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# Prevalence of Gestational Diabetes in Iran: A Systematic Review and Meta-analysis

Sara Sadeghi[1], Seyed Reza Khatibi[2], Mehrsadat Mahdizadeh[3], Nooshin Peyman[3], Samira Zare Dorniani[1]*

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## Abstract

**Background:** Pregnant women who have gestational diabetes mellitus (GDM) are more prone to adverse pregnancy outcomes. We estimated the prevalence of GDM in Iran.

**Methods:** Web of Science, Scopus, PubMed, Google Scholar, and Persian databases (SID, Magiran, Irandoc, and) were searched using the MeSH and non-MeSH terms in abstract, title, or keywords of articles until June 2021, with no limitation in time. Random effects models were applied to summarize the GDM prevalence in Iran. The obtained data were quantitatively analyzed to determine an effect size for each paper. The pooled effect size was introduced as prevalence and 95% confidence interval. Sensitivity analyses and subgroup analyses were done to determine heterogeneity. Publication bias was assessed by the classic fail-safe N and Egger test.

**Results:** A total of 53 papers were considered for meta-analysis, involving 56,521 Iranians. The total GDM prevalence in Iran was 7.6% (95% CI, 6.1%–9.4%).

**Conclusion:** This meta-analysis was the newest to estimate the GDM prevalence among Iranian women. Our results suggest a high prevalence of GDM in Iran, showing that Iran might have many GDM patients.

**Keywords:** Prevalence, Gestational Diabetes Mellitus, Iran

*Conflicts of Interest:* None declared
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## Introduction

Diabetes is defined as high blood glucose levels caused by a lack of insulin secretion or by biological dysfunction (1). The World Health Organization (WHO) introduces GDM as "any level of early or early diagnosis of glucose intolerance in pregnancy" (2). Diabetes has become the third "silent killer" in the world after cancer and cardiovascular disease due to the increase in disease and mortality among the human race. The increasing prevalence of type 2 diabetes is significantly elevated in adults, particularly in women diagnosed during childbirth (3). GDM depends on age, race, body composition, ethnicity, and screening and diagnostic criteria. The prevalence of gestational diabetes varies from 5% to 25.5% worldwide, and in the United States, it affects 1 in 10 pregnant women, and approximately 90% of cases of gestational diabetes occur during pregnancy (4). However, the prevalence of GDM is higher in Asian women compared with American women. In Europe, the prevalence of GDM varies and in

*Corresponding author:* Samira Zare Dorniani, zareds971@mums.ac.ir

1. Department of Health Education and Health Promotion, Student Research Committee, Mashhad University of Medical Sciences, Mashhad, Iran
2. Department of Epidemiology and Biostatistics, School of Health, Torbat Heydariyeh University of Medical Sciences, Torbat Heydariyeh, Iran
3. Department of Health Education and Health Promotion, Social Determinants of Health Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

***↑What is "already known" in this topic:***
Gestational diabetes depends on age, race, body composition, ethnicity, and screening and diagnostic criteria. The prevalence of gestational diabetes mellitus (GDM) varies from 5% to 25.5% worldwide, and approximately 90% of cases of GDM occur during pregnancy.

***→What this article adds:***
The total prevalence of GDM in Iran was 7.6% (95% CI, 6.1%–9.4%). Considering the imposition of high costs on the health system, increasing prevalence, and adverse outcomes on mothers and infants, one of the most important research aims is to achieve a cost-effective approach according to the characteristics of different cities for training, measuring, preventing, and controlling GDM in Iran.



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some populations, more than 20% of pregnancies are recorded (5). The GDM prevalence reached 14% of pregnancies among American women (6). The International Diabetes Federation reported in 2014 that the global prevalence of GDM varied between 1% and 14% (7). Diabetes during pregnancy affects both the mothers' health and the fetus' growth (8). One of the main causes of premature birth or even infant mortality is gestational diabetes. Diabetic mothers are more prone to miscarriage (9).

As a result of economic development and improvement of living standards, along with more attention to GDM screening, an increase in the incidence of GDM has been observed. Iran has a high prevalence of diabetes and the increasing GDM prevalence in Iran is also worrying. Therefore, a meta-analysis is needed to quantitatively aggregate the results of relevant studies. Therefore, we conducted a systematic review and meta-analysis of studies on the prevalence of GDM in Iran.

## Methods

### Study Protocol

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (10) was applied. The study protocol was registered at the international prospective register of systematic reviews database (PROSPERO) (https://www.crd.york.ac.uk/prospero; CRD42021259379) on June 2021.

### Search strategy

Using a systematic search, studies on the prevalence of gestational diabetes in Iran were found. We searched the Web of Science, Scopus, PubMed, Google Scholar, and Persian databases (Magiran, SID, IranDo) using the MeSH and non-MeSH terms in the abstract, title, or keywords of articles until December 2022, with no time limitation. The search strategy was (Prevalence OR Incidence) AND ("Diabetes, Gestational" OR "Diabetes, Pregnancy-Induced" OR "Diabetes, Pregnancy Induced" OR "Pregnancy-Induced Diabetes" OR "Gestational Diabetes" OR "Gestational Diabetes" OR "Diabetes Mellitus, Gestational" OR "Gestational Diabetes Mellitus" OR "GDM") AND (Iran) with no limitation in time.

### Eligibility Criteria

Original English and Persian papers investigating the prevalence of gestational diabetes in Iran were included. Studies with incomplete or non-extractable data were excluded.

### Study Selection

Two authors (S.Z.D. and S.S.) reviewed the retrieved papers for exclusion and inclusion criteria and discrepancies were discussed and resolved by a third author (S.R.Kh.). Also, the references of the obtained studies and related review articles were manually reviewed for possible missing articles in the electronic search.

### Qualitative Study

The Newcastle–Ottawa quality assessment scale was applied to score the included studies. It addresses 3 major study designs in analytical epidemiology, namely, case-control, cohort, and cross-sectional studies.

### Data Extraction

The authors' name, publication year, name of the journal, country of origin, duration of data collection, GMD prevalence, 95% CI, and sample size were extracted from the studies.

### Statistical Analysis

Data analysis was done using comprehensive meta-analysis software (CMA; Version 3.3.070) to determine the effect size. The pooled effect size was introduced as prevalence and 95% confidence interval by the random effects model. There was significant heterogeneity between studies evidenced by the *P* value of the Q-statistic < 0.10 and the $I^2$ statistic of > 50% (11, 12). Thus, meta-regressions and subgroup analyses were applied to determine the possible sources of heterogeneity. The tau-squared (Tau2) statistic was used to assess the between-study variance (13). Also, a sensitivity analysis was performed through the removal of studies one by one and assessing the P value of the pooled effect (leave-one-out sensitivity analysis). The Egger and Begg tests investigated publication bias. $P < 0.05$ was considered significant.

## Results

### Description of the Included Studies

Figure 1 shows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 flow diagram of the process of study selection. We retrieved 313 original journal articles (199 from Scopus, 30 from PubMed, 6 from Web of Science, 53 from Persian databases, and 25 in the references of related articles), of which 53 articles had the inclusion criteria for the qualitative assessment (14-65). The quality score of the studies ranged from 8 to 10 according to the Newcastle–Ottawa quality assessment scale. Hence, all 53 articles were considered for the quantitative meta-analysis.

The characteristics of the 53 articles included in the meta-analysis with a total sample size of 56,521 are summarized in Table 1. All of the papers reported the prevalence of GDM in Iran. The articles were published between 1999 and 2021. According to geographical locations, 16 studies were performed in Tehran, (16, 17, 19, 24-27, 33, 34, 41, 45, 46, 48, 57, 62, 66), 4 in Isfahan, (30, 35, 59, 67), 4 in Mazandaran, (15, 21, 28, 38), 3 in Kermanshah, (36, 50, 51), 4 in Yazd, (58, 60, 61, 65), 3 in Hamadan, (20, 23, 63), 2 in Khuzestan, (54, 55), 2 in Kerman, (47, 53), 2 in Urmia, (29, 42), 2 in Fars, (14, 64); and 1 study was conducted in each of the following cities and provinces: Ardabil, Hormozgan, South Khorasan, Bushehr, Golestan, Ilam, Alborz, Lorestan, Semnan, Sistan and Baluchestan and Zanjan (22, 31, 32, 37, 39, 43, 44, 49, 52, 56, 68). All the studies have reported the prevalence of gestational diabetes (Figure 2).

### Findings of Individual Studies

The highest prevalence (39.5) was declared from Hamadan in 2018 (20). The lowest prevalence (0.7) was de-





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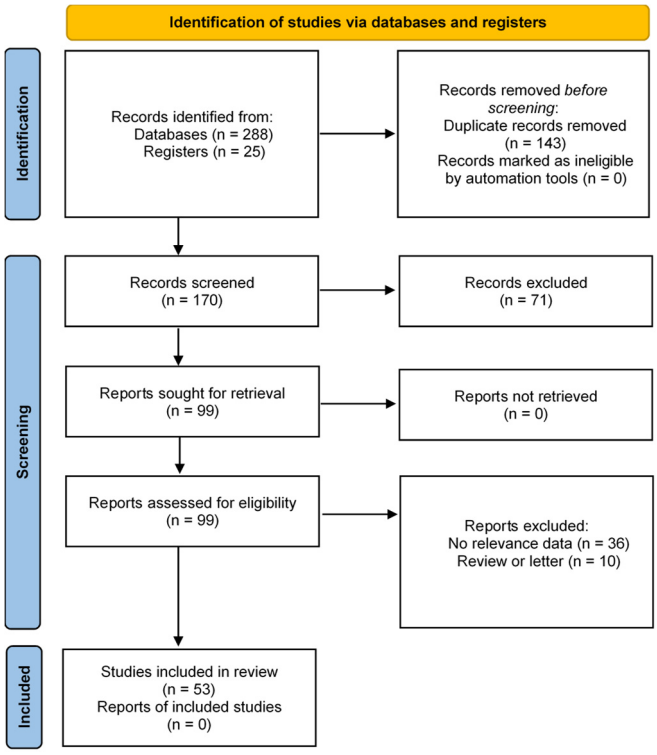


*Figure 1.* Flow and Characteristics of the Included Studies

*Table 1.* Characteristics of the studied papers in the meta-analysis

| First Author | Year | Sample size | Place | Study Design | Prevalence | Newcastle - Ottawa Quality Assessment Scale |
|---|---|---|---|---|---|---|
| Manafi, M (42) | 2013 | 84 | Urmia | Cross-Sectional | 0.119 | 9 |
| Khodaei, S (52) | 2003 | 102 | Khorramabad | Cross-Sectional | 0.0686 | 9 |
| Nazari Robati, F (47) | 2017 | 160 | Shahdad-Kerman | Cross-Sectional | 0.125 | 9 |
| Kashi. Z (38) | 2007 | 200 | Sari | Cross-Sectional | 0.103 | 10 |
| Ekhtiari, A (24) | 2016 | 271 | Tehran | Cross-Sectional | 0.24 | 9 |
| Shafi poor, M (53) | 2013 | 290 | Rafsanjan | Cross-Sectional | 0.093 | 10 |
| Ghasemi-kakalar, S (29) | 2018 | 301 | Urmia | Cross-Sectional | 0.1628 | 9 |
| Shahdadi, H (56) | 2016 | 363 | Zabol | Cross-Sectional | 0.047 | 9 |
| Etminan-Bakhsh, M (25) | 2020 | 400 | Tehran | Cross-Sectional | 0.115 | 9 |
| Vakili, M (61) | 2014 | 400 | Yazd | Cross-Sectional | 0.12 | 10 |
| Asnafi, N (15) | 2006 | 401 | Babol | Cross-Sectional | 0.047 | 9 |
| Abolfazl, M (14) | 2008 | 420 | Shiraz | Cohort | 0.167 | 9 |
| Kamali, S (37) | 2003 | 450 | Zanjan | Cohort | 0.029 | 9 |
| Dorostkar, H (23) | 2015 | 493 | Razan | Cross-Sectional | 0.122 | 10 |
| Jalilian, N (36) | 2010 | 504 | Kermanshah | Cross-Sectional | 0.007 | 9 |
| Borzouei, S (20) | 2018 | 534 | Hamadan | Cross-Sectional | 0.395 | 9 |
| Rahimi, G (49) | 2004 | 601 | Ardebil | Cross-Sectional | 0.013 | 9 |
| Bojnordi, S (19) | 2021 | 613 | Tehran | Case-Control | 0.23 | 8 |
| Zangeneh, M (63) | 2018 | 620 | Hamadan | Cross-Sectional | 0.086 | 9 |

clared from Kermanshah in 2010 (36).

The forest plot summarizing the pooled prevalence is depicted in Figure 3. Using a random effects model, 53 studies were included in the meta□analysis, including 56,521 Iranian participants. The total prevalence of GDM in Iran was 7.6% (95% CI 6.1%–9.4%). This pooled effect was robust in the leave-one-out sensitivity analysis (Figure 4). However, a significant between-study heterogeneity was found (Q-statistic $P < 0.001$; $I^2 = 98.08\%$).

Meta-regression analysis was done to evaluate the association between the prevalence of GDM in Iran and the publication year of the study. The results suggested that the prevalence of GDM in Iran increased over time (Figure 5).

The funnel plot in Figure 6 shows no significant publication bias considering Egger linear regression (intercept = –7.93; S.E. = 2.48; 95% CI: –12.91 to –2.95; t = 3.20; df = 51; 2-tailed $P = 0.002$) and Begg rank correlation (Kendall's Tau with continuity correction = –0.13; z = 1.34; 2-tailed $P = 0.18$). Duval and Tweedie "trim-and-fill" correction caused the imputation of 1 potentially missing study as well as an adjusted effect size of 0.099 (95% CI:





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*Table 1.* Continued

| First Author | Year | Sample size | Place | Study Design | Prevalence | Newcastle - Ottawa Quality Assessment Scale |
|---|---|---|---|---|---|---|
| Ghadiri, M (28) | 2018 | 627 | Sari | Cross-Sectional | 0.042 | 9 |
| MirFeizi, m (43) | 2008 | 668 | Karaj | Cross – Sectional | 0.186 | 9 |
| Shahbazian,BH (55) | 2012 | 678 | Ahvaz | Cross – Sectional | 0.074 | 9 |
| Dolatian, M (22) | 2020 | 734 | Ilam | Cross-Sectional | 0.098 | 9 |
| Shahbazian,H (54) | 2016 | 750 | Ahvaz | Cohort | 0.299 | 9 |
| Hadaegh, F (31) | 2004 | 800 | Bandar Abbas | Cross-Sectional | 0.063 | 9 |
| Navayi, L (46) | 2002 | 820 | Tehran | Cross-Sectional | 0.023 | 9 |
| Karimi, F (68) | 2003 | 910 | Bushehr | Cohort | 0.0175 | 9 |
| Babaniamansour S (17) | 2021 | 925 | Tehran | Cross-Sectional | 0.127 | 10 |
| Shirazian, N (57) | 2009 | 971 | Tehran | Cohort | 0.074 | 9 |
| Hedayati, H (32) | 2012 | 980 | Birjand | Cross-Sectional | 0.051 | 9 |
| Hosseini, E (72) | 2018 | 1000 | Isfahan | Cohort | 0.093 | 9 |
| Hosseini, E. (67) | 2018 | 1000 | Isfahan | Prospective Cohort | 0.1 | 9 |
| Bouzari, Z (21) | 2013 | 1004 | Babol | Cross-Sectional | 0.0805 | 9 |
| Soheilukhah, S (58) | 2010 | 1071 | Yazd | Cohort | 0.102 | 9 |
| Tabatabaei, A (59) | 2007 | 1112 | Isfahan | Cross – Sectional | 0.0676 | 9 |
| Niroomand, M (48) | 2019 | 1117 | Tehran | Cross-Sectional | 0.156 | 9 |
| Garshaspi, E (27) | 2004 | 1200 | Tehran | Cross-Sectional | 0.069 | 9 |
| Vakili, M (60) | 2016 | 1209 | Meibod-Yazd | Cross-Sectional | 0.271 | 9 |
| Rahimi, M (50) | 2017 | 1272 | Kermanshah | Cross-Sectional | 0.0881 | 9 |
| Mohammadzadeh,F (44) | 2015 | 1276 | Gorgan | Cross-Sectional | 0.049 | 9 |
| Keshavarz, M (39) | 2003 | 1310 | Shahrood | Cross-Sectional | 0.048 | 10 |
| Rahimi, M (51) | 2010 | 1720 | Kermanshah | Cross-Sectional | 0.0343 | 9 |
| Garshasbi, A (26) | 2008 | 1804 | Tehran | Cohort | 0.068 | 9 |
| Zahedi, M (62) | 2020 | 1894 | Tehran | Cohort | 0.183 | 9 |
| Goli, M (30) | 2013 | 2014 | Isfahan | Cross-Sectional | 0.038 | 9 |
| Momenzadeh, F (45) | 2015 | 2033 | Tehran | Cross Sectional | 0.068 | 10 |
| Larijani, B (66) | 1999 | 2100 | Tehran | Cross-Sectional | 0.045 | 9 |
| Atashzadeh, F (16) | 2006 | 2221 | Tehran | Cross – Sectional | 0.048 | 9 |
| Hossein-Nezhad, A (34) | 2007 | 2416 | Tehran | Cross-Sectional | 0.047 | 9 |
| Larijani, B (41) | 2002 | 2416 | Tehran | Cross-Sectional | 0.0223 | 10 |
| Hematyar, M (33) | 2008 | 5107 | Tehran | Cross-Sectional | 0.033 | 9 |
| Rashidi, H (65) | 2021 | 3202 | Yazd | Cross-Sectional | 0.033 | 9 |
| Rezaee, E (64) | 2021 | 953 | Gerash | Cross-Sectional | 0.04 | 9 |

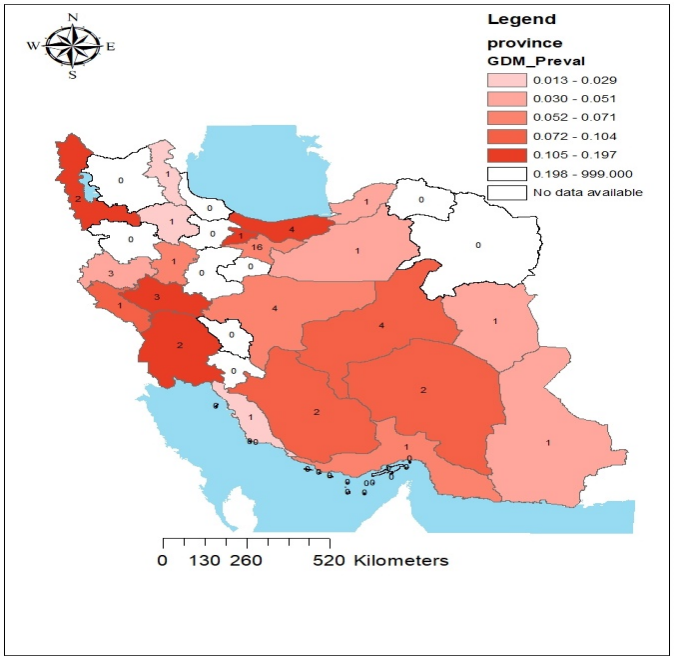


*Figure 2.* Prevalence of gestational diabetes mellitus in Iran by province. The numbers on the map indicate the number of studies conducted in each province.

0.096–0.102). According to the "fail-safe N" test, 8386 studies were needed to turn the effect size into a nonsignificant value.



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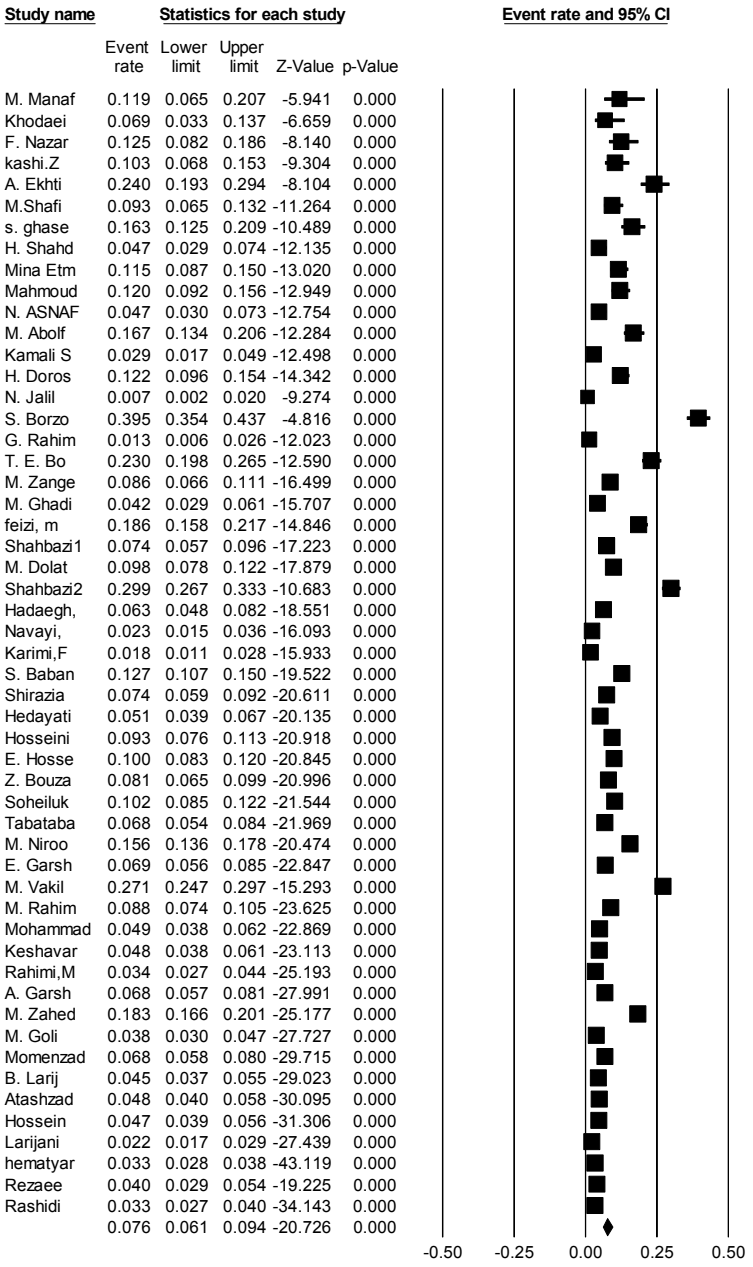


*Figure 3.* Forest plot of the random-effect meta-analysis for the prevalence of gestational diabetes in Iran

## Discussion

Diabetes is a major threat to health. The WHO reported diabetes as the eighth cause of death in 2016, which will be the fourth cause in 2030 (18). We tried to determine the GDM prevalence in Iran. A total of 53 studies performed on 56,521 women between 1999 and 2021 entered the final stage. The GDM prevalence in Iran was 7.6%, which is lower than previous reviews (11.5%) in Asia (69) and Eastern Mediterranean (12.9%) (70), which can be attributed to the similarity in sociodemographic features of some of the studied countries. In this study, Kermanshah showed a lower prevalence (0.7%) of GMD. (36) Also, the prevalence of GDM was higher in Hamadan (39.5%) (20). This could be due to the time of the study, as well as various diagnostic criteria of GDM. The fact that more women of reproductive age are obese and overweight results in the increasing prevalence of GDM. Other factors causing this difference are the ethnic and racial variation in the population of different cities, as the prevalence of GDM in the Asian race was more than in European Whites and African Americans of the same age (71). We faced a limitation because we analyzed data on the crude prevalence without considering the effect of confounders, like social, demographic, and geographical factors. This was because various studies have used different confounding factors and similarity in this regard is scarce.





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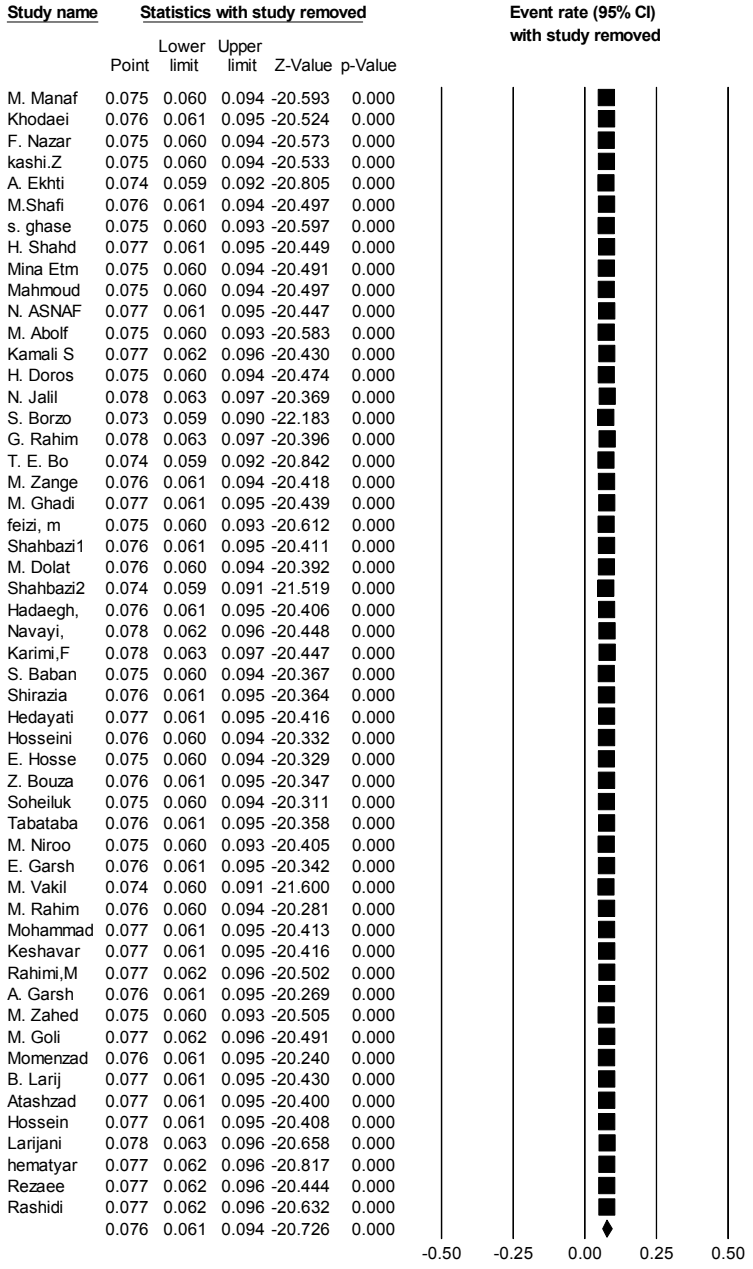


*Figure 4.* The results of the leave-one-out sensitivity analysis

## Conclusion

Despite the high diversity of methods, our results indicated a high GDM prevalence in Ahvaz, which indicates more interest of policymakers in timely screening and appropriate management of the disease. Concerning increasing the prevalence and adverse outcomes on mothers and infants, and imposition of high costs on the health system, one of the most important research points is to achieve a cost-effective approach according to characteristics of different cities of Iran to train, prevent, measure, and control GDM in Iran. Policymakers should take measures to raise the awareness of pregnant women and families about the warning signs of GDM.

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### *Conflict of Interests*

The authors decle that they have no competing interests.





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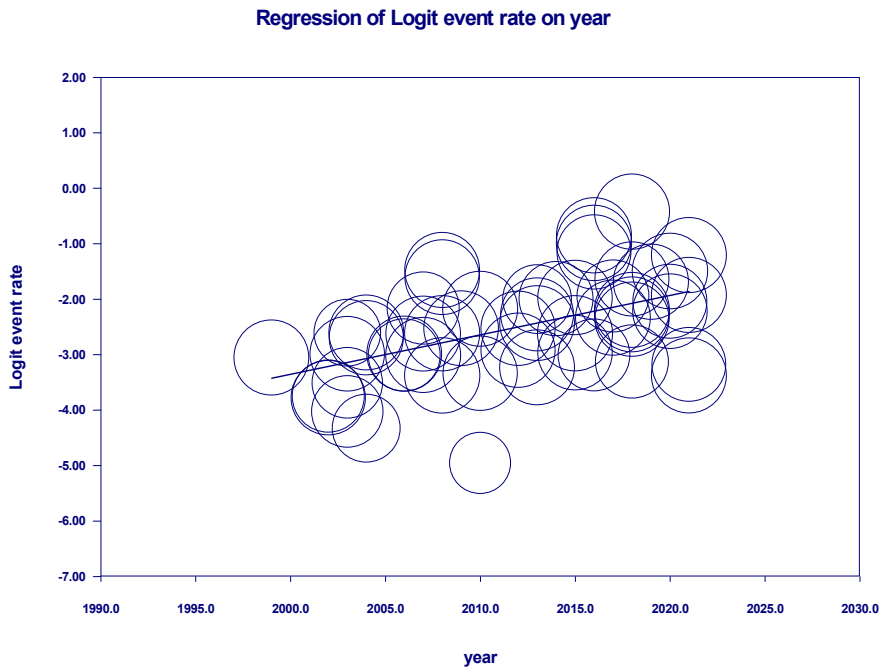


*Figure 5.* Meta-regression between publication year of studies and GDM prevalence in Iran

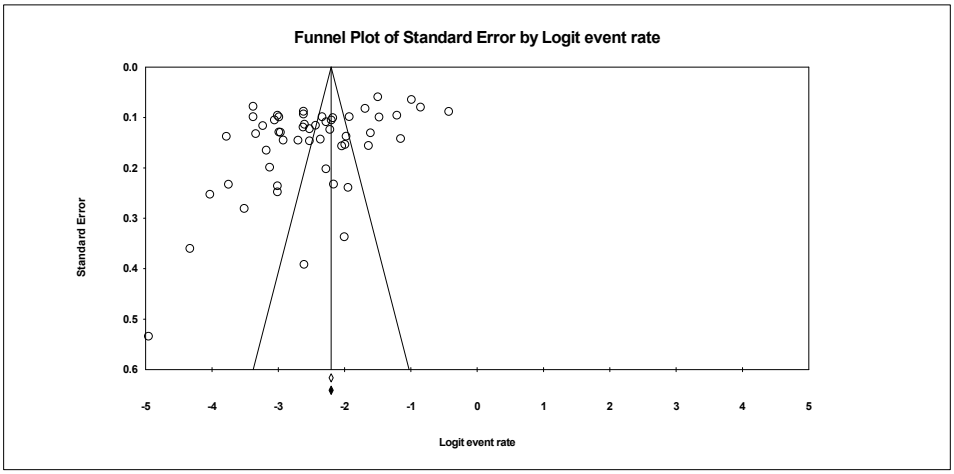


*Figure 6.* The funnel plot of the meta-analysis

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