

Epidemiology of Maternal and Fetal's Burn in Iran: A Systematic Review and Meta-Analysis

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Abstract

Background: Burn is one of the public health problems, especially in low-income and middle-income countries, and this problem is far more important for pregnant women and their fetus. There was no a systematic study to comprehensively review the epidemiology of Maternal and Fetal's Burn in Iran, this study was conducted for this purpose.

Materials and Methods: In this systematic review and meta-analysis study, all related studies (Published in 2017 and earlier) extracted by two independent groups from national and international databases (Magiran, SID, Web of Science, Medline, Scopus, etc.). Meta-analysis has been applied to obtain the overall outcomes of maternal and fetal mortality in pregnant women in Iran. Forest plot, τ^2 , and I^2 tests are applied to evaluate heterogeneity, significance and its percentage, respectively. The analysis of meta-regression is applied because of the existence of heterogeneity. Publication bias is investigated by Funnel plot and Egger test.

Results: The range of maternal and fetal mortality was 29.2% to 66.67% and 38.5% to 72.8%, respectively. Also, 48.4% and 54.2% were the overall outcome of maternal and fetal mortality based on meta-analysis, respectively. The highest maternal mortality is reported for pregnant women with Total Body Surface Area (TBSA) over 50%, intentional burns, and acute respiratory failures. Finally, reduction of maternal mortality had a statistically significant relationship with passing time based on the univariate analysis.

Conclusion: It can be inferred from our results that some hazards of burn in pregnant women are average age of 22-27 years, living in rural areas, low levels of socio-economic, low education level and being housewife. Also, according to meta-analysis results, about half of mothers and fetuses died in pregnant women as a result of burns in Iran.

Key Words: Burns, Fetal Mortality, Iran, Maternal Mortality, Meta-Analysis.

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1- INTRODUCTION

Burns are considered as the most important incidents related to human health and they can cause death, disability, pain, and physical, psychological and economic problems (1, 2). Among the victims of burns, pregnant women are exposed to more serious injuries and complications due to their physiological conditions. This can lead to undesirable clinical problems such as miscarriage, fetal mortality and preterm delivery (3-6). On the other hand, the fetus of affected mother should be considered as the second patient (6). In such circumstances maternal and fetal survival rate depends on various factors such as the intensity and burn percentage, gestational age, maternal health and the involvement of respiratory system and other organs of the body (5, 7).

Applying an effective approach for burn prevention in a geographic region requires the awareness of etiological patterns of burns in a particular geographic region and different socio-economic backgrounds in epidemiology of burn for that area and its people. According to World Health Organization (WHO), the awareness of the epidemiology of burn is considered as the first step in the prevention of mortality, complications and any preventive intervention (8-10). As mentioned above, epidemiology of burns in high-risk groups including pregnant women is very important. It should be noted that there are only a few studies conducted on this issue in recent years (5, 11-16).

Since there was no study on the epidemiology of Maternal and Fetal's Burn in Iran, this study was conducted to apply a systematic review and meta-analysis for investigation the outcome of maternal mortality and fetal mortality. The aim of this study was to provide a comprehensive review for relevant authorities to take appropriate policies and

decisions on preventing pregnant women from burns, maternal and fetal mortality and reducing the burn costs.

2- MATERIALS AND METHODS

This study was conducted by using systematic review and meta-analysis method.

2-1. Systematic review

For this purpose, all the published studies on burn epidemiology in pregnant women from Iran were extracted by different methods with no time limit.

2-2. Inclusion and exclusion criteria

All published studies somehow associated with the burn epidemiology of Iranian pregnant women were gathered regardless of the type of study (cross-sectional, case-control, etc.), time of the study (Published in 2017 and earlier) and publication language.

2-3. Case study

Various variable related to burn of pregnant women individually were studied such as age, occupation, education, socio-economic level, living location (city or village), burn type (accidental, suicidal, unknown), seasonal distribution, burn agent, gestational age or the period of pregnancy (in weeks or months), number of pregnancies, consequences of burn (maternal mortality, fetal mortality, miscarriage, abortion, intrauterine fetal death and stillbirth, caesarean section and preterm delivery), burn percentage in terms of total body surface area (TBSA), the depth of burns due to the involvement of the superficial layers of the skin and other organs, length of stay, clinical problems and cause of death.

2-4. Search strategy

National and international databases were applied to achieve the aim of study and high sensitivity such as Web of Science, Medline, Scopus, Embase, SID, Magiran, Google scholar, Iranmedex (Barakat knowledge network system), and Science Direct. Several keywords were utilized by two independent groups such as burn AND (women pregnancy OR gestational age OR maternal mortality OR maternal death) AND (fetus OR fetal mortality OR fetal death) AND Iran. It should be noted that sources in accepted articles from mentioned databases were evaluated to find more studies. The quality of studies in term of performing and reporting procedure was evaluated by STROBE checklist of cross-sectional studies containing 5 sections and 20 titles (17). The main criteria for assessing the quality of studies based on this checklist were as follows: location, date, and accurate definition of disease, inclusion

and exclusion criteria, and number of cases, main keywords and sampling procedure. All related articles were extracted by two distinct search teams. If there was a controversy, the final commentary was provided by the first author of the article as an epidemiologist.

2-5. Study Selection

First, 72 studies were gathered by two independent search groups. Then, 14 related studies were selected by repeating and reviewing of titles and abstracts of them. Some studies were excluded because of their investigation only on women of childbearing age and haven't information on pregnant cases. Finally, 12 related studies were found that all of them, except for the study of Farrokh Eslamo in Urmia (that studied on injury among women in reproductive age with information about pregnant case) (17), were specifically performed on pregnant women (**Figure.1**).

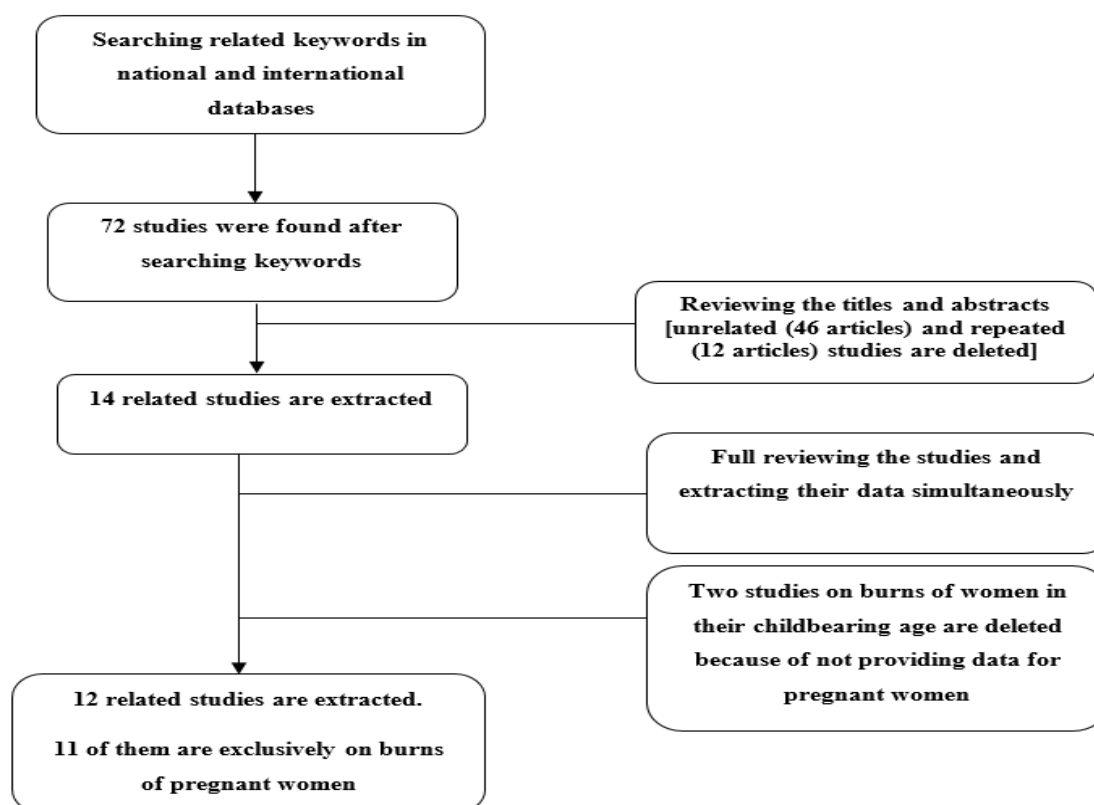


Fig.1: The chart of the search process and selection of studies.

2-6. Meta-analysis

The results of the systematic review were used as a prelude to meta-analysis in this stage. The overall outcome of maternal and fetal mortality was investigated as significant consequences of burns in pregnant women. Forest plot, chi-square, T^2 (Variance of true effects) and I^2 (True/total variance) tests were applied to evaluate heterogeneity and determine the method of meta-analysis (random or fixed). It should be noted that standard deviation (SD) was not reported in reviewed studies. Therefore, standard deviation has been obtained by the root of " pq/n " where p was the desired outcome in the target group, q equals $1-p$ and n is sample size.

Meta-regression test has been utilized to evaluate heterogeneity. The effect of several variables on percentage of maternal and fetal mortality was investigated as a univariate input of regression model. The variables considered in this study were average age of patients, mean of Total Body Surface Area (TBSA), percentage of intentional burns and mid-year of study (since all studies were done over a period of years, mid-year is defined as a new variable). Other variables excluded from analysis due to missing or a lack of reported data. Funnel plot and Egger test applied to investigate publication bias. Metatrim command also was used to estimate the censored results of studies by a non-parametric method (Duval and Tweeie). The overall outcome of objective indices was reported based on adjusted meta-analysis. Considering few numbers of studies, the significance level considered 10% for used tests.

3- RESULTS

Firstly, based on a systematic review of maternal and fetal's burn in Iran, the

results of related studies were evaluated and then the heterogeneity, cause of heterogeneity and publication bias investigated and an estimate of the percentage of maternal and fetal mortality were presented.

3-1. Results of systematic review

All found studies on pregnant women burn were cross-sectional using available data except a prospective study of Maghsoudi et al. (13) conducted in Tabriz. Also, the quality of all studies is approved based on the STROBE checklist except the study of Farrokh-Eslamlou et al. (11) (they did not report the outcome of fetal mortality percent). It should be noted that we contacted with the authors of the Farrokh-Eslamlou et al. (11), Study to obtain the index of fetal mortality percent. According to them, this index was not measured at the time of their study (**Table.1**) (*please see the table in the end of paper*).

3-2. Average age

The average age of pregnant women suffered from burn incidents was in same range for all studies. The maximum and minimum average age are belonged to Vaghardoost et al. [2007 to 2014 in Tehran (22), and Tavassoli Ashrafi and Khani [1998 to 2003 in Tehran (15)] by the value of 26.5 and 22.54 years, respectively. It can be concluded from the studies conducted in Tehran that the average age of pregnant women suffered from burn incidents has been increasing over the past years (10, 15, 19, 22).

Pasalar et al. (21) showed that the average age of survived mothers in Shiraz was higher than died women (by the value of 25 and 20.9 years, respectively), so that this difference was statistically significant ($P=0.004$). Furthermore, Karimi et al. (19) showed that the average age of cases with intentional burns was higher than that ones with accidental burns (25.2 and 21.8 years, respectively) in Tehran, so that it was

statistically significant ($P=0.02$). It should be noted that the average age was not reported in the studies of Ghotbi et al. [from 2000 to 2005 in Shiraz (18), and Rezavand et al. (from 1991 to 2002 in Kermanshah) (5)].

3-3. Occupation

The occupation of patients was not investigated in most of studies. Karimi et al. reported that 94.3% of patients were housewives in Tehran (19). According to a study conducted by Rezavand et al. in Kermanshah from 1991 to 2002 (5), 95% of burn cases were housewives and only 3% of them were employed. In another study of Rezavand et al. in Kermanshah from 2003 to 2008 (14), 89.74% of patients were housewives and 2.56% of them were employees, respectively. They also reported that the occupation of patients' spouses was as follows: 38.46 % were farmers, 28.20% were laborers, 5.12% were employees and 28.20% were unemployed (14).

3-4. Education level

The education level of patients reported in the study of Rezavand et al. (5) during 1991 and 2002 in Kermanshah was as follows: 74% were illiterate, 21% had an education level below high school diploma, 3% had a high school diploma and 2% had an academic qualification. In another study of Rezavand et al. (14) in Kermanshah from 2003 to 2008, the most cases of burns were illiterate or had an education level below high school diploma. It is worth mentioning that the numbers of these cases were reduced compared to their previous study for time period of 1991 to 2001. They reported that 38.46% of burn cases were illiterate and 51.12% had an education level below high school diploma, respectively. Only 7.70% of pregnant women had a high school diploma and 2.56% of them had an academic qualification, respectively (14).

Mehdizadeh et al. (10), in a study conducted in Tehran, reported that 82.5% of burn cases had no high school education. They also showed that a significant relationship was observed between education level and the risk of burn during pregnancy so that this value was 1.5 and 1.7 for the risk of burns in illiterate women and ones with basic education, respectively. Also, p-value was 0.5 for the risk of burns in women with high school or academic education. There was also a statistically significant relationship between low to high education levels and average TBSA ($P=0.8$). It should be mentioned that this relationship was not linear uniform. However, the relationship between education level and cause of burns was not statistically significant ($P=0.8$) in their study (10). Karimi et al. showed that the majority of burn cases (71.7%) were illiterate, 20.8 % had primary school education and 7.5% had an elementary education level (19).

3-5. Socio-economic status

Socio-economic status of patients is reported only in the study of Ghotbi et al. conducted in Shiraz. According to their study, the majority of burn cases (59.9%) had low socioeconomic status, 3.33% had average status and 6.8% had high socioeconomic status, respectively (18).

3-6. Residence

According to the study of Rezavand et al. on pregnant women suffered from burn incidents in Kermanshah from 1991 to 2002, 59% and 41% were from urban and rural areas, respectively (5). However, Rezavand et al. reported different statistics for the time period of 2003 to 2008 compared to their previous study. They reported that the frequency of burn patients from urban and rural areas was 41% and 59%, respectively (14).

3-7. Burn type (accidental, intentional, unknown)

Intentional burns were less than accidental burns based on reviewed studies reported the type of burns. The maximum and minimum frequency for intentional burns is reported by the values of 47% (Rezavand et al. (5) conducted in Kermanshah for time period of 1991 to 2002) and 14.6% (Mehdizadeh et al. (10) conducted in Tehran for time period of 1994 and 2000), respectively. There was a slight decrease for intentional burns in Kermanshah by comparing the reported intentional cases for time period of 1991 to 2001 (47%) with the time period of 2003 to 2008 (43.6%) (5, 14). The intentional burn rates were 41.7%, 38.46% and 27.45% for Mashhad [by Rezaei et al. (20)], Shiraz [by Pasalar et al. (21)], and Tabriz [by Maghsoudi et al. (13)], respectively. The rate of intentional burns for Tehran is reported in several studies with different time periods as follows: 28.9% from 2007 to 2014(22), 34% from 2001 and 2007(19), 15.38% from 1998 and 2003 (15) and 15.38% from 1994 to 2000 (10), respectively.

3-8. Seasonal distribution

Rezavand et al. (5) in a study conducted in Kermanshah from 1991 to 2002 showed that the seasonal distribution of burns was as follows: 42% in spring; 22% in summer; 21% in fall; and 15% in winter. The different findings are reported in another study of Rezavand et al. (14) for the seasonal distribution of pregnant women burns in Kermanshah during 2003 to 2008. According to their study, the highest and lowest frequency of burn cases are reported in winter (35.89%) and spring (15.38%), respectively. 25.64% and 23.07% of burn cases also were in fall and summer, respectively (14). Mehdizadeh et al. (10) showed that a significant difference of seasonal distribution of burn was not observed in Tehran from 1994 to

2000. They reported that the frequency of burn cases was 28.2%, 26.2%, 24.3% and 21.3% in spring, winter, summer, and fall, respectively (10). However, Karimi et al., showed that summer and spring had the maximum (37.7%) and minimum (11.3%) frequency of burn cases, respectively, in Tehran for the period of time from 2001 to 2007. The burn cases in winter and fall were 26.4% and 20.8% in their study (19). It should be noted that the seasonal distribution of burn is not mentioned in other reviewed studies.

3-9. The most common burn agents

Kerosene is reported as the most common burn agent of pregnant women in several studies such as Rezaei et al. (20) in Mashhad (by 70.8%), Tavassoli Ashrafi and Khani, (15) in Tehran (by 70%), Maghsoudi et al. (13) in Tabriz (by 68.6%), and in Farrokh-Eslamlou et al. (11) in Orumieh (by 34.5%). Kerosene or diesel was the main burn agent in the city of Tehran by the value of 96.4% and 53% for different time period of 2001-2007 [Karami et al. (19)] and 2007-2014 [Vaghardoost et al. (22)], respectively. The minimum frequency (10.25%) of reported burns with kerosene is reported by Rezavand et al. (14) in Kermanshah from 2003 to 2008.

Rezavand et al. (14) also showed that hot oil as a hot liquid was the most reported burn agent by 61.35% of cases and boiling water by 15.38% of cases was the main burn agent of pregnant women, respectively. Mehdizadeh et al. (10) reported that only 5.8% of cases had burned by boiling water (known as scald) in Tehran. Flame was reported as main burn agent in 96.87%, 85.18% and 66.7% of cases for Ahwaz [Zarei et al. (20)], Shiraz [Ghotbi et al. (18) from 2000 to 2005], and Shiraz [Pasalar et al. (21) from 2003 to 2010], respectively. It is worth mentioning that kerosene was reported as burn agent for 87.1% and 37.5% of cases

in Tehran [Mehdizadeh et al. (10)], and Ahwaz [Zarei et al. (16)], respectively. Stove explosion, electric shock, alcohols, and acids are considered as other burn agents of pregnant women in Iran.

3-10. Gestational age (in weeks or trimesters of pregnancy)

According to studies with gestational age based on trimester of pregnancy, most of burns were reported in the second trimester of pregnancy. The most (73.7%) and least (41.8%) reported burn cases in second trimester of pregnancy were belonged to Tehran [Vaghardoost et al. (22) from 2007 to 2014], and Kermanshah [Rezavand et al. (5) from 1991 to 2002], respectively. The first trimester of pregnancy was the least reported gestational age for most of studies. The maximum and minimum burn cases in first trimester of pregnancy were in Tabriz [by 25.49 % (13)], and Tehran [by 7.9% (22)], respectively. However, Rezavand et al. (5) showed that third trimester was the least reported gestational age (27.4%) for women in Kermanshah from 1991 to 2002. The reported burn cases for first and third trimester of pregnancy were same by the value of 25.64% in Shiraz conducted by Pasalar et al. (21). It should be noted that most reported gestational age for Tehran was second trimester during 2007 to 2014 (22) in comparison with other time periods of 2001 to 2007 (19), and 1998 to 2003(15).

Karimi et al. (19) showed that reported burn cases for women in their first trimester of pregnancy in Tehran from 2001 to 2007 was higher than other time periods [presented in other studies (15, 22)]. Pasalar et al. (21) reported higher and lower burn cases compared to Gotbi et al. (18) for second and first trimester of pregnancy in Shiraz, respectively. According to the studies reported gestational age in terms of weeks, Rezavand et al. (14) showed that mean gestational age was 23.79 ± 7.61 weeks in

Kermanshah during 2003 to 2008. Furthermore, maximum and minimum number of burn cases for pregnant women in Tehran are reported in 20-30 weeks (by 44.5%) and less than 10 weeks (by 7%), respectively [presented by Tavassoli Ashrafi and Khani (15)].

3-11. Parity

According to studies reported the number of pregnancies (parity), Rezavand et al. (5) showed that women with a history of more than three pregnancies (multiparas) were the most reported cases (45%) and those with two pregnancies were the least reported cases (16.5%) among pregnant women in Kermanshah during 1991 to 2002, respectively. This was inconsistent with the study of Ghotbi et al. (18) in Shiraz during 2000 to 2005 (70.4% of burn cases were women with multipara). Ghotbi et al. (18) also showed that the lowest frequency of burn cases (29.6%) was belonged to women with their first pregnancy experience (nullipara). However, women with first (nullipara) and more than three pregnancy experience (multipara) had the highest (61.5%) and lowest (12.9%) frequency of burn cases in Kermanshah during 2003 to 2008 presented by Rezavand et al. (14), respectively. The results of studies conducted in Kermanshah showed a significant change of reported burn cases for women with first pregnancy experience in time period of 2003 to 2008 in comparison with 1991 to 2002 (by the value of 61.5% to 38.5%) (5, 14).

3-12. Total body surface area (TBSA)

The extent of burns is reported by the percentage of TBSA in all studies. This is defined as the percentage of the burned skin with moderate to severe level and it can be calculated by the schematic symbols representing the front and back surfaces of the human body. Another classification is considered to evaluate to clinical severity of burns by three degrees

(2nd, 3rd and 4th) in some studies. It should be noted that the redness of the skin, indicate mild burns (1st degree), is not calculated (11). Considering TBSA is a number reported between 0 and 100, it is reported in a broad spectrum for different studies and the comparability of studies is impossible. Therefore, it has been tried to compare the studies with similar reporting. According to studies reported the mean TBSA, the maximum and minimum values of mean TBSA were 53.3% [Medizadeh et al. (10) conducted in Tehran] and 37.7% [Maghsoudi et al. (13) conducted in Tabriz], respectively. Tavassoli Ashrafi and Khani, (15) showed in a study conducted in Tehran from 1998 to 2003 that 32% of burn cases had TBSA less than 40%.

Several studies classified TBSA as less than 20%, 21-40%, 41-60%, 61-80% and 81-100%. Comparison of these results showed that the frequency of reported burn cases with TBSA less than 20% in Orumieh [Farrokh-Eslamlou et al. (11)], and Tabriz [Maghsoudi et al. (13)] were 34.5% and 34.14%, respectively. The frequency of reported burn cases with 21-40% of TBSA were 46.1% [Psalar et al. (21)], 30.2% [Karimi et al. (19)] and 26.4% [Vaghardoost et al. (22)], respectively. The lowest frequency of reported burn cases was belonged to 40-59% and 80-100% of TBSA by the value of 17.24% presented by Farrokh-Eslamlou et al. (11). However, TBSA of 61-80% had the lowest frequency of reported burn cases in Tabriz (13) and Shiraz (21) by the values of 4% and 2.6%, respectively. Karimi et al. (19) showed that TBSA below 20% and 61-80% had the same frequency (11.3%) in Tehran.

Furthermore, Vaghardoost et al. (22) resulted that the lowest frequency (13.2%) of reported burn cases is belonged to TBSA of 81-100%. TBSA has been categorized in two groups of below and over 50% to facilitate interpretation of

results for studies including Gotbi et al. in Shiraz (21), Rezaei et al. in Mashhad (20), Rezavand et al. in Kermanshah from 1991 to 2002 and from 2003 to 2008 (5, 14). The results showed that all of them except Rezavand et al. study in Kermanshah from 1991 to 2002 (5) had most reported burn cases with TBSA below 50%. Ghotbi et al. (18) reported the highest frequency (70.4%) of burn cases with TBSA below 50% among these studies. According to studies conducted in Kermanshah by Rezavand et al. (5, 14), burn cases with TBSA over 50% with a frequency of 48.7% in the years between 2003 and 2008 were lower than ones in the years between 1991 and 2002 with the frequency of 58.3%. Mehdizadeh et al. (10) also showed that burn cases with TBSA more than 40% had the frequency of 60%. According to the studies reported burns depth, superficial layers of the skin and organs of the body involved with burns, Mehdizadeh et al. (10) showed that the frequencies of burn cases with 2nd and 3rd degrees were 41.7% and 58.3%, respectively.

In the study of Rezavand et al. (14) in Kermanshah, 23% and 77% of burn cases had 2nd and 3rd degrees of burn, respectively. The depth of burn in pregnant women in Ahwaz is reported by the combination of 2nd and 3rd degrees of burn (16). It is worth mentioning that burns with 3rd degree had higher frequency than other degrees. According to most of reviewed studies, it can be stated that high TBSA has been reported in fewer burn cases.

3-13. Length of stay (LOS)

Several studies reported length of stay (LOS) in hospital (16, 21, 22); maximum and minimum LOS are reported in Ahwaz (24±14.2 days) and Shiraz (18.92±15.1 days), respectively (16, 22). The results of the studies conducted in Shiraz (18, 21) showed that mean LOS in time period of 2003-2010 was 18.92 which is decreased

in comparison with the years of 2000-2005 (21.12 days).

3-14. The most common clinical problems

Clinical problems are reported in only four reviewed studies. Respiratory failures were the main problems in these studies. 75.5% and 41% of burn cases had respiratory failure in the studies of Karimi et al. (19) and Pasalar et al. (21), respectively. Burns led to undesirable clinical problems in 59.4% of burn cases in Ahwaz [the type of clinical problem is not mentioned (16)]. According to the study of Mehdizadeh et al. (10) in Tehran, important clinical problems were septicemia and burn scar in died and surviving mothers, respectively.

3-15. Percent of maternal mortality

The highest and lowest maternal mortality rate are reported by Rezavand et al. (14) in Kermanshah during 2003 to 2008 (66.67%), and Rezaei et al. (20) in Mashhad (29.2%), respectively. Considering the studies of Rezavand et al. in Kermanshah (5, 14), maternal mortality during 2003 to 2008 was 66.67% compared to its values for the years between 1991 and 2002 by 59.5%. The maternal mortality in Shiraz (18, 21) is also decreased for time period of 2003 to 2010 (30.8%) in comparison with 2000 to 2005 (40.74%).

The results of reviewed studies in Tehran showed that maternal mortality rate, among pregnant women suffered burns accident, were 66%, 52.8% and 47.4% by Tavassoli Ashrafi and Khani, (15) from 1998 to 2003, Karimi et al. (19) from 2001 to 2007 and the Vaghardoost et al. (22) from 2007 to 2014, respectively. It can be inferred from these results that maternal mortality rate has been decreased in Tehran in recent years. Generally, the highest maternal mortality rate is reported in cases with high TBSA (5, 10, 13, 14, 18-22), intentional burns (13, 15, 19, 21), low average age, first

pregnancy experienced (18), burns caused by kerosene and stove explosion (10, 18, 22), death by respiratory failures (5, 13, 14, 20, 21), septicemia (including reduced body temperature, leukopenia, thrombocytopenia, decreased blood pressure and decreased urine output) (5, 10, 18) and the severity of burn damages (15, 21), respectively. Karimi et al. (19) showed that died women were significantly ($P=0.003$) older than survived women in Tehran unlike the study of Pasalar et al. (21) conducted in Shiraz. The results of Rezaei et al. (20) and Vaghardoost et al. (22) showed that maternal mortality was increased by increasing gestational age. However, Pasalar et al. (21) showed that first trimester of gestational age led to the highest maternal mortality rate.

A statistically significant relationship between gestational age and maternal mortality was not observed in the study of Karimi et al. (19) in Tehran. Survived mothers had higher LOS in comparison with died mothers in Shiraz [Pasalar et al. (21)], and this difference was statistically significant ($P=0.012$). Tavassoli Ashrafi and Khani, (15) showed that highest and lowest maternal mortality rate in Tehran had occurred for the LOS of seven (or more than seven) and three days, respectively.

3-16. Percent of Fetal Mortality

The highest and lowest percent of fetal mortality are reported with the frequency of 72.8% (10) and 38.5% (21) in burn cases, respectively. It should be noted that the percent of fetal mortality was not reported in the study of Farrokh-Eslamlou et al. (11). It can be concluded from the results of reviewed studies that fetal mortality has been decreased in recent years as follows: for Tehran was 72.8%, 57.5% and 56.6% in time period of 1994 to 2000 (10), 1998 to 2003 (15) and 2001 to 2007 (19), respectively; for

Kermanshah was 64.1% and 52.7% in time period of 1991 to 2002 (5) and 2003 to 2008(14), respectively; and for Shiraz was 48.1% and 38.5% in time period of 2000 to 2005(18) and 2003 to 2010 (21), respectively. According to the studies conducted in Ahwaz (16), Mashhad (20) and Tehran (19), the main causes of fetal mortality was abortion and intrauterine fetal death, respectively. However, intrauterine fetal death and abortion were first and second, respectively, causes of fetal mortality in Studies of Rezavand et al. (5, 14) and Mehdizadeh et al. (10). Preterm delivery was reported as another reason for fetal mortality based on studies of Karimi et al. (19) and Mehdizadeh et al. (10) conducted in Tehran. Ghotbi et al. (18) showed that the decrease of blood circulation between uterus and placenta was the main cause of fetal mortality.

Pasalar et al. (21) showed that the most reported fetal mortality was occurred in the age group of 26 to 30-year-old mothers, and there was a statistically significant relationship between cause of burn and fetal mortality. However, Karimi et al. (19) showed that fetal mortality had no significant relationship with gestational age, cause of burn and age in pregnant women of Tehran. Finally, it can be concluded that the highest percentage of fetal mortality is reported for following reasons: high TBSA (5, 10, 13, 14, 18, 19, 22); intentional burns (10, 13, 19-21); acute respiratory failures (13, 19, 21); first pregnancy experience (21); first trimester of pregnancy; burn agents [kerosene and stove explosion (22)]; and in the early days of burn incidents (18).

3-17. The results of Heterogeneity

As can be seen from **Figure 2 and 3**, the non-overlapping of confidence distance between targeted indices and overall outcome line implies a heterogeneity in most reviewed studies (*please see the figures in the end of paper*).

According to **Table.2**, the existence of heterogeneity is confirmed by significance of T^2 and Chi-square tests for indices of maternal and fetal mortality. P-values of T^2 test were 0.015 and 0.01 for maternal and fetal mortality, respectively. Chi-square test had also $P < 0.001$ for both indices. It should be noted that the percentage of heterogeneity based on I^2 test was 78% (confidence interval [CI]: 62-88) and 70% (CI: 44-84) for maternal and fetal mortality, respectively. According to the existence of heterogeneity, the obtained overall outcome of maternal and fetal mortality caused by burn incidents among pregnant women of Iran based on random method was 48.4% (CI:40.5-56.4) and 54.2% (CI: 46.9- 61.5), respectively (*please see the table in the end of paper*).

3-18. The investigation of heterogeneity cause

Table.3 shows that only mid-year of study period with $P=0.071$ (significance level of 10%) influences percent of maternal mortality using meta-regression analysis. Therefore, it is considered as the reason of heterogeneity of maternal mortality in reviewed studies. It can be inferred from the **Table.3** that increasing a year to median year leads to reduce 1.5% of maternal mortality (*please see the table in the end of paper*).

3-19. The results of publication bias

According to the investigation of publication bias, Funnel plot (**Figures 4 and 5**) diagnoses two and four studies as an outlier study for maternal and fetal mortality, respectively (*please see the figures in the end of paper*). **Table.4** also shows that the existence of publication bias is confirmed by Egger test with $P=0.038$ and $P=0.012$ for maternal and fetal mortality, respectively. The command metatrim based on non-parametric method of Duval and Tweeie identified two

censored study because of the existence of publication bias. It can be concluded from applying the potential effects of these two studies that there is no difference in total outcome of meta-analysis between random method of adjusted meta-analysis and that one obtained from Meta command in meta-analysis (*please see the table in the end of paper*).

4- DISCUSSION

This study is a systematic review to investigate the epidemiology of burn in pregnant women of Iran. Therefore, 12 relevant studies (data from 1991 to 2014 in some provinces of Iran) are eventually gathered by the researchers of this study in late 2016 (Table.1). The results showed that the average age of Iranian pregnant women suffered from burn incident was between 22.54 and 26.5 years. Mago et al. (23), Subrahmanyam et al. (24) (both from India), and Still et al. (25) (from Georgia state of America) also showed that the average age of pregnant women suffered from burns was 27, 23 and 22 years, respectively (23-25).

The results of this study and many other studies (including Mago et al., Subrahmanyam et al., Prasann et al., Masoodi et al. and Akhtar et al. in India) showed that the most reported burn cases of pregnant women are belonged to women from rural area with low socioeconomic status and low education level (or illiterate) (23, 24, 26-28). In this, a similar pattern for seasonal distribution of burn cases is not found. Most of pregnant women suffered from burn incidents were housewives. Subrahmanyam et al. (24) also showed that all burn cases were housewives and burn incidents occurred in house. Kerosene and flame were the main burn agents of reviewed studies conducted exclusively on Iranian pregnant women. Subrahmanyam et al. (24) also showed that most reported burn agent for cases from India was flame

by stove explosion and kerosene. Furthermore, Still et al. (25) reported that the main burn agent of American pregnant women was fire caused by cooking or house fire. In our study, the highest and lowest frequency of intentional burn cases are reported 47% [by Rezavand and Seyedzadeh (5) in Kermanshah from 1991 to 2002], and 14.6% [by Mehdizadeh et al. (10) in Tehran from 1994 and 2000], respectively. It is worth mentioning that such statistics for Kermanshah are expected because it is a province with the problem of self-immolation among women (11). According to the studies of Mghsoudi et al. (13) in Tabriz and Pasalar et al. (21) in Shiraz, the burn agent of all intentional burn cases was kerosene or diesel.

These results are inconsistent with the study of Subrahmanyam et al. (24) conducted in India which showed that 25% of burn cases in Indian pregnant women was intentional burns mostly caused by kerosene. These results can be justified by considering the culture of developing countries including Iran, responsibilities of housewives in the preparation of food (work with fire) and availability of kerosene. The results showed a significant reduction of intentional burns compared to previous years. However, it implies a great alarm about the consequences of maternal and fetal mortality in Iran with this high level of self-immolation among pregnant women in some provinces in Iran than in India [as a developing country (24)].

It should be noted that suicide is one of the most reported examples of maternal mortality among pregnant women according to the latest International Classification of Diseases (10-ICD) (29). Investigation national system of maternal mortality in Iran uses the division 9-ICD, and none of the burn deaths are considered as maternal mortality. Therefore, there is no action applied to investigate the cause of death or death reporting (24). The second and first trimester of pregnancy

were the most and least reported gestational age for most of reviewed studies, respectively. The studies conducted by Subrahmanyam et al, and Masoodi et al, in India also showed that the majority of pregnant women had burn incidents in their second trimester of pregnancy and The lowest frequency of burn cases is reported in third trimester of pregnancy (24, 27). Reviewed studies showed that the most burn cases were pregnant women with a history of more than three pregnancies. In some studies, women with a history of first pregnancy were the lowest frequency of burn cases (22). Average TBSA was between 37% and 53.3% based on the results of studies conducted in Iran. Still et al. (25) reported lower average TBSA compared to this value (25.3%) for American pregnant women. In the present study, TBSA below 20% and over 61% had the lowest frequency of burn cases. Masoodi et al. (27) also showed that the majority and minority of burn cases had 31-50% and over 51% of TBSA in India, respectively.

Maternal mortality among pregnant women suffered from burns in Iran was between 29.2% and 66.67% and its overall outcome was 48.4% based on the result of meta-analysis. In studies conducted in India, the maternal mortality among pregnant women suffered from burns was reported 28.3%, 70% and 63.6% by Akhtar et al. (26), Mago et al. (23) and Subrahmanyam et al. (24), respectively. These results were roughly inconsistent with the results of our study. Maternal mortality was 12.5% and 21.84% in the United States [Still et al. (25) and India (Masoodi et al. (27))], respectively (which was lower than its value in Iran). The univariate analysis of meta-regression showed that maternal mortality is decreased by increasing the mid-year of study and this reduction was statistically significant ($P=0.071$). It can be inferred

from the results that maternal mortality has been decreased by health measures in recent years. The majority of burn cases are generally in patients with TBSA more than 50%, intentional burns and burn agents of kerosene and stove explosion. The main causes of death were acute respiratory damage, sepsis and severity of lesions. Burn cases with TBSA more than 50% were the most reported cases of pregnant women presented by Unsur et al. (30) in Turkey, Still et al. (25) in the United States, Masoodi et al. (27) and Mago et al. (23) in India. Agarwal et al. (31) showed that TBSA was the only statistically significant factor predicting maternal and fetal mortality. Subrahmanyam et al. (24) and Still et al. (25) reported some main reasons for maternal mortality such as shock, sepsis and severe respiratory distress in some organs.

According to this study, the highest TBSA is reported for burn cases caused by kerosene, stove explosion and intentional burns. Therefore, maternal and fetal mortality is reasonably increased in higher value of TBSA resulted in higher respiratory damage (13-16, 18-22). Rezaei et al. (20) and Vaghardoost et al. (22) (in Mashhad and Tehran, respectively) resulted that maternal mortality has been increased by increasing gestational age. However, first trimester of pregnancy was the most reported gestational age for maternal mortality presented by Pasalar et al. (21) in Shiraz. Fetal mortality rate was between 38.5% and 72.8% among reviewed studies conducted in Iran. Moreover, overall outcome of fetal mortality for Iranian pregnant women suffered from burns was 54.2% based on applied meta-analysis. Subrahmanyam et al. (24) and Akhtar et al. (26) also reported 65.9% and 72%, respectively, for fetal mortality of pregnant women in India so that it was almost as same as results of studies conducted in Iran. This

study showed that fetal mortality has been decreased in pregnant women in recent years. However, there was no statistically significant relationship between fetal mortality and mid-year of study based on univariate regression analysis. There several main factors of fetal mortality in this study such as abortion, intrauterine fetal death, preterm delivery due to uterine contractions increase or decrease in blood circulation of the placenta and uterus. The results of Akhtar et al. (26) conducted in India confirm our results. The highest percentage of fetal mortality of burn cases belonged to women with acute respiratory damage, TBSA more than 50% and intentional burns.

According to the most of reviewed studies, maximum fetal mortality in the early days of burn was reported in women with first pregnancy, first trimester of pregnancy and burns caused by kerosene and stove explosion. It should be mentioned that one of the main reason for fetal mortality in the first trimester of pregnancy is the lack of cesarean section in this period of pregnancy in order to save embryos. However, cesarean section can be applied in second and third trimester of pregnancy. Mabrouk et al. (32) showed in a study conducted in Egyptian university that maternal and fetal mortality had relationship with TBSA. The highest fetal mortality rate is reported for the burn cases with TBSA more than 50% presented by Mago et al. (23) and Unsur et al. (30) for India and Turkey, respectively. According to Subrahmanyam et al. (24), fetal mortality is only occurred for burn cases with TBSA over 30%. Unlike the results of some studies conducted in Iran (20-22), Masoodi et al. (27) showed that the highest and lowest frequency of fetal mortality in India were in second and third trimester of pregnancy, respectively. Subrahmanyam et al. (24) did not observe a statistically significant relationship between maternal mortality and gestational age. Based on

meta-analysis regression, maternal and fetal mortality had no significant relationship with some factors including average age of pregnant women, mean TBSA and intentional burns.

4-1. Strengths and weaknesses

The low number of studies in this field was one of the weaknesses of this study. Also some of the studies were descriptive so that many variables were not studied (incomplete) or reported in different ways. However, the present study is the first comprehensive and systematic review on epidemiology of burns in pregnant women in Iran as part of West Asia with high reported burn cases. As strength of this study, meta-analysis has been applied to obtain overall outcome of maternal and fetal mortality.

5- CONCLUSIONS

According to obtained results from this study, the risk of burn incidents and consequently the maternal and fetal mortality were more reported for pregnant women with the age group of 22 to 27 years, from rural areas, low socio-economic levels and under diploma (or illiterate). These findings indicate the necessity of applying management to prevent burns in these pregnant women. Meta-analysis confirmed that that reduction of mortality in pregnant woman had a significant relationship with the passing of time. This can be explained by improvement of health measures in recent years. Considering that the majority of burn cases caused accidentally by kerosene among housewives, it is a necessity to apply some measures taken by the authorities. These measures are the correction of consumption pattern, changing the sources of household fuel, standardization of heating instruments and training preventive behaviors, especially in rural areas. According to most of studies, maternal and fetal mortality were mostly

reported in pregnant women with TBSA over 50% and intentional burns because of acute respiratory damage, septicemia and severe injuries, especially in the early days of patients' acceptance. It is suggested that the future analytical studies be conducted on factors affecting survival of pregnant women (and their fetuses) suffered from burns. Also, it is necessary to investigate the reasons of higher self-immolation cases among pregnant women in some provinces of Iran in comparison with developing countries.

6- CONFLICT OF INTEREST: None.

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Table-1: Details of reviewed studies.

Author	Province	Year of study	Median year	Sample size	MM (%)	FM (%)	Burn agent	Mean TBSA %	Average age	Intentional burn,%
Rezavand et al. (5)	Kermanshah	1991-2002	1997	91	59.5	52.7	*	-	-	47.0
Mehdizadeh et al. (10)	Tehran	1994-2000	1997	103	62.1	72.8	Kerosene	53.3	23.5	14.6
Maghsoudi et al. (13)	Tabriz	1996-2005	2001	51	39.22	45.1	Kerosene	37.7±29.7	24.2±6.1	27.6
Tavassoli-Ashrafi and Khani (15)	Tahran	1998-2003	2001	74	66	67.5	Kerosene	-	22.5±4.8	15.4
Ghotbi et al. (18)	Shiraz	2000-2005	2003	27	40.74	48.1	Flame	-	-	-
Karimi et al. (19)	Tehran	2001-2007	2004	53	52.8	56.6	Kerosene	52.5±27.2	22.9±5.3	34.0
Rezavand et al. (14)	Kermanshah	2003-2008	2006	39	66.67	64.10	Hot oil	-	23.5±4.8	43.6
Rezaei et al. (20)	Mashhad	2000-2013	2007	48	29.2	43.8	Kerosene	45.1±25.5	25.0±6.3	41.7
Pasalar et al (21)	Shiraz	2003-2010	2007	39	30.8	38.5	Flame	38.1±26.3	23.7±4.8	38.5
Zarei et al. (16)	Ahvaz	2006-2009	2008	32	40.6	46.87	Flame	52.2±26.8	25.5±6.0	18.7
Vaghardoost et al. (22)	Tehran	2007-2014	2011	38	47.4	50	Kerosene	45.8±26.2	26.5±6.0	28.9
Eslamlou et al. (11)	Orumieh	2010-2012	2011	29	37.9	-	Kerosene	39.1±30.0	25.2±5.3	-

MM: Maternal Mortality; FT: Fetal Mortality; TBSA: Total Body Surface Area; * not reported data.

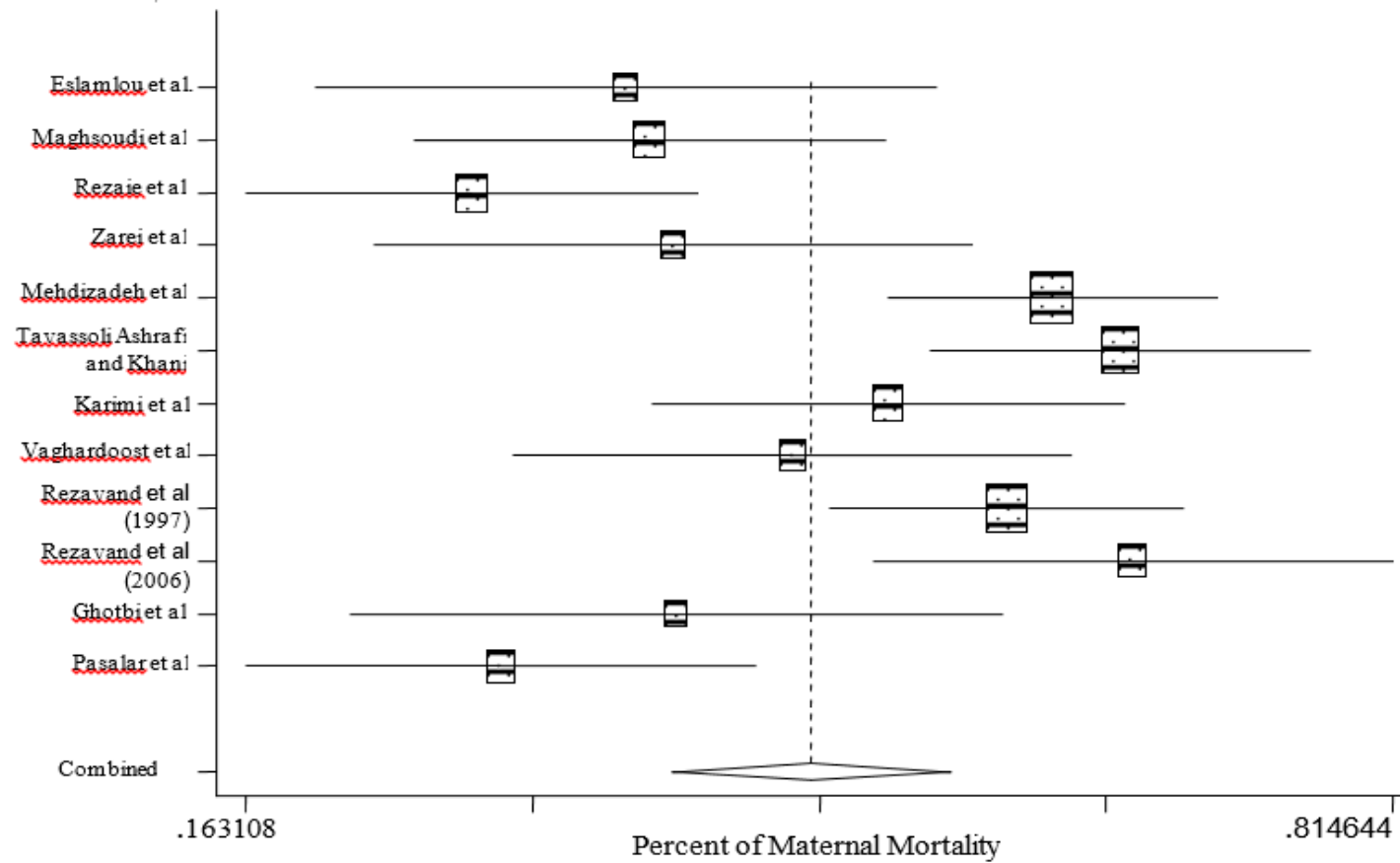


Fig.2: Forest plot designed to evaluate Heterogeneity for the reported maternal mortality rate among pregnant women suffered from burn in Iran.

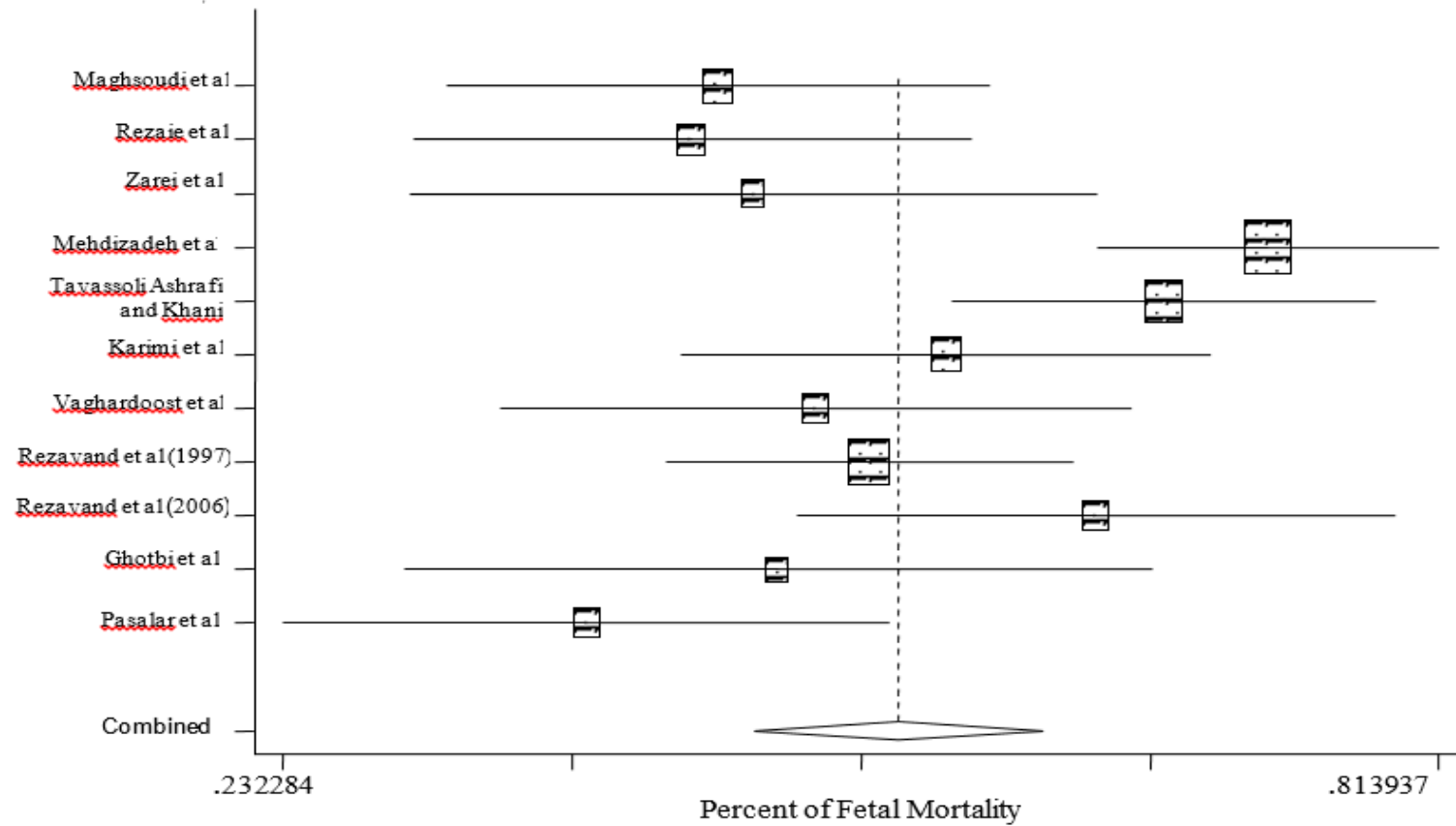


Fig.3: Forest plot designed to evaluate Heterogeneity in reported fetal mortality rate among pregnant women suffered from burn in Iran.

Table-2: The results of heterogeneity by statistical tests.

Variables	I ² (CI)*	P-value for T ² †	(df) ‡χ ²	P-value for χ ²
Maternal Mortality %	78 %(62-88)	0.015	46.312(11)	P<0.001
Fetal Mortality%	70 %(44-84)	0.01	33.109(10)	P<0.001

* I²: True variance of studies/Total variance of studies (CI: confidence of interval), † T²: True variance of studies, ‡ χ²(df): chi-square (df: degree of freedom).

Table-3: Results for the cause of heterogeneity based on Meta-regression test.

Variables	B	T	P-value	
Maternal Mortality, (%)	TBSA Mean	0.01315	0.89	0.408
	Intentional burn%	-0.00283	-0.42	0.687
	Age Mean	-0.06879	-0.96	0.360
	Mid-year of study period	-0.014938	-2.02	0.071
Fetal Mortality, %	TBSA Mean	0.01449	0.91	0.402
	Intentional burn	-0.0046903	-1.64	0.139
	Age Mean	-0.05688	-0.77	0.466
	Mid-year of study period	-0.012225	-1.70	0.122

B: Coefficient of Regression, T: (B/standard error of B).

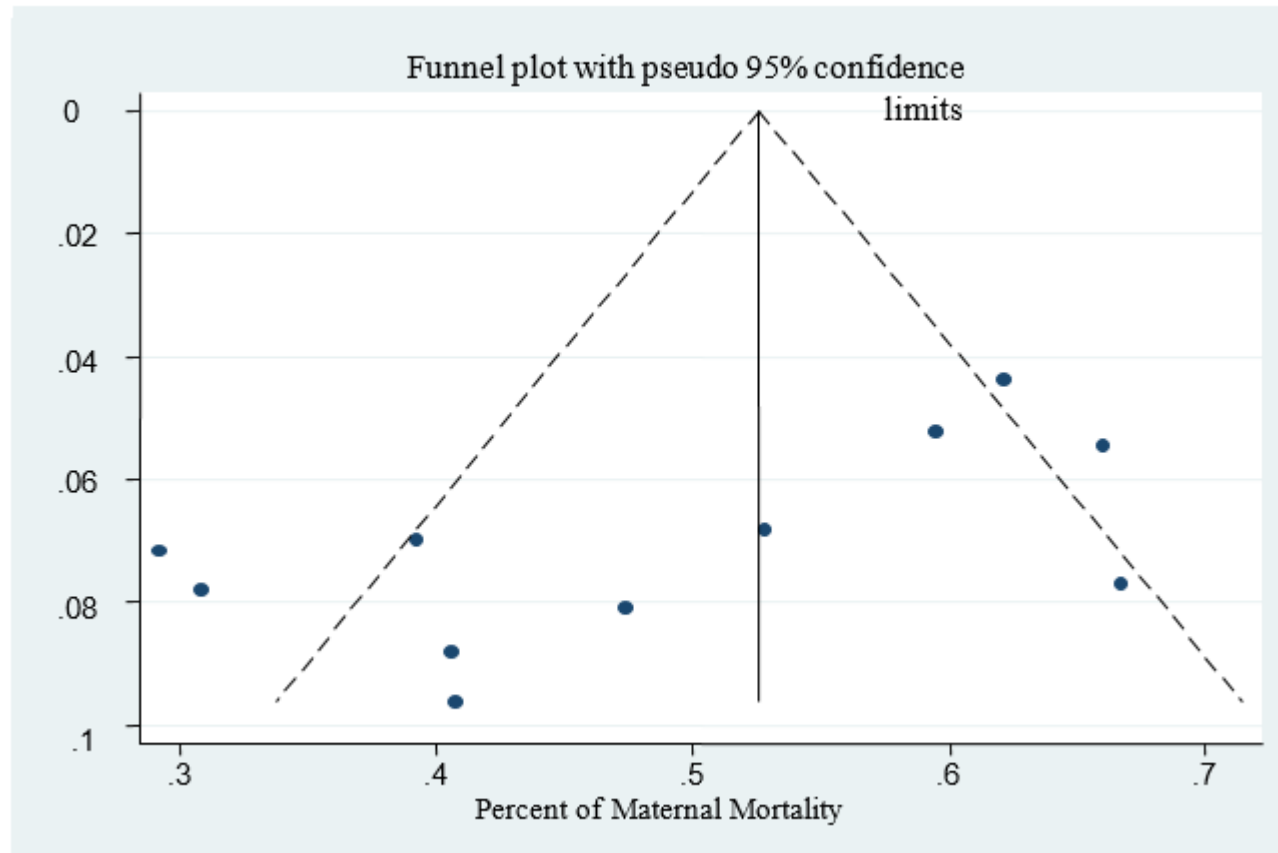


Fig.4: Funnel Plot for the maternal mortality rate among pregnant women suffered from burns in Iran to assess publication bias and identify remote areas of found studies.

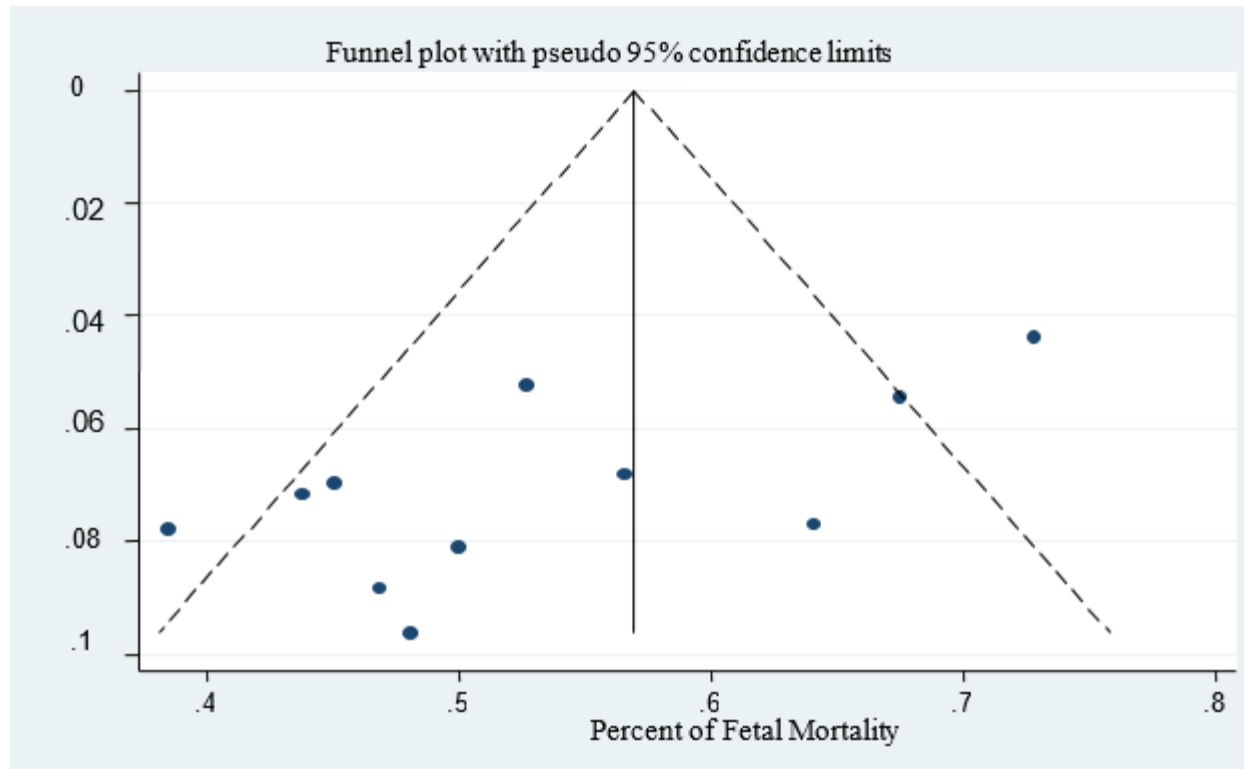


Fig.5: Funnel Plot for the fetal mortality rate among pregnant women suffered from burns in Iran to assess publication bias and identify remote areas of found studies.

Table-4: Egger's test applied to check publication bias.

Variables	Standardized Effect	B	Standard Error	T	P-value	95% Confidence Interval
Maternal Mortality, (%)	Slope	0.8734602	0.1550924	5.63	0.000	.5278929,1.219028
	Bias	-5.55233	2.318823	-2.39	0.038	-10.71899,-.3856715
Fetal Mortality, (%)	Slope	0.9097354	0.1119437	8.13	0.000	.656501, 1.16297
	Bias	-5.339269	1.708459	-3.13	0.012	-9.204073, -1.474466

B: Coefficient of regression.