators such as 'OR' were used to join keywords and MeSH terms defining the same concepts, and different concepts were searched with 'AND' to achieve the result. Search words were a combination of (maternal mortality OR maternal death OR pregnancy death OR Maternal mortality ratio OR Maternal Mortality rate) AND (measure OR estimation OR measure).

2-6. Study selection

The database search was done for possible studies, abstracts were screened for eligible studies, full-text articles were obtained and assessed, and a final list of included studies was made. This process was done independently and in duplication by two reviewers, and any disagreement was resolved by the third reviewer. References were organized and managed using EndNote software (version X8).

2-7. Data collection

A summary table was developed and accepted by all authors before the full-text review was conducted, and all included studies were then summarized. Two reviewers collected the data independently.

The obtained information included the author's name, setting, study design, sample size, maternal age, prevalence of MMR, maternal gestational age, and the main results.

2-8. Risk of bias

The same two authors using the standard tool of STROBE (STrengthening the Reporting of Observational Studies in Epidemiology) positioning guidelines (16) assessed the methodological quality of the studies independently. STROBE is a valuable tool for evaluating the quality of observational studies. This checklist has 22 items, scored based on the importance of each item according to the present study. The final score of the checklist was 30, and the minimum score was 15.0. Two authors independently assessed the risk of bias, and any disagreement was resolved by discussion with a third reviewer.

2-9. Synthesis of results

Due to the diversity of the studies in the main objective, study population, age groups, design, geographical areas, and publication dates, a formal meta-analysis

for estimating the effect of the determinants on maternal death was not possible.

3- RESULTS

In total, 21 studies met the inclusion criteria (**Figure 1**). The MMR between 2008 and 2018 is shown in **Figure 2** (17). MMR in ten poles of the country in 2018 is shown in **Figure 3** (17). It should be mentioned that, to provide better health and medical services to the people of each area, the Ministry of Health and Education has divided the country into ten poles (**Figure 4**). As can be seen, poles one (Babol, Semnan, Shahrood, Golestan, Gilan, and Mazandaran, located in the North of Iran), nine (Birjand, Mashhad, Bojnourd, Neyshabour, Esfaraen, Gonabad, Sabzevar, Torbat Heydarieh, and Torbat-e-jam in the Northeast of Iran), and eight (Rafsanjan, Zahedan, Kerman, Bam, Jiroft, Zabol, Iranshahr, and Sirjan, located Southeast of Iran) had the highest MMR. The studies included in the systematic review are characterized in **Table 1** and the following:

Table-1: General characteristics of included studies (n=21).

Author, Reference	Setting	Study design	Study period	Maternal age, year	*Prevalence of MMR	Gestational age, week	Main results
Mobasheri et al., (18)	Chaharmahal Va Bakhtiari province	Cross-sectional	2013-2014	31.1±5.9	17.2	35.17±6.61	The most prevalent reasons for direct and indirect deaths were bleeding and heart disease.
Ghasemi et al., (19)	Population covered by Zahedan University of Medical Sciences	Cross-sectional	2013-2017	≤19=9.5% 20-29=41.3% 30-39=44.4% ≥40=4.8	31.68 per 100,000	<14=4.8% 14-28=15.1% >28=80.2%	Bleeding was the most common cause of death (42.53%).
Karimi-Zarchi et al., (20)	Yazd Province	Cross-sectional	2002- 2011	29.17 ± 5.6	20.8 per 100,000	32.78	Bleeding was the most common cause of maternal mortality (30%).
Tajvar et al., (21)	Hamadan province	Retrospective descriptive	2002- 2016	-	35 per 100,000	-	The primary causes of maternal mortality in Hamadan province were bleeding and preeclampsia.
Jamshidpoor et al., (22)	Kermanshah province	Cross-sectional	2001- 2012	31.3± 7.3	25.9 per 100,000	-	The most common cause of maternal death was bleeding.
Damadi et al., (23)	Population covered by Kerman University of Medical Sciences	Cross-sectional	2010-2012	28.25±7.03	23.57 per 100,000	-	Preeclampsia was the most common direct cause, and heart disease was the most common indirect cause of maternal deaths.
Rahimi et al., (24)	Ardebil city	Cross-sectional	2006- 2016	30±1.8	18.70 per 100,000	-	Hemorrhage was the most common cause of maternal mortality.

Haseli et al. (25)	Ilam province	Cross-sectional	2002- 2010	31.14±5.99	25.51 per 100,000	-	Bleeding was the most common cause of maternal mortality (22.7%).
Mohammadinia et al. (26)	Sistan and Baluchistan province	Cross-sectional descriptive-analytical	2002- 2009	28± 7.3	82.6 per 100,000	-	The most common cause of maternal death was bleeding (37.4%).
Eftekhar-Vaghefi et al. (27)	Kerman province	Narrative text analysis with a holistic approach	2007- 2011	<18=6.2% 19-34=67.2 ≥35=26.6	a total of 64 maternal deaths	-	The most common medical causes of death were preeclampsia/eclampsia (15.6%), postpartum hemorrhage (12.5%), and deep phlebothrombosis (10.9%).
Kalantari et al. (28)	Golestan province	Cross-sectional	2006- 2012	29±6.44	23.46 per 100,000	-	The results showed that the primary causes of maternal deaths were hemorrhage (43.75%), and cardiovascular disease (21.87%).
Damadi et al. (29)	Population covered by Kerman University of Medical Sciences	Cross-sectional	2002- 2016	31.5+6.31	15.1 per 100,000	-	Bleeding was the primary direct cause, and heart diseases were the primary indirect cause of maternal death.
Banaei et al. (30)	Hormozgan province	Descriptive cross-sectional	2011- 2017	<18=2% 18-35=73% ≥35=25%	32.76 per 100,000	-	The most common cause of death was postpartum hemorrhage.
Zokaiei et al. (31)	Kurdistan province	Descriptive-analytical	2002- 2014	35.1±6.4	a total of 79 maternal deaths	-	The first three causes of death based on oral autopsy results were hemorrhage (34.2%), embolism (22.8%), and eclampsia (19%).
Golyan Tehrani et al. (32)	Kurdestan province	Descriptive-analytical	1998- 2002	<18 and >35=18.2% 18-35=81.8%	a total of 55 maternal deaths	-	There was a statistically significant relationship between maternal death and prenatal care variables, delivery factor, use of a family planning method, number of pregnancies, and delivery method.
Amini Moghadam et al., (33)	Tehran city	Retrospective study	2020	30.0 ± 5.0	a total of 15maternal deaths	-	The most common complications were acute respiratory distress syndrome followed by respiratory failure
Farzianpour et al., (34)	Tehran province	Descriptive-analytic cross-sectional	2011-2015	-	15.8 per 100,000	17-26= 15.59%, 27-35= 28.44%, 36-57= 55.96%	Vaginal bleeding was the primary cause of death (33.8%).
Mostafazadeh et al., (35)	Tehran Legal Medicine Organization	Cross-sectional	2009- 2018	31.06 ± 6.38	a total of 49 maternal deaths	7.04 ± 2.49	The most common cause of pregnancy death was hemorrhage (38.8%), followed by eclampsia (24.5%), and sepsis (12.2 %).
Karimzaei et al., (36)	Iranshahr County	Retrospective descriptive	2009-2013	30±6.4	a total of 34 maternal deaths	-	The most common cause of mortality among the study individuals included hemorrhage (38.2%), and eclampsia and preeclampsia (26.5%).
Farzollahpour et al., (37)	Ardabil province	Cross-sectional descriptive-analysis	2001-2011	Age range=18-35	20 per 100,000	-	The common causes of death were bleeding (28%), preeclampsia/eclampsia and their side effects (16%), thromboembolic disorders (16%), and infection (8%).
Arab et al., (38)	All province	Cross-sectional	2014- 2015	31±30	16.3 per 100,000	-	The most common causes of maternal death were hemorrhage (34.8%), hypertension and preeclampsia (24%), and heart disease (19%).

*MMR: Maternal mortality ratio.

1. A descriptive, cross-sectional, retrospective study in 2013-2014 aimed to examine the pregnant women's mortality in Chaharmahal Va Bakhtiari province over ten years. The results showed that within this 10-year period, 28 (17.2 per 100,000 live births) pregnant women died. The mean age of women was 31.1 ± 5.9 years, and the mean gestational age was 35.17 ± 6.61 weeks. Most women were illiterate and lived in rural areas (71.4%). A high proportion (46.4%) of the women experienced \geq fourth pregnancy, and most (46.4% of the) deliveries were through C-sections. The most prevalent reasons for direct and indirect deaths were bleeding and heart disease. Four (14.28%) women whose death was the direct result of pregnancy had not received complete pregnancy healthcare (18).

2. A retrospective, descriptive, cross-sectional study in 2013-2017 aimed to investigate the prevalence and causes of pregnant mothers' death in the population covered by Zahedan University of Medical Sciences. During this period, 126 maternal deaths with the maternal mortality ratio of 31.68 per 100,000 live births were reported. The results showed that maternal mortality in Zahedan was 174.96 per 100,000 cases, 190.56 per 100,000 cases in Khash, 371.87 per 100,000 cases in Saravan, and 384.03 per 100,000 cases in Chabahar. Therefore, the maternal mortality ratio was high in Sistan and Baluchestan province. Bleeding was the most common cause of death (42.53%); 61.9% of pregnant women lived in rural areas, 80.2% died in the third trimester of pregnancy, and 42.9% died in the first 24 hours after delivery. The most common underlying disease was hypertension, 70.6% of mothers died in hospitals, and 47.6% were illiterate. The most common cause of maternal death in Zahedan was cardiac disease. In Khash, it was hemolysis, elevated liver enzymes, low platelets (HELLP) syndrome, eclampsia,

and preeclampsia, and in Saravan and Chabahar, bleeding (19).

3. A cross-sectional study from 2002 to 2011 aimed to determine the frequency and causes of pregnancy-related mortality rates in Yazd Province. A total of 40 pregnancy-related deaths occurred in this period. The results showed that the maternal mortality rate was 20.8 per 100,000 live births, and the mean age of death of the mothers was 29.17. Of the women who died, 55% delivered their babies through C-section, and 20% delivered vaginally. Bleeding was the most common cause of maternal mortality (30%), and had a direct association with maternal death. Also, 20% of mothers died due to heart diseases and cardiac complications, which were associated indirectly with maternal mortality (20).

4. A retrospective descriptive study from 2002 to 2016 aimed to determine the mortality rate and causes of maternal mortality in Hamadan province. The results showed that the maternal mortality rate reduced from 35 per 100,000 live births in 2002 to 14 in 2016. The primary causes of maternal mortality in Hamadan province were bleeding and preeclampsia, and most deaths occurred in hospitals (21).

5. A cross-sectional study aimed to investigate the rate and causes of maternal mortality in Kermanshah province between 2001 and 2012. The results showed that the maternal mortality rate was 25.9 per 100,000 live births. Most of the deceased mothers were aged 18 to 35 years (64.6%), lived in the city (66.7%), and had high-risk pregnancies (65.3). The most common cause of maternal death was bleeding (23.2%) (22).

6. A cross-sectional study in 2010-2012 aimed to assess the status of maternal death and its causes in hospitals affiliated with the Kerman University of Medical Sciences. During the three years of the study, 28 maternal deaths occurred. The

results showed that maternal death ratio was 23.57 per 100,000 live births. Preeclampsia was the most common direct cause, and heart disease was the most common indirect cause of maternal deaths. Maternal deaths were related to shortcomings in all stages of before pregnancy, during pregnancy, and the post-partum period (23).

7. A cross-sectional study was conducted from 2006 to 2016 to investigate the causes of maternal mortality and related risk factors in Ardebil, Iran. There were 39 cases of maternal mortality during the study period. The ratio of maternal deaths was 18.70 per 100,000 live births. The mean age of deceased mothers was 30 ± 1.8 years, 11 (28.2%) had a normal vaginal birth (NVD), and 28 (71.8%) had a C-section. There was a positive relationship between the type of delivery (C-section or NVD), parity (the first and second pregnancy), and risk factors during pregnancy with maternal mortality. Hemorrhage was the most common cause of maternal mortality (24).

8. A cross-sectional, short-term study from 2002 to 2010 aimed to investigate the frequency and effective factors of pregnant women's mortality in the Ilam province. The results showed that the frequency of maternal mortality was 22, and the maternal mortality rate was 25.51 per 100,000 live births. The highest deaths in 2013 (22.73%), in the age group 30 to 35 years (36.36%), first pregnancy (31.9%), urban residency (59.09), illiterate or poorly educated (50%), housewife (90.9%), receiving special care during pregnancy (81.8%), C-section delivery (54.54%), and planned pregnancy (72.7%). Bleeding was the most common cause of maternal mortality (22.7%). The causes of maternal mortality had a statistically significant association with maternal education level ($p=0.031$), maternal age ($p=0.029$), requiring special care ($p=0.003$), the time of death (before, during, or after delivery,

$p=0.019$), and the type of delivery ($p=0.019$) (25).

9. A cross-sectional descriptive-analytical study between 2002 and 2009 aimed to determine the frequency and factors affecting the mortality of pregnant mothers in Sistan and Baluchistan province. The results showed that the frequency of deaths of pregnant women was 307, with a rate of 82.6 per 100,000 live births. Most of the deceased mothers were younger than 25, the gestational age was longer than 22 weeks, the number of pregnancies was more than four, the pregnancy interval was two years or less, and most were illiterate, lived in villages, and needed special care during pregnancy. Most of the deaths occurred postpartum at the hospital. The most common cause of maternal death was bleeding (37.4%). The cause of death had a statistically significant relationship with the place of death, the number of pregnancies, the delivery agent (e.g., an untrained local midwife and obstetrician), the type of delivery, and the age of the mother ($p<0.05$) (26).

10. A narrative text analysis with a holistic approach from 2007 to 2011 aimed to explore the circumstances and events leading to maternal mortality. The study examined a total of 64 maternal deaths. One-third of deaths occurred in women younger than 18 and older than 35 years. Approximately 95% of the deceased mothers had a low or middle socioeconomic status. The inappropriate use or nonuse of contraceptives was found in half of the cases. The most common medical causes of death were preeclampsia/eclampsia (15.6%), postpartum hemorrhage (12.5%), and deep phlebothrombosis (10.9%). Negligence accounted for 95% of maternal deaths. According to the results, more emphasis should be devoted to system failures and patient safety rather than the underlying causes of death and medical issues solely (27).

11. A cross-sectional study from 2006 to 2012 aimed to determine the causes and characteristics of maternal deaths in health facilities in Golestan province in Iran. The results showed that the primary causes of maternal deaths were hemorrhage (43.75%), and cardiovascular disease (21.87%). There were (53.3%) direct obstetric deaths and (34.9%) indirect obstetric deaths and the maternal mortality rate was 23.46 per 100,000 live births. There was a statistically significant relationship between ethnicity and mortality risk ($p=0.001$). The leading causes of maternal death were divided into three groups: 1. factors related to health systems (80%), 2. factors outside the organization (10.38%), and 3. factors related to patients and families (9.6%) (28).

12. A descriptive study from 2002 to 2016 aimed to determine the status and effective factors of maternal death at Kerman University of Medical Sciences. The results showed that the maternal mortality rate was 15.1 per 100,000 live births. The mean age of pregnant women who died was 31.5 ± 6.31 years. Bleeding was the primary direct cause, and heart diseases were the primary indirect cause of maternal death (29).

13. A descriptive cross-sectional study from 2011 to 2017 aimed to determine the prevalence and causes of mortality in pregnant women in Hormozgan province. The results showed that the maternal death rate in Hormozgan province was 32.76 per 100,000 live births, and the frequency of maternal death was 100. The most common cause of death was postpartum hemorrhage. The majority of deceased mothers were 18-35 years (73%), with pregnancy intervals of more than three years (80%), and delivery times less than five (87%), were rural residents (57%), and had planned pregnancies (86%). The delivery type in the majority of deceased mothers was C-section (60%). In addition,

75% of maternal deaths occurred in hospitals, and specialists and midwives assisted the delivery (91%). The highest mortality rate occurred in the postpartum period (65%) (30).

14. A descriptive-analytical study between 2002 and 2014 aimed to investigate and compare the causes of maternal death in Kurdistan province based on oral and forensic autopsy results. The results showed that 79 maternal deaths occurred during the study period. The first three causes of death based on oral autopsy results were hemorrhage (34.2%), embolism (22.8%), and eclampsia (19%). The three causes of death based on forensic autopsy were hemorrhage (34.2%), eclampsia (13.2%), and embolism (21.1%). The Kappa agreement coefficient was 0.528 (31).

15. A descriptive-analytical study conducted between 1998 and 2002 aimed to determine factors affecting maternal mortality in Kurdistan province. The results showed that out of 55 cases of maternal death that occurred during the study, the highest percentage belonged to the age group of 18-35 years, illiterate, stay-at-home, and rural resident mothers. There was a statistically significant relationship between maternal death and prenatal care variables ($OR=22.7$), delivery factor ($OR=9.85$), use of a family planning method ($OR=5.4$), number of pregnancies ($OR=2.5$), and delivery method ($OR=2.3$) (32).

16. A retrospective study in 2020 aimed to evaluate the clinical presentation of pregnant women who died due to COVID-19 in Firoozgar General Hospital, Tehran. Of the 32 pregnant women who tested positive for COVID-19, 15 were enrolled in the study (mean age 30.0 ± 5.0 years). The mean time from the first symptoms to death was 12 ± 7.0 days. Pre-existing comorbidities were seen in six patients. The main presentations at admission were fatigue and coughing, but most women had

a fever below 38 °C. Increased white blood cell count and neutrophils were noticeable. A significant drop of O₂ saturation with ground glass and consolidation in both lungs was prominent. The most common complications were acute respiratory distress syndrome followed by respiratory failure (33).

17. A descriptive-analytic cross-sectional study in 2011-2015 aimed to determine the causes of maternal death during childbirth in Tehran province. The results showed that the mean MMR was 15.8 per 100,000 live births (95% CI, 1.076-13.546). Most deaths (23.6%) occurred due to preeclampsia-eclampsia, and the least were the result of 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 two years passed between successive pregnancies in 23.8% of cases. Vaginal bleeding was the primary cause of death (33.8%) (34).

18. A cross-sectional study from 2009 and 2018 aimed to determine the causes of maternal death in the cases referred to Tehran Legal Medicine Organization. The results showed that the mean gestational age of pregnant women (n=49) ranged from three to nine weeks with a mean of 7.04±2.49 weeks. The most common cause of pregnancy death was hemorrhage (38.8%), followed by eclampsia (24.5%), and sepsis (12.2 %). The cause remained unknown in 8.2% of cadavers. The causes of pregnancy death had no relationship with age, body mass index, or the type of baseline pathologies (35).

19. A retrospective descriptive study conducted in 2009 to 2013 in 2009-2013 aimed to determine the frequency and causes of maternal mortality in urban and rural areas in Southeast Iran. The results showed that the frequency of maternal

mortality during birth delivery was 34. The studied individuals were aged 13 to 40 years with a mean age of 30±6.4. The most common cause of mortality among the study individuals included hemorrhage (38.2%), and eclampsia and preeclampsia (26.5%) (36).

20. A cross-sectional descriptive-analysis study conducted in 2001-2011 aimed to determine the rate of maternal mortality and the factors affecting it in Ardabil province. The results showed that the maternal death rate was 20 per 100,000 live births. The common causes of death were bleeding (28%), preeclampsia/eclampsia and their side effects (16%), thromboembolic disorders (16%), and infection (8%). A total of 72% of maternal deaths occurred in the age range of 18 to 35 years. Also, 33% of mothers were illiterate and had low education (primary school level), and 62% were urban residents. There was a significant relationship between maternal deaths and pre-pregnancy care, suffering from diseases during pregnancy, and the interval between two pregnancy times ($p<0.05$) (37).

21. A cross-sectional study from 2014 to 2015 aimed to investigate maternal mortality in Iran and its epidemiologic and etiologic characteristics. The results showed that the MMR in the study period was 16.3 per 100,000 live births. Most cases (74.8%) were aged 18 to 35 years. The most common causes of maternal death were hemorrhage (87 cases, 34.8%), hypertension and preeclampsia (in 60 cases, 24%), and heart disease (47 cases, 19%). Provinces of West Azerbaijan, Qazvin, Markazi, Kohgiluyeh and Boyer-Ahmad, Bushehr, Hormozgan, and Sistan and Baluchestan were high-risk provinces with a maternal mortality rate of above 20 per 100,000 live births (38).

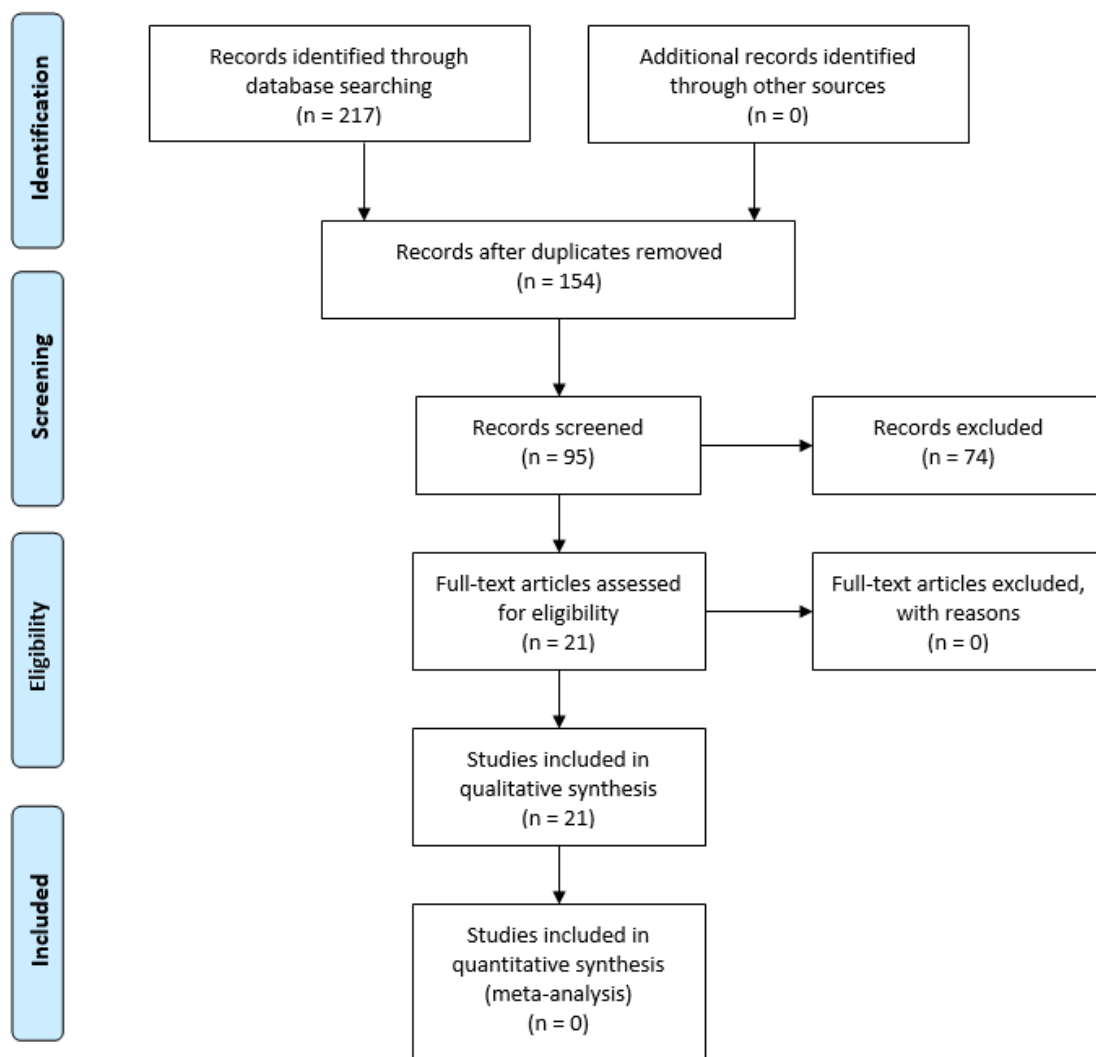


Fig.1: PRISMA flowchart.

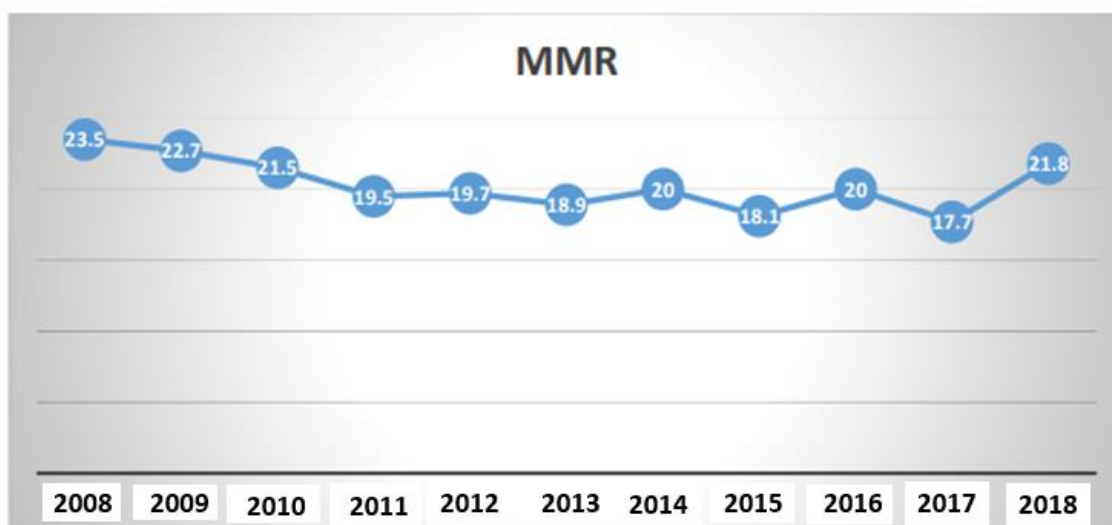


Fig.2: MMR between 2008 and 2018 in Iran (17).

MMR: Maternal mortality ratio.

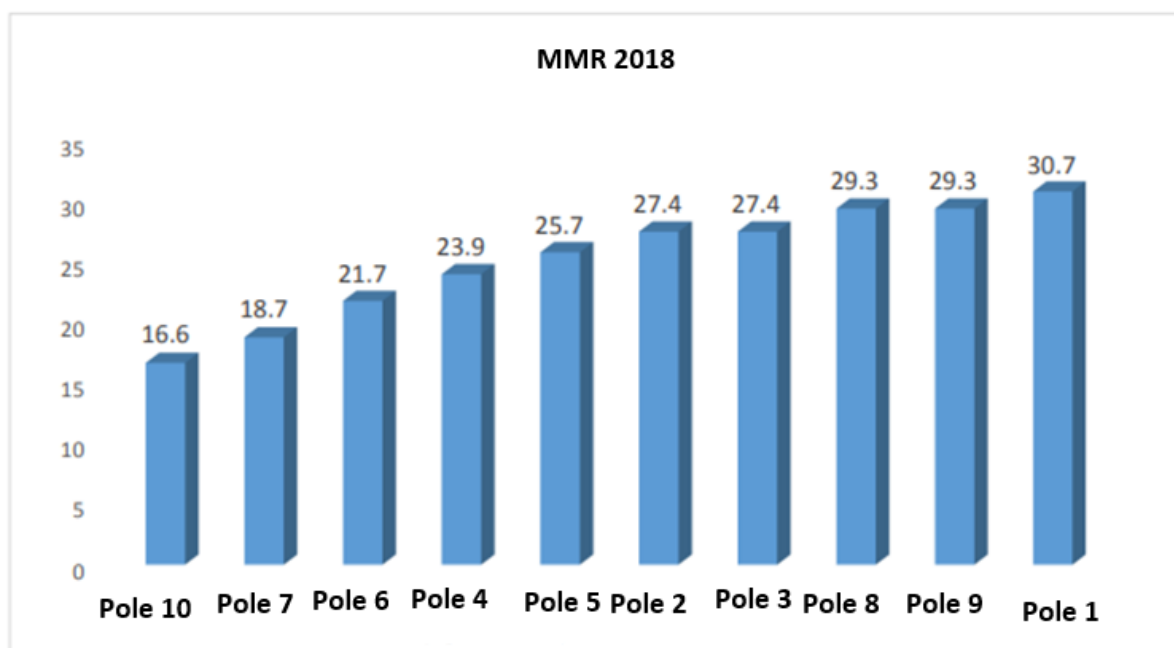


Fig.3: MMR in ten poles of the country in 2018 (17).

MMR: Maternal mortality ratio.

Pole 1	Pole 2	Pole 3	Pole 4	Pole 5	Pole 6	Pole 7	Pole 8	Pole 9	Pole 10
Babol	Ardabil	Ilam	Ahvaz	Bandar Abbas	Arak	Isfahan	Rafsanjan	Birjand	Iran University of Medical Sciences
Semnan	Urmia	Kermanshah	Shushtar	Bushehr	Zanjan	Shahr-e Kord	Zahedan	Mashhad	Shahid Beheshti University of Medical Sciences
Shahroud	Tabriz	Kurdistan	Dezful	Shiraz	Saveh	Kashan	Kerman	Bojnurd	Tehran University of Medical Sciences
Golestan	Maragheh	Hamadan	Behbahan	Fasa	Ghazvin	Yazd	Bam	Neyshabur	AJA University of Medical Sciences
Guilan	Khoy	Asadabad	Abadan	Jahrom	Qom		Jiroft	Esfarayen	University of Social Welfare and Rehabilitation Sciences
Mazandran			Lorestan	Gerash	Karaj		Zabol	Gonabad	Baqiyatallah University of Medical Sciences
				Yasuj	Khomein		Iranshahr	Sabzevar	
				Larestan			Sirjan	Torbat Heidarieh	
								Torbat-e Jam	

Fig.4: Ten poles based on the Ministry of Health and Education (17).

4- DISCUSSION

The present systematic review aimed to investigate the factors affecting maternal mortality in various regions of Iran. Based on the results, the most common causes for MMR were bleeding, preeclampsia/eclampsia, hypertension disorders, and embolus. The results also indicated that there was a significant relationship between maternal deaths and pre-pregnancy care, diseases during pregnancy, type of delivery, maternal education level, maternal age, requiring special care, delivery agent (midwife or specialist doctor), location of birth, maternal socio-economic status, and the interval between two pregnancies. Poles one, nine, and eight had the highest MMR.

Maternal mortality as a result of pregnancy and childbirth complications is a critical indicator of the development of countries. The World Health Organization defines maternal death as the death of a pregnant woman due to complications related to pregnancy, underlying conditions worsened by pregnancy, or management of these conditions (4). This index is chosen as a development indicator because various social and economic factors affect its prevalence. Pregnant women are a priority in every society. Mothers form a vulnerable and high-risk group due to childbirth and pregnancy. The death of pregnant mothers is detrimental to the foundation of the family and the health of the children (1, 39).

Hemorrhage (bleeding) was the leading cause of maternal death in Iran in 43.7% of cases in the present study and 35% in the study of Dadipoor et al. (40). However, no in-depth study has investigated why hemorrhage is still the leading cause of death in Iran despite various interventions. One study (41) states that the primary factors leading to hemorrhage and its resulting mortality in Iran are the doctors' delay in decision-making and delayed transfer to a primary care center. Also,

bleeding can be due to demographic and social factors. Tort (42) has investigated the effect of women's demographic characteristics on postnatal bleeding.

In the present review, preeclampsia/eclampsia was the second cause of maternal mortality in Iran. This condition is also a chief cause of maternal mortality in developing countries (43), particularly among those with hypertension in South Africa and worldwide (44). Reliable and cost-effective screening programs for preeclampsia are lacking. Therefore, a primary preventative measure is the timely identification and treatment of those at risk with appropriate prenatal care.

Hypertensive disorders are the second highest direct causes of death in Iran (24%), and worldwide (14%). Adequate and timely prenatal care could be highly effective in the early detection of hypertension and controlling its consequences, particularly in developing countries (45).

Embolism was another cause of maternal mortality in the present systematic review. Lung embolism was an important maternal mortality factor in England (46), Norway (47), and the U.S. (48). C-sections, hypertension at pregnancy, age above 40, more than three pregnancies, preterm birth, and transfusion of blood clots, lupus, and stillborn delivery had a significant correlation with the risk of lung embolism in pregnant women. The present systematic review found that embolism might lead to maternal mortality through insufficient attention to the mothers at risk and lack of timely diagnosis and referral of patients to specialists (40).

The current study showed that poles one, nine, and eight had the highest MMR in 2018. These areas are located in the North, Southeast, and Northeast of Iran and require particular attention from the relevant authorities to reduce MMR. The

Ministry of Health can reduce MMR by prioritizing these areas, spending more funds to remove deprivation, and developing more healthcare facilities in these areas. From 2000 to 2017, the maternal mortality ratio dropped by about 38% worldwide and 94% of all maternal deaths occurred in low and lower-middle-income countries (49). The high number of maternal deaths in some world regions reflects inequalities in accessing quality health services and highlights the gap between rich and poor. The MMR in low-income countries in 2017 was 462 per 100,000 live births versus 11 in high-income countries (49).

Some women die because of complications of pregnancy and childbirth. Most complications develop during pregnancy, and most are preventable or treatable. Other complications may exist before but are worsened during pregnancy, especially if not managed. The major complications that account for nearly 75% of all maternal deaths are (50):

- Severe bleeding (mostly after childbirth),
- Infections (usually after childbirth),
- High blood pressure during pregnancy (pre-eclampsia and eclampsia),
- Complications from delivery,
- Unsafe abortion.

According to the report of the World Health Organization, the maternal mortality rate in Iran has decreased from 123 to 25 deaths per 100,000 live births during 1990-2019 (13, 51).

The present review indicated a significant relationship between maternal death and pre-pregnancy care. It should be noted that most maternal deaths are preventable, as the healthcare solutions to prevent or manage complications are well known. All women should access high-quality care

during pregnancy and after childbirth. Maternal and newborn health are closely linked. It is essential that all births are attended by skilled health professionals, as timely management and treatment can make the difference between life and death for the mother as well as for the baby (49, 52, 53). The latest available data suggest that in high-income and upper-middle-income countries, more than 90% of all births benefit from the presence of a trained midwife, doctor, or nurse.

However, skilled health personnel (54) assist fewer than half of all births in many low-income and lower-middle-income countries.

According to the WHO report, the main factors that prevent women from receiving or seeking care during pregnancy and childbirth are (49, 54):

- Poverty,
- Distance from care facilities,
- Lack of information,
- Inadequate and poor quality services,
- Cultural beliefs and practices.

The results of this review showed that the most common causes of MMR were bleeding, preeclampsia/eclampsia, and hypertension. The WHO reports that severe bleeding after birth can lead to the death of a healthy woman within hours if she is unattended. Injecting oxytocics immediately after childbirth reduces the risk of bleeding effectively. Preeclampsia should be detected and appropriately managed before the onset of convulsions (eclampsia), and other life-threatening complications. Administering drugs such as magnesium sulfate for pre-eclampsia can lower the risk of developing eclampsia. It is also vital to prevent unwanted pregnancies to reduce the risk of maternal mortality. All women, including young adults, should have access to contraception, safe and legal abortion

services, and high-quality post-abortion care (49, 50).

According to UNFPA, there are four essential elements in preventing maternal death (55): prenatal care, assistance with birth, access to emergency obstetric care, and adequate postnatal care.

1. It is recommended that expecting mothers receive at least four antenatal visits to check and monitor the health of the mother and fetus.
2. Skilled birth assistance with emergency backup (doctors, nurses, and midwives) should be present with the skills to manage normal deliveries and recognize the onset of complications.
3. Emergency obstetric care should be available to address the major causes of maternal death, i.e., hemorrhage, sepsis, unsafe abortion, hypertensive disorders, and obstructed labor.
4. Postnatal care should be provided six weeks after delivery. During this time, bleeding, sepsis, and hypertensive disorders can occur, and newborns are extremely vulnerable immediately after birth. Therefore, follow-up visits by a health worker to assess the health of both mother and child in the postnatal period are strongly recommended (56-58).

4-1. Study Limitations

1. Due to the lack of sufficient information, this study did not provide a complete review of maternal mortality in Iran.
2. Not all articles contained comprehensive and detailed data on all the reviewed elements.
3. There was considerable heterogeneity in the way studies reported their findings which limited some of the comparisons made in the present research.
4. The stated results are specific to Iranian society and pregnant women and cannot be generalized to other societies.

5- CONCLUSION

The maternal mortality ratio is a measure of the quality of a healthcare system. The results of the present study showed that the total MMR for the study period ranged from 15.8 (Tehran city) to 384 (Sistan and Baluchestan province) per 100,000 live births. Poles one, nine, and eight had the highest MMR in 2018. The causes of maternal death vary by region and level of healthcare access. A Persian study conducted from 1990 to 2013 indicated that the most common causes of maternal death in Iran were bleeding (43.7%), preeclampsia/eclampsia (24.5%), hypertensive disorders (24%), and embolism (22.8%). According to the report of the WHO, the maternal mortality rate in Iran has decreased from 123 to 25 deaths per 100,000 live births from 1990 to 2018. Although Iran has had a successful history in reducing the maternal mortality rate, there remains a noticeable disparity in MMR between and among provinces, which should be addressed.

6- CONFLICT OF INTEREST: None.

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