



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

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Abstract

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

Materials and Methods: For this systematic review, we conducted a comprehensive search of online databases (MEDLINE, EMBASE, Scopus, Web of Science, Cochrane Library, CIVILICA, SID, Magiran, and Google Scholar) for relevant studies published up to July 2022, using appropriate MeSH keywords. Two reviewers independently assessed the quality and selected the studies.

Results: A total of 20 relevant studies were selected. The maternal mortality rate (MMR) during the study period ranged from 15.8 per 100,000 live births in Tehran to 384 per 100,000 live births in Sistan and Baluchestan province. According to the World Health Organization (WHO), the MMR in Iran decreased from 123 to 25 deaths per 100,000 live births between 1990 and 2018. The leading causes of maternal death were hemorrhage (43.7%), preeclampsia/eclampsia (24.5%), other hypertensive disorders (24%), and embolism (22.8%). A significant association was found between maternal mortality and pre-pregnancy care, pregnancy-related diseases, mode of delivery, maternal education level, maternal age, and the need for specialized care, birth attendant, delivery location, maternal socioeconomic status, and interpregnancy interval ($p < 0.05$).

Conclusion: While Iran has made significant progress in reducing maternal mortality, rates varied considerably across provinces, ranging from 15.8 to 384 per 100,000 live births. This disparity warrants further attention. Hemorrhage, pre-eclampsia/eclampsia, hypertensive disorders, and embolism were the most common causes of maternal death.

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

**Please cite this article as:* Pouyanfar A, Bolourian M, Fazli B, Ghazanfarpour M, Sabaghian M, Shakeri F. Factors Affecting Maternal Mortality in different Areas of Iran: A Systematic Review. Health Provid 2022; 2(2): 79-95. doi: [10.22034/hp.2022.361682.1024](https://doi.org/10.22034/hp.2022.361682.1024)

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Received date: Jul. 15, 2022; Accepted date: Dec.22, 2022

1- INTRODUCTION

Pregnancy, a natural and significant event for women and families, is often a time of joyful anticipation. However, it can also be accompanied by fear, suffering, and even death. As the central pillar of the family and a key determinant of the health and well-being of its members, a mother's death inflicts irreparable damage on both the family and society (1). The maternal mortality ratio (MMR), defined as the number of maternal deaths per 100,000 live births within a specified period (2), serves as a critical indicator for evaluating maternal health. Consequently, the MMR is an important marker of a nation's overall health and reflects the quality of its healthcare infrastructure (3).

The World Health Organization (WHO) defines maternal death as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (4). In contrast, the Centers for Disease Control and Prevention (CDC) extends the period of consideration for pregnancy-related deaths to include one year from the end 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 the termination of a pregnancy, regardless of the cause (3). Although the global maternal mortality rate declined by 44% between 1990 and 2017, approximately 808 women still die every day from pregnancy or childbirth-related causes (7). The United Nations Population Fund (UNFPA) reported that complications from childbirth or pregnancy lead to one maternal death approximately every two minutes (7, 8). Moreover, a significant proportion of these deaths occur in low-

resource communities within Africa and Asia (7).

Based on the Millennium Development Goals and the latest statement from the WHO, the following indicators have been established for the equitable reduction of maternal deaths after 2015:

- By 2030, the global maternal mortality ratio (MMR) should be reduced to less than 70 per 100,000 live births, with no country exceeding an MMR of more than 140 per 100,000 live births, which is more than twice the global average.
- In countries where the maternal death ratio was lower than 420 per 100,000 live births in 2010 (including most countries, such as Iran), this figure should be reduced by at least two-thirds by 2030.
- In countries where the maternal death ratio was higher than 420 per 100,000 live births in 2010, there should be a downward trend in this index, and no country shall have more than 140 maternal deaths per 100,000 live births by 2030 (9-12).

The World Health Organization reported that maternal mortality in Iran decreased from 123 deaths per 100,000 live births in 1990 to 25 in 2015 (13). In every society, mothers play a fundamental role in maintaining the health of the family and, as guardians of societal health, are of special importance. The death of a mother is not merely the loss of one individual; it signifies the loss and disability of the family and society. Identifying the causes and mitigating factors of maternal mortality has been a primary concern for communities. Since many injuries, complications, and deaths caused by pregnancy can be prevented, understanding their effective factors is crucial for adopting preventative strategies (14, 15). 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 Reviews and Meta-Analyses (PRISMA) checklist was used as the template for this review (16).

2-1. Eligibility criteria

The PICO (Participants, Interventions, Comparators, Outcomes) framework 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 observational; therefore, there was no intervention group.

2.1.3. Comparator: No comparison group was applicable, as the studies were observational.

2.1.4. Outcome: Maternal mortality was defined according to the International Classification of Diseases, Tenth Revision (ICD-10) (17).

2-2. Included studies

This review included studies that featured any form of quantitative assessment, measurement, or evaluation of the maternal mortality ratio and its causes in pregnant women in Iran. The general inclusion criteria focused exclusively on Iranian pregnant women, with publications up to July 2022, and written in either English or Persian.

2-3. Exclusion criteria

The exclusion criteria were: abstracts without accompanying full-text articles; studies focusing on populations other than pregnant women; studies lacking specified dates or locations; suspected duplicate publications 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 systematic search was conducted across the following electronic databases: MEDLINE, EMBASE, Scopus, Web of Science, Cochrane Library, CIVILICA, SID, Magiran, and Google Scholar search engine. Additionally, the reference lists of retrieved articles, proceedings of related congresses, and abstract books were investigated. The search was performed independently and in duplicate by two reviewers, with any discrepancies resolved through discussion with a third researcher.

2-5. Search

Medical Subject Headings (MeSH) were searched to identify all relevant terms related to maternal mortality, maternal mortality rate, maternal mortality ratio, and contributing factors. Boolean operators, such as 'OR,' were used to combine keywords and MeSH terms that defined the same concepts, while 'AND' was used to search for different concepts to achieve comprehensive results. The search terms included a combination of (maternal mortality OR maternal death OR pregnancy death OR maternal mortality ratio OR maternal mortality rate) AND (measure OR estimation OR assessment).

2-6. Study selection

Two reviewers independently searched the database, screened abstracts, and assessed full-text articles to identify eligible studies. A third reviewer resolved any discrepancies. References were managed using EndNote (version X8).

2-7. Data collection

Before the full-text review, all authors agreed upon a summary table, which was then used to summarize all included studies. Two reviewers independently collected data, including 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 independently assessed the methodological quality of the studies using the STROBE (STrengthening the Reporting of Observational Studies in Epidemiology) guidelines (18). STROBE is a valuable tool for evaluating the quality of observational studies. This checklist comprises 22 items, scored based on their relevance to the present study. The maximum possible score for the checklist was 30, while the minimum score was 15.0. Two authors independently assessed the risk of bias, and disagreements were resolved through discussion with a third reviewer.

2-9. Synthesis of results

Due to the heterogeneity of the studies in terms of their main objective, study population, age groups, design, geographical areas, and publication dates, a formal meta-analysis to estimate the effect of determinants on maternal death was not possible.

2-10. Ethical considerations

Approval from a research ethics committee was not required, as the study exclusively analyzed publicly available articles. The research upheld ethical standards by adhering to copyright laws and maintaining transparency in its methods and sources.

3- RESULTS

In total, 20 studies met the inclusion criteria (**Figure 1**). The maternal mortality ratio (MMR) between 2008 and 2018 is shown in **Figure 2** (19). MMR in ten poles of the country in 2018 is shown in **Figure 3** (19). To improve healthcare services, the Ministry of Health and Medical Education has divided Iran into ten poles (**Figure 4**).

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) exhibited 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=20).

Author, Reference	Setting	Study design	Study period	Maternal age (years)	*Prevalence of MMR	Gestational age (weeks)	Main results
Mobasheri et al., (20)	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 maternal deaths were bleeding and heart disease.
Ghasemi et al., (21)	Population covered by Zahedan University of Medical Sciences	Cross-sectional	2013-2017	≤19 years:9.5% 20-29 years:41.3% 30-39 years:44.4% ≥40 years:4.8	31.68 per 100,000	<14 weeks: 4.8% 14-28 weeks: 15.1% >28 weeks: 80.2%	Bleeding was the most common cause of death, accounting for 42.53% of cases.
Karimi-Zarchi et al., (22)	Yazd Province	Cross-sectional	2002-2011	29.17 ± 5.6	20.8 per 100,000	32.78	Bleeding was the leading cause of maternal mortality, responsible for 30% of cases.
Tajvar et al., (23)	Hamadan province	Retrospective descriptive	2002-2016	-	35 per 100,000	-	In Hamadan province, the primary causes of maternal mortality were bleeding and preeclampsia.
Jamshidpoor et al., (24)	Kermanshah province	Cross-sectional	2001-2012	31.3± 7.3	25.9 per 100,000	-	Bleeding was the most frequent cause of maternal death.
Damadi et al., (25)	Population covered by	Cross-sectional	2010-2012	28.25±7.03	23.57 per 100,000	-	Preeclampsia was the most common direct cause of maternal deaths,

	Kerman University of Medical Sciences							while heart disease was the most common indirect cause.
Rahimi et al., (26)	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. (27)	Ilam province	Cross-sectional	2002-2010	31.14±5.99	25.51 per 100,000	-		Bleeding was the most common cause of maternal mortality, accounting for 22.7% of cases.
Mohammadinia et al. (28)	Sistan and Baluchistan province	Cross-sectional	2002-2009	28± 7.3	82.6 per 100,000	-		Bleeding was the most frequent cause of maternal death, responsible for 37.4% of cases.
Eftekhari-Vaghefi et al. (29)	Kerman province	Narrative text analysis with a holistic approach	2007-2011	<18 years:6.2% 19-34 years: 67.2 ≥35 years: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. (30)	Golestan province	Cross-sectional	2006-2012	29±6.44	23.46 per 100,000	-		The primary causes of maternal deaths were hemorrhage (43.75%) and cardiovascular disease (21.87%).
Banaei et al. (31)	Hormozgan province	Descriptive cross-sectional	2011-2017	<18 years: 2% 18-35 years:73% ≥35 years: 25%	32.76 per 100,000	-		The most common cause of death was postpartum hemorrhage.
Zokaei et al. (32)	Kurdistan province	Descriptive-analytical	2002-2014	35.1±6.4	a total of 79 maternal deaths	-		The top three causes of death based on oral autopsy results were hemorrhage (34.2%), embolism (22.8%), and eclampsia (19%).
Golyan Tehrani et al. (33)	Kurdestan province	Descriptive-analytical	1998-2002	<18 or >35 years: 18.2% 18-35 years: 81.8%	a total of 55 maternal deaths	-		There was a statistically significant relationship between maternal death and variables such as prenatal care, delivery factors, use of family planning methods, number of pregnancies, and delivery methods.
Amini Moghadam et al., (34)	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., (35)	Tehran province	Cross-sectional	2011-2015	-	15.8 per 100,000	17-26 weeks: 15.59%, 27-35 weeks: 28.44%, 36-57 weeks: 55.96%		Vaginal bleeding was the primary cause of death, accounting for 33.8%.
Mostafazadeh et al., (36)	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-related death was hemorrhage (38.8%), followed by eclampsia (24.5%) and sepsis (12.2%).
Karimzaei et al., (37)	Iranshahr County	Retrospective descriptive	2009-2013	30±6.4	a total of 34 maternal deaths	-		The leading causes of mortality among the study participants included hemorrhage (38.2%), as well as eclampsia and preeclampsia (26.5%).
Farzollahpour et al., (38)	Ardabil province	Cross-sectional	2001-2011	Age range: 18-35	20 per 100,000	-		The common causes of death were bleeding (28%), preeclampsia/eclampsia and their complications (16%), thromboembolic disorders (16%), and infections (8%).
Arab et al., (39)	All province	Cross-sectional	2014-2015	31±30	16.3 per 100,000	-		The most prevalent 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 conducted in 2013-2014 examined maternal mortality in Chaharmahal Va Bakhtiari province over a ten-year period. The results indicated that 28 pregnant women died during this time (17.2 per 100,000 live births). The mean age of the women was 31.1 ± 5.9 years, and the mean gestational age was 35.17 ± 6.61 weeks. Most women were illiterate and resided in rural areas (71.4%). A large proportion (46.4%) of the women had experienced four or more pregnancies, and the majority (46.4%) of deliveries were cesarean sections. The most common causes of direct and indirect maternal deaths were hemorrhage and heart disease, respectively. Four (14.28%) women whose deaths were directly related to pregnancy had not received complete prenatal care (20).

2. A retrospective, descriptive, cross-sectional study conducted from 2013 to 2017 aimed to investigate the prevalence and causes of maternal deaths among pregnant women in the population served by Zahedan University of Medical Sciences. During this period, 126 maternal deaths were reported, resulting in a maternal mortality ratio (MMR) of 31.68 per 100,000 live births. The findings indicated that the MMR in Zahedan was 174.96 per 100,000 cases, in Khash it was 190.56 per 100,000 cases, in Saravan it was 371.87 per 100,000 cases, and in Chabahar it was 384.03 per 100,000 cases. Consequently, the maternal mortality ratio was notably high in Sistan and Baluchestan province.

Bleeding was identified as the most common cause of death (42.53%). Additionally, 61.9% of pregnant women resided in rural areas, 80.2% died during the third trimester of pregnancy, and 42.9% died within the first 24 hours after delivery. The most prevalent underlying condition was hypertension; furthermore, 70.6% of mothers died in hospitals, and

47.6% were illiterate. In Zahedan, cardiac disease was the leading cause of maternal death, while in Khash, hemolysis, elevated liver enzymes, and low platelets (HELLP) syndrome, along with eclampsia and preeclampsia were prominent causes. In Saravan and Chabahar, bleeding was the primary cause of maternal mortality (21).

3. A cross-sectional study conducted from 2002 to 2011 aimed to determine the frequency and causes of pregnancy-related mortality in Yazd Province. During this period, a total of 40 pregnancy-related deaths occurred. The results indicated a maternal mortality rate of 20.8 per 100,000 live births, with a mean age at death of 29.17 years. Among the women who died, 55% had delivered their babies via C-section, and 20% had vaginal deliveries. Hemorrhage was the most common cause of maternal mortality (30%) and was directly associated with maternal death. Additionally, 20% of the maternal deaths were attributed to heart diseases and cardiac complications, which were indirectly associated with maternal mortality (22).

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 (23).

5. A cross-sectional study investigated 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%) (24).

6. A cross-sectional study in 2010-2012 assessed 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 the maternal mortality 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: before pregnancy, during pregnancy, and the post-partum period (25).

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, resulting in a ratio of 18.70 per 100,000 live births. The mean age of the 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 (first and second pregnancies), and risk factors during pregnancy with maternal mortality. Hemorrhage was the most common cause of maternal mortality (26).

8. A cross-sectional, short-term study from 2002 to 2010 aimed to investigate the frequency and effective factors of maternal mortality in Ilam province. The results showed that the frequency of maternal mortality was 22 cases, with a maternal mortality rate of 25.51 per 100,000 live births. The highest number of deaths occurred in 2013 (22.73%), among women aged 30 to 35 years (36.36%), during their first pregnancy (31.9%), among urban residents (59.09%), among those who were illiterate or poorly educated (50%), and among housewives (90.9%). Additionally, a significant proportion received special care during pregnancy (81.8%), had C-

section deliveries (54.54%), and had planned pregnancies (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 ($p = 0.019$) (27).

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 years, had a gestational age longer than 22 weeks, had more than four pregnancies, had a pregnancy interval of two years or less, were illiterate, lived in villages, and needed special care during pregnancy. Most deaths occurred postpartum in 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 ($p < 0.05$) (28).

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. Inappropriate use or non-use 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 solely focusing on the underlying causes of death and medical issues (29).

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: factors related to health systems (80%), factors outside the organization (10.38%), and factors related to patients and families (9.6%) (30).

12. 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, with a total of 100 maternal deaths. The most common cause of death was postpartum hemorrhage. The majority of deceased mothers were aged 18-35 years (73%), had pregnancy intervals of more than three years (80%), had fewer than five deliveries (87%), were rural residents (57%), and had planned pregnancies (86%). The delivery type for the majority of deceased mothers was C-section (60%). In addition, 75% of maternal deaths occurred in hospitals, with specialists and midwives assisting in the delivery (91%). The highest mortality rate

occurred in the postpartum period (65%) (31).

13. A descriptive-analytical study conducted 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 (32).

14. A descriptive-analytical study conducted between 1998 and 2002 aimed to determine the 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 mothers aged 18-35 years, who were illiterate, stay-at-home, and rural residents. There was a statistically significant relationship between maternal death and several variables, including prenatal care (OR = 22.7), delivery factors (OR = 9.85), use of family planning methods (OR = 5.4), number of pregnancies (OR = 2.5), and delivery method (OR = 2.3) (33).

15. A retrospective study conducted in 2020 aimed to evaluate the clinical presentation of pregnant women who died due to COVID-19 at Firoozgar General Hospital in 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 onset of symptoms to death was 12 ± 7.0 days. Pre-existing comorbidities were observed in six patients. The main presentations at admission were fatigue and coughing; however, most women had a fever below 38°C . An increased white blood cell count and elevated neutrophils

were notable findings. A significant drop in O₂ saturation, along with ground-glass opacities and consolidation in both lungs, was prominent. The most common complications were acute respiratory distress syndrome followed by respiratory failure (34).

16. A descriptive-analytic cross-sectional study conducted from 2011 to 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). The most frequent cause of death (23.6%) was preeclampsia-eclampsia, while autoimmune disease and addiction were the least frequent (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 had passed between successive pregnancies in 23.8% of cases. Vaginal bleeding was the primary cause of death (33.8%) (35).

17. A cross-sectional study conducted from 2009 to 2018 aimed to determine the causes of maternal death in cases referred to the 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-related death was hemorrhage (38.8%), followed by eclampsia (24.5%) and sepsis (12.2%). The cause remained unknown in 8.2% of cases. The causes of pregnancy-related death had no relationship with age, body mass index, or the type of baseline pathologies (36).

18. A retrospective descriptive study conducted from 2009 to 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 childbirth was 34 cases. The studied

individuals were aged 13 to 40 years, with a mean age of 30 ± 6.4 years. The most common causes of mortality among the study individuals included hemorrhage (38.2%), and eclampsia and preeclampsia (26.5%) (37).

19. A cross-sectional descriptive-analytical study conducted from 2001 to 2011 aimed to determine the rate of maternal mortality and the factors affecting it in Ardabil province. The results showed that the maternal mortality 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. Additionally, 33% of mothers were illiterate or 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 pregnancies ($p < 0.05$) (38).

20. A cross-sectional study conducted from 2014 to 2015 aimed to investigate maternal mortality in Iran, focusing on its epidemiological and etiological characteristics. The results indicated that the maternal mortality ratio (MMR) during this period was 16.3 per 100,000 live births. Most cases (74.8%) involved mothers aged between 18 and 35 years. The leading causes of maternal death included hemorrhage (87 cases, 34.8%), hypertension and preeclampsia (60 cases, 24%), and heart disease (47 cases, 19%). The provinces identified as high-risk, with a maternal mortality rate exceeding 20 per 100,000 live births, included West Azerbaijan, Qazvin, Markazi, Kohgiluyeh and Boyer-Ahmad, Bushehr, Hormozgan, and Sistan and Baluchestan (39).

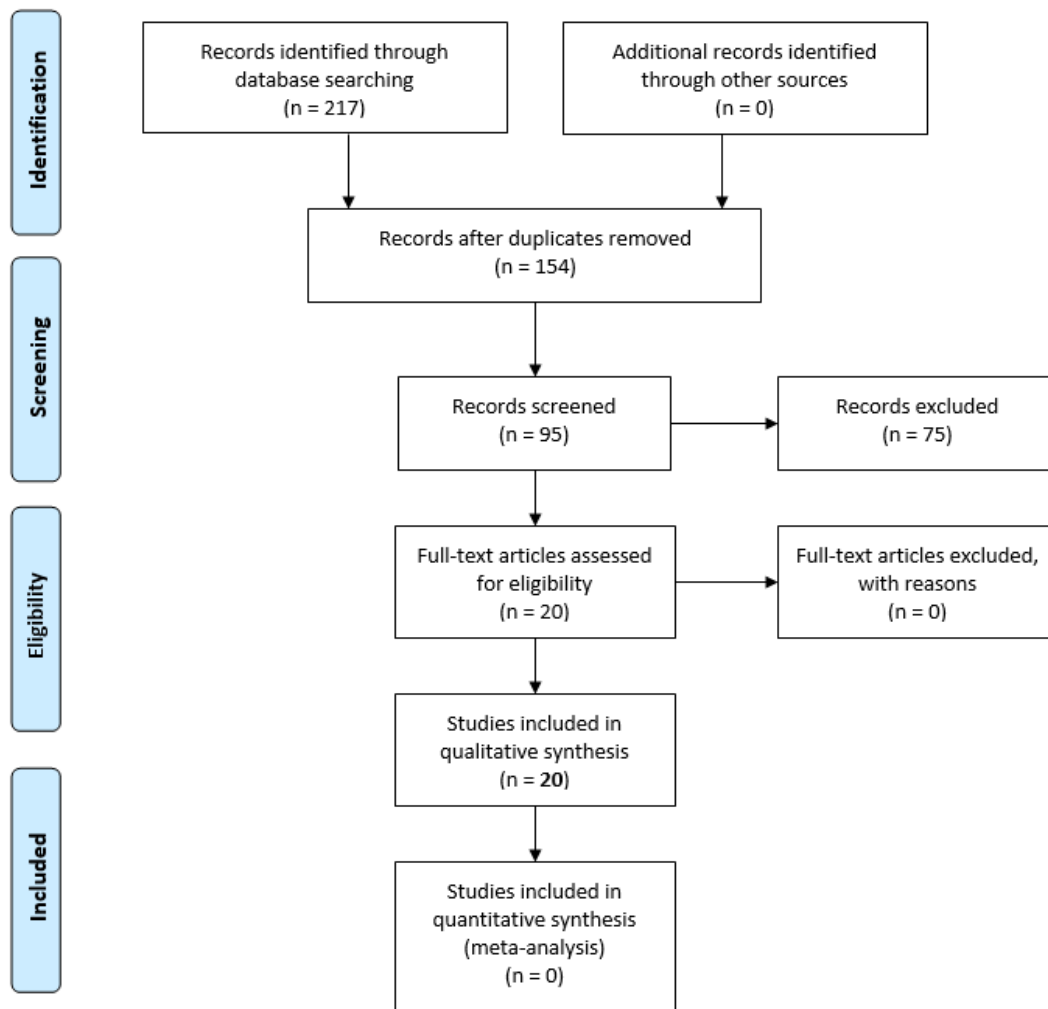


Fig.1: PRISMA flowchart.

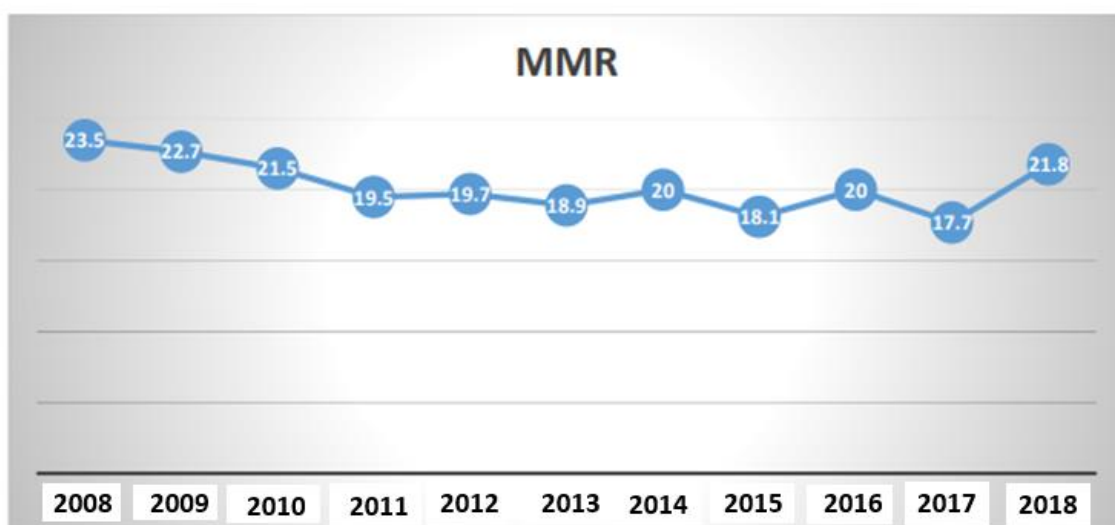


Fig 2: Maternal mortality ratio (MMR) in Iran between 2008 and 2018 (19).

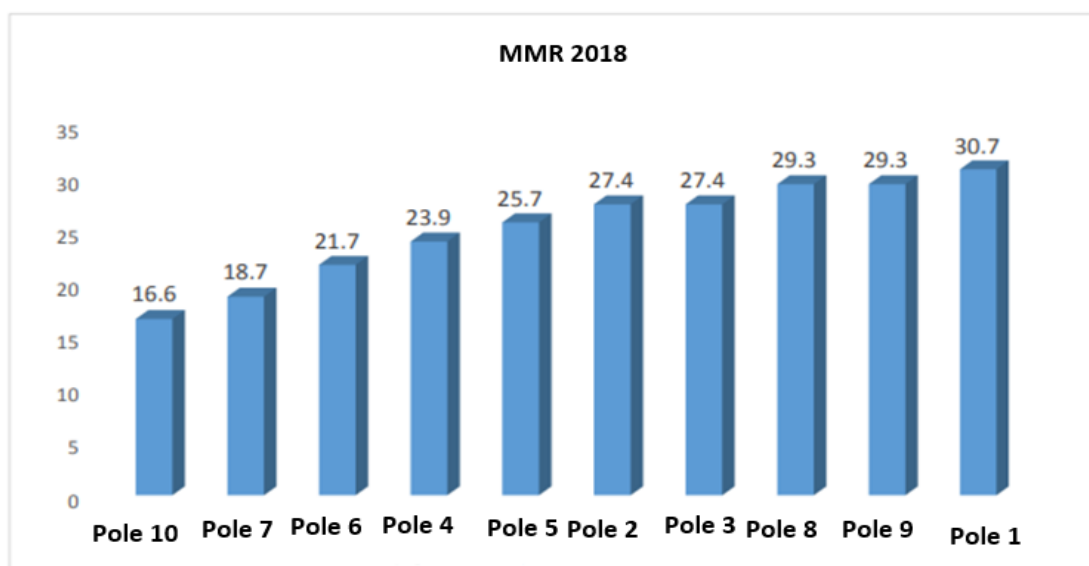


Fig 3: Maternal mortality ratio (MMR) in ten provinces of the country in 2018 (19).

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 Medical Education (19).

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 of maternal mortality ratio

(MMR) were hemorrhage, preeclampsia/eclampsia, hypertensive disorders, and embolism. The results also indicated a significant relationship between maternal deaths and factors such as pre-pregnancy care, diseases during pregnancy, type of delivery, maternal

education level, maternal age, the need for specialized care, delivery attendant (midwife or specialist doctor), place of birth, maternal socioeconomic status, and interpregnancy interval. Provinces within Poles one, nine, and eight exhibited the highest MMR.

Maternal mortality resulting from pregnancy and childbirth complications is a critical indicator of a country's development. The World Health Organization defines maternal death as the death of a woman during pregnancy or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (4). This metric is chosen as a development indicator because various social and economic factors influence its prevalence. Pregnant women are a priority in every society, and mothers form a vulnerable, high-risk group due to childbirth and pregnancy. The death of pregnant mothers is detrimental to family stability and child health (1, 40).

Hemorrhage was the leading cause of maternal death in Iran, accounting for 43.7% of cases in the present study and 35% in the study by Dadipoor et al. (41). However, there is a lack of in-depth investigation into why hemorrhage remains the primary cause of maternal death in Iran despite various interventions. One study (42) suggests that delays in decision-making by healthcare providers and delayed transfer to appropriate care centers are primary factors contributing to hemorrhage-related mortality in Iran. Additionally, demographic and social factors can contribute to bleeding. Tort (43) has investigated the effect of women's demographic characteristics on postpartum hemorrhage.

In the present review, preeclampsia/eclampsia was the second leading cause of maternal mortality in Iran.

This condition is also a major cause of maternal mortality in developing countries (44), particularly among those with hypertension in South Africa and worldwide (45). Reliable and cost-effective screening programs for preeclampsia are lacking. Therefore, timely identification and treatment of at-risk individuals through appropriate prenatal care is a primary preventative measure. Hypertensive disorders are the second highest direct cause of maternal death in Iran (24%) and worldwide (14%). Adequate and timely prenatal care could be highly effective in the early detection of hypertension and in controlling its consequences, particularly in developing countries (46).

Embolism was another cause of maternal mortality identified in the present systematic review. Pulmonary embolism has been identified as a significant maternal mortality factor in England (47), Norway (48), and the U.S. (49). Risk factors significantly correlated with pulmonary embolism in pregnant women include Cesarean sections, hypertension during pregnancy, age above 40, more than three pregnancies, preterm birth, transfusion of blood products, lupus, and stillbirth. The present systematic review suggests that embolism may lead to maternal mortality due to insufficient attention to at-risk mothers and a lack of timely diagnosis and referral of patients to specialists (41).

The current study showed that provinces within Poles one, nine, and eight had the highest MMR in 2018. These areas, located in the North, Southeast, and Northeast of Iran, require particular attention from relevant authorities to reduce MMR. The Ministry of Health can potentially reduce MMR by prioritizing these areas, allocating more resources to address deprivation, and developing more healthcare facilities. From 2000 to 2017, the maternal mortality ratio dropped by

approximately 38% worldwide, with 94% of all maternal deaths occurring in low- and lower-middle-income countries (50). The high number of maternal deaths in some regions highlights inequalities in access to quality health services and underscores the gap between wealthy and impoverished nations. In 2017, the MMR in low-income countries was 462 per 100,000 live births, compared to 11 in high-income countries (50).

Some women die due to complications arising from pregnancy and childbirth. Most complications develop during pregnancy, and many are preventable or treatable. Other complications may predate pregnancy but can worsen during this period, especially if not properly managed. The major complications that account for nearly 75% of all maternal deaths are (51):

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

According to a report by the World Health Organization, the maternal mortality rate in Iran decreased from 123 to 25 deaths per 100,000 live births between 1990 and 2019 (13, 52).

The present review indicated a significant relationship between maternal death and pre-pregnancy care. It is important to note that most maternal deaths are preventable, as the healthcare solutions to prevent or manage complications are well-established. All women should have access to high-quality care throughout pregnancy and after childbirth. Maternal and newborn health are closely intertwined; therefore, it is essential that all births are attended by skilled health professionals, as timely management and treatment can be critical in determining the outcome for both

mother and baby (50, 53, 54). Current data suggest that in high-income and upper-middle-income countries, trained midwives, doctors, or nurses attend more than 90% of all births (55).

However, skilled health personnel assist fewer than half of all births in many low-income and lower-middle-income countries (51). According to the WHO report, the main factors that prevent women from receiving or seeking care during pregnancy and childbirth are (50, 51):

- 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 effectively reduces the risk of bleeding. 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 preeclampsia 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 (50, 51).

According to UNFPA, there are four essential elements in preventing maternal death (56): prenatal care, assistance with birth, access to emergency obstetric care, and adequate postnatal care.

- It is recommended that expecting mothers receive at least four antenatal visits to monitor the health of both the mother and the fetus.
- Skilled birth assistance with emergency backup (doctors, nurses, and midwives) should be present, equipped with the skills to manage normal deliveries and recognize the onset of complications.
- Emergency obstetric care should be available to address the major causes of maternal death, including hemorrhage, sepsis, unsafe abortion, hypertensive disorders, and obstructed labor.
- Postnatal care should be provided within six weeks after delivery. During this time, complications such as 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 during the postnatal period are strongly recommended (57-59).

4-1. Study Limitations

- Due to insufficient information, this study could not provide a complete review of maternal mortality in Iran.
- Not all articles contained comprehensive and detailed data on all the reviewed elements.
- Considerable heterogeneity in how studies reported their findings limited some comparisons made in the present research.
- The stated results are specific to Iranian society and pregnant women and may not be generalizable to other populations.

5- CONCLUSION

The maternal mortality ratio is a measure of the quality of a healthcare system. The present study showed that the

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

6- CONFLICT OF INTEREST: None.

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