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META-ANALYSIS

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Prevalence of gestational diabetes mellitus in Eastern Mediterranean region: a systematic review and meta-analysis

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Abstract

Purpose Gestational diabetes mellitus (GDM) is one of the costly challenges in the health field. Despite the individual studies in the Eastern Mediterranean, there is no comprehensive study in this regard. The aim of this study was to determine the prevalence of GDM in the Eastern Mediterranean region.

Methods In this meta-analysis and systematic review, three international databases (PubMed, Web of science and Scopus) were searched from inception until 30 December 2018. The Hui tool was used to assess the quality of the included studies.

Results Thirty-three studies performed on 887166 participants were included in the meta-analysis. Based on the results of random effect method, the overall prevalence of GDM was 11.7%. Between six country with have three or more study, pooled prevalence for Saudi Arabi it was 3.6 times more than Israel (17.6 vs. 4.9%), and for Pakistan, Qatar, Bahrain and Iran were 15.3%, 14.7%, 12.2%, and 8.6%, respectively.

Conclusion Despite the high diversity of methods, the results of the present study indicate a high prevalence of GDM in the Eastern Mediterranean region, indicating more policymakers' interest in timely screening and proper management.

Keywords Epidemiology · Gestational diabetes mellitus · Eastern Mediterranean region · Meta-analysis

Introduction

Gestational diabetes mellitus (GDM) is one of the challenges of the health system in the world today. GDM is a type of diabetes that has been diagnosed for the first time in pregnancy period that is characterized by glucose intolerance in the second and third trimester of pregnancy in people who have no previous history [1]. GDM, along with other types of diabetes, is known as one of the most costly cases, which annually imposes a cost of 1.2 trillion dollars worldwide and expected to reach over 2.2 trillion dollars by 2030 [2]. One of the major challenges in determining the exact prevalence of GDM is the presence of more than eight criteria for its diagnosis, which is provided by various organizations [3].

According to the latest figures in 2017, more than 18.6% of women suffered from different types of hyperglycemia, of whom 18.6 million were diagnosed with GDM [4]. The prevalence of GDM is rising annually. The global prevalence of GDM varies from 1–28% in different regions of the world based on the characteristics of the population studied and the various diagnostic methods of GDM [5]. The Eastern Mediterranean region with the South Asian region account for the highest prevalence of GDM [4].

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The most important risk factors of GDM are the history of GDM, macrosomia, previous genetic anomalies, BMI > 25, gestational hypertension, family history of diabetes, polycystic ovary syndrome, history of abortion, and preterm labor history [6]. GDM is associated with various maternal and neonatal complications. The most frequent maternal complications of GDM on the basis of various WHO and IADPSG criteria are include macrosomia, perinatal mortality, preeclampsia, cesarean section, birth injury, shoulder dystocia, neonatal hypoglycemia, and long-term metabolic complications for mother and fetus [7, 8]. There are individual studies in this area, and so far, there has not been any comprehensive study in the East Mediterranean despite being regarded as one of the region of world with highest prevalence of GDM. On the other hand, determining the exact prevalence of GDM will help health policymakers to prioritize and plan for better screening and control. This meta-analysis study was conducted to determine the prevalence of GDM in the Eastern Mediterranean region from 2000 to 2018.

Methods

Study design and eligibility criteria

The methods adopted for this systematic review have been developed in accordance with the Cochrane Handbook for Systematic Reviews and reported using Preferred Reporting Items for Systematic Reviews and Meta-Analyses tool [9]. Descriptive, cohort, case-control studies included but reviews, letter to editor, studies that did not allow access to the full text version, and studies written in languages other than English were excluded from the study. Only studies that were conducted in EMRO region countries were included. Diagnosis of GDM was based on the standards defined in the literature [3]. The target population of the current study was pregnant woman.

Search strategy

The International databases include PubMed, web of science and Scopus were searched for relevant studies in EMRO region limits in English language from inception to 30 December 2018. The MEDLINE search strategy was adopted to search in other databases. The specific search strategies were created by a Health Sciences Librarian with expertize in systematic review according to the PRESS standard [10]. In addition, PROSPERO was used to search for ongoing or recently completed systematic reviews. Boolean operators (AND, OR, and NOT), Medical Subject Headings (MeSH), truncation "*" and related text words were used for search using the following keywords: "prevalence", "Epidemiology", "gestational diabetes mellitus", "GDM", "hyperglycemia in pregnancy", and "gestational hyperglycemia" in Eastern Mediterranean region countries.

Selection of studies and data extraction

According to the study protocol, two researchers independently screened the titles and abstracts based on the eligibility criteria, in next step, after removing duplicated studies, studies full texts were screened based on the eligibility criteria, and the required information was extracted. Consensus method was used for solving controversies among two researchers. Extracted data items included: author, year of publication, country, sampling method, design, diagnostic criteria of GDM, setting, gestational age, Year of data collection, sample size, Age and Risk Factor, Risk of bias, and prevalence of GDM.

Quality assessment

To assess the methodological quality and risk of bias, each included observational study was evaluated by using the Hoy et al tool. This 10-item tool evaluated the quality of studies in two dimensions including external validity (items 1–4 assess target population, sampling frame, sampling method and nonresponse bias minimal) and internal validity (items 5–9 assess data collection method, case definition, study instrument, mode of data collection and item 10 assesses bias related to the analysis). Risk of bias was evaluated by two researchers independently, disagreements were resolved via consensus method.

Data synthesis

All the eligible studies were included in the synthesis after a systematic review. Data were combined with the forest plot. The random-effects model was used for evaluation the overall GDM. The heterogeneity of the preliminary studies was evaluated with I2 tests. Subgroup analysis was conducted to determine heterogeneity based on the country of study conducted and diagnosis criteria of GDM. Meta-analysis was performed using STATA 14 (StataCorp, Texas, USA) statistical software.

Results

Overall results

Study selection

A total of 1166 articles from initial searches were retrieved in three databases. Out of 772 nonduplicated studies in the

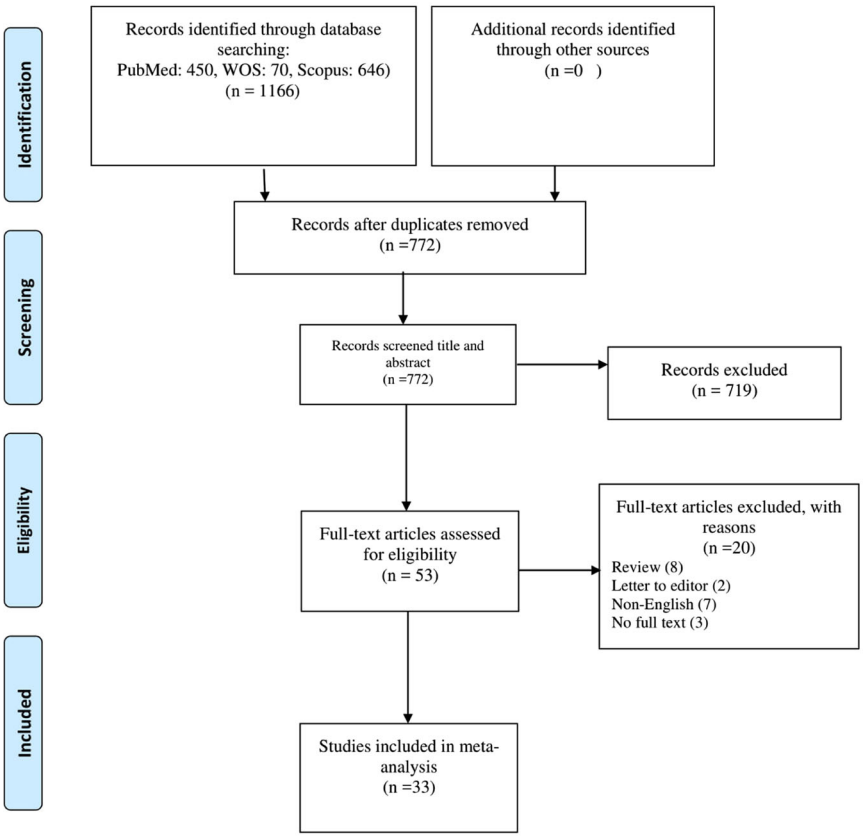

Fig. 1 Study selection process

title and abstract screening process, 394 studies were excluded due to inappropriate titles. Out of 53 studies, 33 had eligibility criteria. Out of 20 excluded studies, eight studies were review, two studies were letter to the editor, three studies had no full text, and seven studies published in non-English language (Fig. 1).

Study characteristics

Thirty three studies which were conducted on 887,166 participants in 11 countries of EMRO. The age range of the participants was between 16 and 51 years. The mean age of participants was 29.5 years. Studies were conducted over the period 2000–2018. Geographically, most studies were conducted in Iran ($n = 10$), Saudi Arabia ($n = 5$), and Pakistan ($n = 4$). The most frequent sampling method was census ($N = 22$). Descriptive studies made up the largest number of studies ($n = 32$). The most common GDM diagnostic criteria were Carpenter and Coustan ($n = 10$) and ADA ($N = 6$). Most of the studies were conducted in hospitals ($n = 31$). Studies were conducted on pregnant women in their 24th to 40th gestational weeks. Most of the studies included had low bias risk ($n = 31$) (Table 1).

Main results

Prevalence of gestational diabetes mellitus

Gestational diabetes mellitus was reported in 33 studies and was between 3.5 and 45.3% in the EMRO region. Prevalence of GDM in 27 studies reported based-on one diagnostic criteria, and five and one study based-on two and three criteria, respectively.

In 33 included study, 887,166 pregnant women assessed for GDM and prevalence based on the diagnostic criteria that reported the lowest and most positive cases (for studies that diagnosis with more than one criterion) were 5.6% (49,697 case) and 5.7% (50,646 case), respectively.

Based on the results of random effect method, the overall prevalence of GDM in 49,697 and 50,646 positive reported case were 10.7% (95% CI: 9.7, 11.6; $I2 = 99.6\%$) and 12.6% (95% CI: 11.6, 13.6; $I2 = 99.7\%$), respectively. Based-on mean number of positive case (for studies that diagnosis with more than one criterion), the overall prevalence of GDM in 50,178 case was 11.7% (95% CI: 10.7, 12.6; $I2 = 99.6\%$) (Fig. 2).

Subgroup analysis done for assessment of heterogeneity base on country of study conducted and diagnosis criteria of

Table 1 Demographic characteristics of included studies

ID	Author	Year	Country	Sampling method	Design	Diagnostic criteria	Setting	Gestational age	Participants	Age (mean or range)	Risk of bias
1	Abdelmola [24]	2017	Saudi Arabia	Simple random	Cross sectional	ADA	Hospital	24–28 weeks	440	15–50	Low
2	Abu-Heija [25]	2015	Oman	Census	Retrospective	WHO	Hospital	24–28 weeks	5811	31.6	Low
3	Agarwal [26]	2015	United Arab Emirates	Convenience	Cross sectional	ADA, CDA, IADPSG	Hospital	24–28 weeks	2337	UK	Low
4	Ahsen [27]	2014	Pakistan	Simple random	Cross Sectional	WHO	Hospital	UK	200	16–50	Low
5	Al Mahroos [28]	2005	Bahrain	Census	Cross sectional	Fourth international workshop-conference on gestational diabetes	Hospital	24–28 weeks	10,495	UK	Low
6	Alfadhli [21]	2015	Saudi Arabia	Convenience	Prospective cohort	ADA, IADPSG	Hospital	24–28 weeks	277	30.8	Low
7	Ali [29]	2016	Yemen	Simple random	Cross sectional	ADA	Hospital	24–40 weeks	311	25.14	Moderate
8	Ali [30]	2018	Pakistan	Census	Cross sectional	WHO	Hospital	28 weeks	200	28	Low
9	Al-Kuwari [31]	2011	Qatar	Census	Cross sectional	Carpenter–Coustan, ADA	Primary health care centers	24–28 weeks	4295	28.3	Low
10	Al-Rowaily [32]	2010	Saudi Arabia	Census	Cross sectional	WHO, ADA	Hospital	24–28 weeks	633	32.62	Low
11	Ardawi [22]	2000	Saudi Arabia	Simple random	Prospective cohort	NDDG	Hospital	24–28 weeks	818	32.1	Low
12	Bashir [23]	2018	Qatar	Census	Retrospective	WHO	Hospital	24–32 weeks	2000	30.2	Low
13	Bener [33]	2011	Qatar	Simple random	Prospective cohort	WHO	Hospital	UK	1608	33.4	Low
14	Bibi [34]	2015	Pakistan	Convenience	Cross sectional	Carpenter–Coustan	Hospital	24–28 weeks	190	33	Low
15	Hadaegh [35]	2005	Iran	Census	Cross sectional	NDDG, Carpenter and Coustan	Hospital	24–28 weeks	700	24.9	Low
16	Hosseini [36]	2018	Iran	Census	Prospective cohort	IADPSG, Carpenter and Coustan	Hospital	24–28 weeks	836	29.2	Low
17	Hossein-Nezhad [37]	2007	Iran	Census	Cross sectional	Carpenter and Coustan, NDDG	Hospital	24–28 weeks	2416	29.0	Low
18	Keshavarz, M [38]	2005	Iran	Census	Prospective cohort	Carpenter and Coustan	Hospital	24–28 weeks	1310	30	Low
19	Manafi [39]	2013	Iran	Census	Cross sectional	Carpenter and Coustan	Health center	24–28 weeks	250	24.34	Low
20	Mohammadzadeh [40]	2015	Iran	Simple random	Cross sectional	ADA, Carpenter and Coustan	Hospital	24–28 weeks	1276	30.1	Low
21	Momenzadeh [41]	2015	Iran	Census	Cross sectional	NDDG, Carpenter and Coustan	Hospital	24–28 weeks	2033	25.05	Low
23	Rajab [42]	2012	Bahrain	Census	Retrospective cohort	NDDG, Carpenter and Coustan	Hospital	26–30 weeks	49,552	31	Low
22	Rajab [43]	2003	Bahrain	Census	Cross sectional	ADA	Hospital	26–32 weeks	1600	27.2	Low
24	Riaz [44]	2018	Pakistan	Census	Cross sectional	WHO	Hospital	26–28 weeks	11,430	27.2	Low

Table 1 (continued)

ID	Author	Year	Country	Sampling method	Design	Diagnostic criteria	Setting	Gestational age	Participants	Age (mean or range)	Risk of bias
26	Sella [45]	2013	Israel	Census	Cross sectional	ADA, Carpenter and Coustan	Hospital	UK	367,247	30.63	Low
25	Sella [46]	2011	Israel	Census	Cohort	Carpenter and Coustan	Hospital	24–28 weeks	185,315	30.72	Low
27	Shahbazian [47]	2016	Iran	Census	Prospective cohort	IADPSG	Hospital	24–32 weeks	750	28.43	Low
28	Shirazian [48]	2008	Iran	Census	Cohort	ADA	Hospital	24–28 weeks	924	24–51	Low
29	Soheilykhah [49]	2010	Iran	Census	Prospective cohort	ADA, Carpenter and Coustan	Hospital	24–28 weeks	1071	27	Low
30	Utz [50]	2018	Morocco	Cluster randomized	RCT	IADPSG, WHO	Hospital	24–28 weeks	1880	27.9	Low
31	Wahabi [51]	2017	Egypt	Random cluster	Cohort	WHO	Hospital	24–34 weeks	9723	31.5	Low
32	Wahabi [52]	2013	Saudi Arabia	Census	Retrospective cohort	ADA	Hospital	24–32 weeks	3041	32.4	Moderate
33	Zamstein [53]	2018	Israel	Census	Population-based cohort	ACOG	Community	24–32 weeks	216,197	32.1	Low

ADA American Diabetes Association, *ACOG* American College of Obstetricians and Gynecologists, *IADPSG* International Association of the Diabetes and Pregnancy Study Groups, *NDDG* National Diabetes Data Group, *UK* Unknown

GDM. Included study in this systematic review conducted in ten country, although Egypt, Morocco, Oman and Yemen had only one study for each and prevalence of GDM was 24.2%, 15.6%, 10.0% and 5.1%, respectively. Between six country with have three or more study, pooled prevalence (based-on random model) for Saudi Arabi it was 3.6 times more than Israel (17.6 vs. 4.9%), and for Pakistan, Qatar, Bahrain and Iran were 15.3%, 14.7%, 12.2% and 8.6%, respectively (Fig. 2).

GDM was diagnosis based-on eight criteria in included study, which three criteria have only one study and of three criteria, highest prevalence was for CDA (30.0%) in Saudi Arabia. In five criteria (had four or more study), pooled prevalence based-on IADPSG criteria was 4.5 times more than Carpenter–Coustan (28.2 vs. 6.2%); and based-on WHO, ADA and NDDG criteria were 15.2%, 10.3% and 8.1%, respectively (Table 2).

Meta-regression results

The results of random-effects meta-regression analyses, publication year of study variable not significantly contributed to heterogeneity with Coef. = 0.36% (95% CI: −0.21, 0.93), Adj R-squared = 1.87%, P-Value = 0.210. Also, there was a nonstatistically significant to explain effect size variation by age mean (P-Value = 0.120) but had direct correlation with Coef. = 0.89% (95% CI: −0.25, 0.20), Adj R-squared = 5.4% (Figs. 3, 4).

Discussion

Today, diabetes is one of the major threats to health worldwide, according to World Health Organization (WHO), diabetes was considered the eighth cause of death in 2016 and will be the fourth cause of death in 2030 [11].

As far as the researcher knows, this is the first meta-analysis study in the Eastern Mediterranean region. This study was conducted to determine the prevalence of GDM in the Middle East. A total of 33 studies completed on 887,166 people from 2000 to 2018 entered the final stage. The prevalence of GDM in the Eastern Mediterranean region is 11.7%, which is similar to previous review studies conducted in Asia (11.5%) [6] and Eastern Mediterranean (12.9%) [12], which could be due to similarity in demographic characteristics of some of the countries included in review study in question.

Contrary to the present study, a lower prevalence of GMD was reported in the developed countries such as Germany (6.81%) [13], and USA (7.51%) [14]. Moreover, the prevalence of GDM was higher developing countries, China (14.8%) [15], India (10–19%) [16], Africa (13.9%) [17], as compared to EMRO. This could be due to better

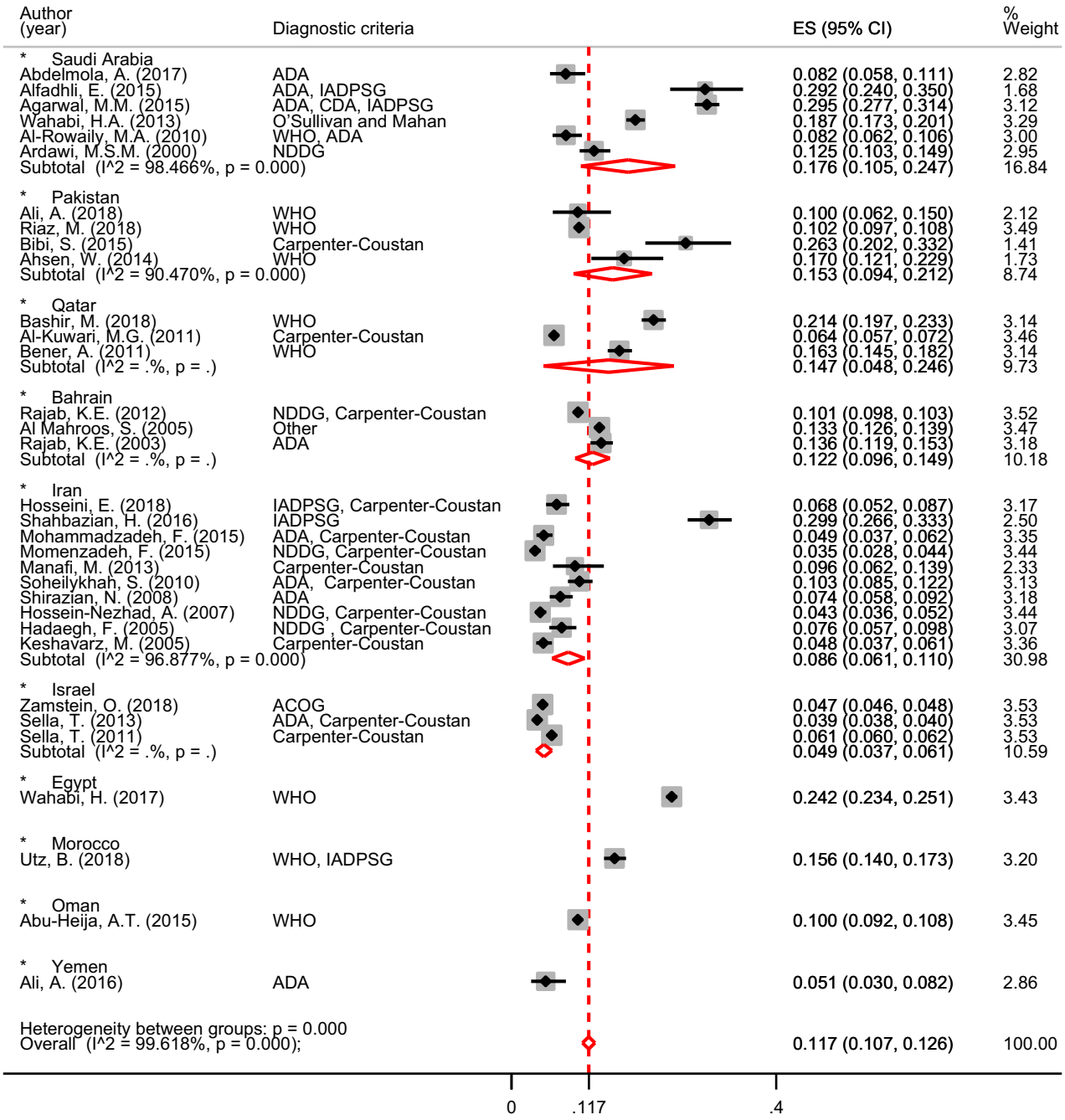

Fig. 2 Forest plot, pooled analyses, and subgroup analyses by country for estimation the gestational diabetes mellitus prevalence in the EMRO

facilities, adequate screening for GDM in developed countries, large population, lower proportion of health facilities, fewer health forces, poorer economic and social status in developing countries, and also due to different diagnostic criteria of GDM. Other factors that could cause this difference are the racial and ethnic difference in the population of different continents, as studies have shown that the prevalence of GDM in the Asian race is more than African Americans and European whites in the same age [18, 19].

The results also showed that the highest prevalence of GDM was in Egypt (24.2%), Saudi Arabia (17.6%), and Morocco (15.6%), which can be due to the methodological differences between the studies included or due to factors such as older age and higher BMI in these countries [19, 20]. Based on the criteria used, the prevalence of GDM was highly variable based on IADPSG (28.2%), Carpenter–Coustan (6.2%), and WHO (15.2%), this suggests that different methods have little agreement on the

Table 2 Prevalence of gestational diabetes mellitus based on different diagnostic criteria in EMRO

Diagnostic criteria First author (year)	Country	Screening test	ES*	95% CI for ES	% Weight
• IADPSG					
Utz (2018) [50]	Morocco	OGTT (75 g)	15.6	14.0, 17.3	20.2
Hosseini (2018) [36]	Iran	OGTT (100 g, 3 h)	9.3	7.4, 11.5	20.1
Shahbazian (2016) [47]	Iran	OGTT (75 g)	29.9	26.6, 33.3	20.0
Alfadhli (2015) [21]	Saudi Arabia	OGTT (75 g, 2 h)	41.5	35.7, 47.6	19.6
Agarwal (2015) [26]	Saudi Arabia	OGTT	45.3	43.2, 47.3	20.1
Overall random pooled ES (I2 = 99.5%)		**28.2**	**13.4, 43.0**	**100.0**	
• WHO					
Riaz (2018) [44]	Pakistan	OGTT (75 g)	10.2	9.7, 10.8	13.0
Ali (2018) [30]	Pakistan	OGTT	10	6.2, 15	11.9
Bashir (2018) [23]	Qatar	OGTT (75 g, 2 h)	21.4	19.7, 23.3	12.8
Wahabi (2017) [51]	Egypt	OGTT (75 g)	24.2	23.4, 25.1	12.9
Abu-Heija (2015) [25]	Oman	OGTT (75 g, 2 h)	10	9.2, 10.8	12.9
Ahsen (2014) [27]	Pakistan	OGTT	17	12.1, 22.9	11.3
Bener (2011) [33]	Qatar	OGTT (75 g, 2 h)	16.3	14.5, 18.2	12.8
Al-Rowaily (2010) [32]	Saudi Arabia	OGTT (75 g, 2 h)	12.5	10.0, 15.3	12.5
Overall random pooled ES (I2 = 99.2%)		**15.2**	**10.4, 20.1**	**100.0**	
• ADA					
Abdelmola (2017) [24]	Saudi Arabia	OGTT (100 g, 3 h)	8.2	5.8, 11.1	10.9
Ali (2016) [29]	Yemen	OGTT	5.1	3.0, 8.2	11.0
Alfadhli (2015) [21]	Saudi Arabia	OGTT (75 g, 2 h)	17	12.7, 21.9	9.8
Agarwal (2015) [26]	Saudi Arabia	OGTT	13.3	12.0, 14.8	11.4
Wahabi (2013) [52]	Saudi Arabia	OGTT (100 g, 3 h)	18.7	17.3, 20.1	11.4
Al-Kuwari (2011) [31]	Qatar	OGTT (100 g, 3 h)	6.4	5.7, 7.2	11.5
Al-Rowaily (2010) [32]	Saudi Arabia	OGTT (75 g, 2 h)	3.8	2.4, 5.6	11.4
Shirazian (2008) [48]	Iran	OGTT (75 g, 2 h)	7.4	5.8, 9.2	11.3
Rajab (2003) [43]	Bahrain	OGTT (75 g)	13.6	11.9, 15.3	11.3
Overall random pooled ES (I2 = 97.9%)		**10.3**	**6.8, 13.8**	**100.0**	
• NDDG					
Rajab (2012) [42]	Bahrain	OGTT	10.1	9.8, 10.3	25.9
Hossein-Nezhad (2007) [37]	Iran	OGTT (100 g, 3 h)	4.0	3.2, 4.8	25.7
Hadaegh (2005) [35]	Iran	OGTT (100 g, 3 h)	6.3	4.6, 8.3	24.6
Ardawi (2000) [22]	Saudi Arabia	OGTT (100 g, 2 h)	12.5	10.3, 14.9	23.9
Overall random pooled ES (I2 = 98.7%)		**8.1**	**4.2, 12.0**	**100.0**	
• Carpenter–Coustan					
Hosseini (2018) [36]	Iran	OGTT (100 g, 3 h)	4.2	2.9, 5.8	8.9
Momenzadeh (2015) [41]	Iran	OGTT (100 g, 3 h)	3.5	2.8, 4.4	9.9
Bibi (2015) [34]	Pakistan	OGTT (100 g, 3 h)	26.3	20.2, 33.2	2.1
Mohammadzadeh (2015) [40]	Iran	OGTT (100 g, 3 h)	4.9	3.7, 6.2	9.3
Manafi (2013) [39]	Iran	OGTT (100 g, 3 h)	9.6	6.2, 13.9	4.4
Sella (2013) [45]	Israel	OGTT (100 g)	3.9	3.8, 4.0	10.6
Al-Kuwari (2011) [31]	Qatar	OGTT (100 g, 3 h)	6.4	5.7, 7.2	10.1
Sella (2011) [46]	Israel	OGTT (100 g)	6.1	6.0, 6.2	10.6
Soheilykhah (2010) [49]	Iran	OGTT (100 g)	10.3	8.5, 12.2	7.9
Hossein-Nezhad (2007) [37]	Iran	OGTT (100 g, 3 h)	4.7	3.9, 5.6	9.9
Hadaegh (2005) [35]	Iran	OGTT (100 g, 3 h)	8.9	6.9, 11.2	7.2
Keshavarz (2005) [38]	Iran	OGTT (100 g, 3 h)	4.8	3.7, 6.1	9.3

Table 2 (continued)

Diagnostic criteria First author (year)	Country	Screening test	ES*	95% CI for ES	% Weight
Overall random pooled ES (I2 = 99.2%)		**6.2**	**5.2, 7.2**	**100.0**	
• CDA					
Agarwa (2015) [26]	Saudi Arabia	OGTT	30.0	28.2, 31.9	100.0
• ACOG					
Zamstein (2018) [53]	Israel	OGTT (100 g)	4.7	4.6, 4.8	100.0
• Other*					
Al Mahroos (2005) [28]	Bahrain	OGTT (75 g, 3 h)	13.3	12.6, 13.9	100.0

*ES: Effect size; other: Fourth international workshop–conference on gestational diabetes

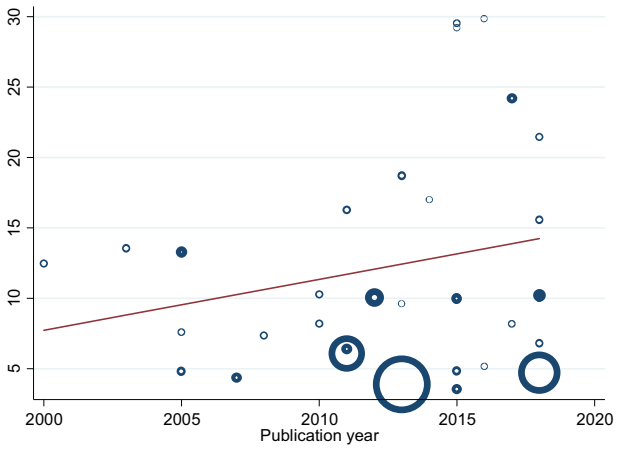

Fig. 3 Meta-regression between publication year of study and the prevalence of gestational diabetes mellitus in EMRO

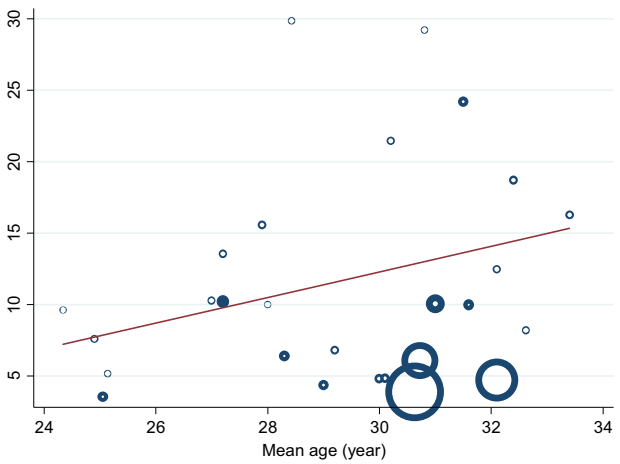

Fig. 4 Meta-regression between mean age of participants and the prevalence of gestational diabetes mellitus in EMRO

diagnosis of a certain degree of GDM that can be explained by the fact that they were created for a specific purpose and evaluated in different populations. Another challenge was the one step and two step approach for GDM screening. The diverse prevalence of GDM based on the geographical areas of the EMRO, various methods of measuring GDM in different countries are an important barrier to establishing a coordinated and similar screening program in the region. The highest prevalence was obtained by the IADPSG method, which was similar to a review study carried out in India [21]. This could be due to the low threshold for fasting blood glucose in this method, which is at a low level; although IADPSG has gained popularity in recent years considering its lower costs and better responses and improvements in pregnancy outcomes in mothers [22, 23]. One of the main challenges in determining the correct prevalence rate is various GDM diagnostic methods in different areas that must be taken into consideration.

Limitations and strengths

1. A limitation was the unequal number of studies in different countries and lack of study in many of them. 2. The more of included studies were descriptive in nature, which have their own specific methodological limitations. 3. Only English articles that were published in valid journals were included, so, articles that were published in other languages were not entered, and 4. Some studies have not provided detailed information on their methodology and GDM measurement procedure and thus attempts were made to contact their authors to obtain the relevant information. The strength of this study was that to the researchers' knowledge, this is the first meta-analysis carried out in the Eastern Mediterranean region on the prevalence of GDM. Also, to minimize the risk of bias, all steps were completed by two researchers. Despite achieving the main aim of the study but according the high prevalence of GDM, factors which may influence the prevalence of GMD were not evaluated in the included studies. As an important limitation, most studies did not evaluate the effects of GDM on the outcomes of mothers and fetuses. In addition, differences in the outcomes due to differences in GDM measurement methods were not examined. The imposed costs based on GDM assessment methods were not also evaluated in the non-enrolled studies.

Conclusion

Despite the high diversity of methods, the results of this study indicate a high prevalence of GDM in the Eastern Mediterranean region, indicating more policymakers' interest in timely screening and proper management of such disease. Regarding increasing prevalence rate, imposition of high costs on the health system, and adverse outcomes on mother and infants, one of the most significant research points in order to achieve a systematic and cost-effective approach based on the characteristics of the countries of the region for measuring, training, preventing, and controlling GDM in the region. It seem crucial for policymakers to take measures regarding raising the awareness of pregnant women, families during fertility about GDM warning signs.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Human and animal rights and informed consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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