

BMJ Open Evaluation of guidelines on the screening and diagnosis of gestational diabetes mellitus: systematic review

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ABSTRACT

Objective Guidelines for screening and diagnosis of gestational diabetes mellitus (GDM) have been updated in the past several years, and various inconsistencies exist across these guidelines. Moreover, the quality of these updated guidelines has not been clarified. We thus conducted this systematic review to evaluate the relationship between the quality and detailed recommendations of these guidelines.

Data sources The Guidelines International Network Library, the National Institute for Health and Clinical Excellence (NICE) database, the Medline database, the Embase and the National Guidelines Clearinghouse were searched for guidelines containing recommendations on screening and diagnosis strategies for GDM between 2009 and November 2018.

Methods Guidelines included a target group of women with GDM, and contained recommendations for screening and diagnostic strategies for GDM were included in the present systematic review. Reviewers summarised recommendations on screening and diagnosis strategies from each guideline and rated the quality of guidelines by using the Appraisal of Guidelines Research and Evaluation (AGREE) criteria.

Results A total of 459 citations were collected by the preliminary literature selection, and 16 guidelines that met the inclusion criteria were assessed. The inconsistencies of the guidelines mainly focus on the screening process (one step vs two step) and criteria of oral glucose tolerance test (OGTT) (International Association of Diabetes and Pregnancy Study Groups [IADPSG] vs CarpenterandCoustan). Guidelines with higher AGREE scores usually recommend a one-step OGTT strategy with IADPSG criteria between 24 and 28 gestational weeks, and the majority of these guidelines likely to select evidence by Grading of Recommendations Assessment, Development and Evaluation criteria.

Conclusions The guidelines of WHO-2013, NICE-2015, American Diabetes Association-2018, Endocrine Society-2013, Society of Obstetricians and Gynaecologists of Canada-2016, International Federation of Gynecology and Obstetrics-2015, American College of Obstetricians and Gynecologists-2018, United States Preventive Services Task Force-2014 and IADPSG-2015 are strongly recommended in the present evaluation, according to the AGREE II criteria. Guidelines with higher quality tend to recommend a one-step 75 g OGTT strategy with IADPSG criteria between 24 and 28 gestational weeks.

Strengths and limitations of this study

- This systematic review present an overview of current clinical guidelines on screening and diagnosis of gestational diabetes mellitus (GDM), and provide an evaluation of quality of these guidelines.
- We used Appraisal of Guidelines Research and Evaluation (AGREE II), an international, rigorously developed and validated instrument, to evaluate the guidelines.
- The present review mainly focuses on guidelines that provided recommendations on the screening and diagnosis of GDM, and did not evaluate other fields, such as therapy, monitoring and obstetric consideration of GDM.
- The AGREE II instrument considered all six domains of guidelines equally, but not weighted by their importance in guideline development.
- Only guidelines and recommendations published in the English language were included in the present review.

INTRODUCTION

Gestational diabetes mellitus (GDM) is a common disorder during pregnancy that affects an increasing number of pregnant women in the global population,^{1 2} likely linked to the increased obesity epidemic. GDM increases the risk of short-term and long-term complications in pregnant women, including pre-eclampsia, the rate of caesarean section, miscarriage and diabetes later in life. Moreover, offspring of mothers with GDM is more likely to have respiratory distress syndrome and hypoglycaemia during the neonatal period,³ and develop diabetes,⁴ obesity⁴⁻⁶ and metabolic disorders⁷ later in life.

In 1964, O'Sullivan and Mahan first developed the two-step method and oral glucose tolerance test (OGTT) for the diagnosis of GDM during pregnancy,⁸ based on the risk of maternal type 2 diabetes mellitus (DM) later in life.⁹ The two-step method for GDM screening consists of a first-step glucose

challenge test (GCT) and a second-step OGTT. GCT test is based on oral intake of 50 g glucose solution followed by venous glucose examination 1 hour later. Then, women whose glucose levels meet or exceed screening threshold undergo a 100 g, 3 hours or a 75 g, 2-hour-diagnostic OGTT. In this approach, GDM is diagnosed in women who have two or more abnormal values (5.3–10.0–8.6 mmol/L at fasting, 1 hour and 2 hours postprandial, namely Carpenter and Coustan [C-C] criteria) on OGTT.

This method and criteria have been adopted by many organisations, including the National Diabetes Data Group (NDDG)¹⁰ and American Diabetes Association (ADA),¹¹ with some modifications,^{10–13} and was the standard method for the diagnosis of GDM for more than two decades.

In 2008, the Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) Study showed that adverse neonatal outcomes were associated with mild hyperglycaemia, even though the glucose levels did not meet the old criteria of GDM.¹⁴ To control for the potential influence of hyperglycaemia on the fetus/neonate, the International Association of Diabetes and Pregnancy Study Groups (IADPSG) recommended a one-step 75 g OGTT testing (without a 50 g GCT before) and reduced the diagnostic cut-off of the OGTT (5.1–10.0–8.5 mmol/L at fasting, 1 hour and 2 hours postprandial) in 2010.¹⁵ In this approach, GDM is diagnosed in women who have one abnormal value.

Later on, many organisation guidelines including the ADA,¹⁶ WHO² and the International Federation of Gynecology and Obstetrics (FIGO)¹⁷ adopted the IADPSG criteria in the screening and diagnosis of GDM. However, several guidelines including the American College of Obstetricians and Gynecologists (ACOG) Practice Bulletin,¹⁸ the National Institutes of Health (NIH) consensus statement¹⁹ and Society of Obstetricians and Gynaecologists of Canada (SOCG)²⁰ did not support the IADPSG criteria.

Inconsistencies in the GDM diagnostic strategy between different guidelines have led to challenges in making clinical diagnosis. Therefore, the purpose of this systematic review is to present an overview of current clinical guidelines on screening and diagnosis of GDM, and to provide an integrated insight into their quality using the Appraisal of Guidelines Research and Evaluation (AGREE) instrument.

METHODS

Search strategy

A systematic search (last updated in November 2018) was performed to retrieve relevant guidelines regarding the management of GDM. The guidelines were identified using computer searches of the Guidelines International Network Library, the National Institute for Health and Clinical Excellence (NICE) database, the Medline database, the Embase and the National Guidelines Clearinghouse. Searches were limited to guidelines from the USA, Canada, UK, Australia and New Zealand, and

international guidelines in the English language. A search for websites of guideline development organisations was also performed (see online supplementary table S1).

Patient and public involvement

Patients and or public were not involved.

Study selection

Articles were considered if they met the Institute of Medicine definition of clinical practice guidelines (CPGs). The Institute of Medicine defines CPGs as ‘systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances.’ We included guidelines if they: (1) included a target group of patients with GDM; (2) contained recommendations for screening and diagnostic strategies for GDM; (3) were produced on behalf of a national or international medical specialty society and (4) were written in English. Guidelines that were developed before 2009 and not been updated before November 2018 would be excluded since they may be out of date. We excluded hits derived entirely from another guideline and those for which we could not identify detailed information on development. If different versions of the guidelines were available, only the latest edition was selected. Review of titles and abstracts was performed independently by two reviewers (LB and X-DZ). For a paper to be excluded, both reviewers had to agree that the article was ineligible. For abstracts, disagreements between the reviewers were discussed and resolved by consensus. The final selection based on the full text was performed by the first author.

Data extracted on the guideline level included the reported methodology for evidence synthesis, and formulating of recommendations. On the recommendation level, we extracted data on the consideration of cost effectiveness, the target population and the strategy for delivery of the test (see online supplementary table S2).

AGREE II instrument

Each guideline was independently evaluated by reviewers according to the AGREE II instrument (table 1). The AGREE II is an international, rigorously developed and validated instrument consisting of 23 key items organised within six domains. Each item in a domain is scored from 1 (strongly disagree) to 7 (strongly agree). The score for each domain is obtained by the sum of all scores of the individual items in a domain and then standardised as follows: (obtained score – minimum possible score)/(maximum possible score – minimum possible score).

The maximum possible score for each item is 7, which indicates that the quality of reporting is exceptional and the guideline meets the full criteria and considerations articulated in the instrument. The minimum possible score for each item is 1 when there is no information about this item reported in the guideline. We initially conducted two rounds of pilot tests before assessing all of the included guidelines. After the above steps were performed, we provided an overall assessment of each set

Table 1 Appraisal of Guidelines Research and Evaluation (AGREE II) instrument for the quality assessment of clinical practice guidelines

AGREE II domain	AGREE II item
Scope and purpose	<p>The overall objective of the guideline is specifically described.</p> <p>The clinical question covered by the guideline is specifically described.</p> <p>The patients to whom the guideline is meant to apply are specifically described.</p>
Stakeholder involvement	<p>The guideline development group includes individuals from the entire prevalent professional groups.</p> <p>The patient's views and preferences have been sought.</p> <p>The target users of the guideline are clearly described.</p> <p>The guideline has been piloted among target users.</p>
Rigour of development	<p>Systematic methods were used to search for evidence.</p> <p>The criteria for selecting the evidence are clearly described.</p> <p>The methods used for formulating the recommendations are clearly described.</p> <p>The health benefits, side effects and risks have been considered in formulating the recommendations.</p> <p>There is an explicit link between the recommendations and the supporting evidence.</p> <p>The guideline has been externally reviewed by experts prior to its publication.</p> <p>A procedure for updating the guideline is provided.</p>
Clarity of presentation	<p>The recommendations are specific and unambiguous.</p> <p>The different options for management of condition are clearly presented.</p> <p>Key recommendations are easily identifiable.</p>
Applicability	<p>The guideline is supported with tools for application.</p> <p>The potential organisational barriers in applying the recommendations have been discussed.</p> <p>The potential cost implications of applying the recommendations have been considered.</p> <p>The guideline presents key review criteria for monitoring or audit purposes.</p>
Editorial independence	<p>The guideline is editorially independent from the funding body.</p> <p>Conflicts of interest of guideline development members have been recorded.</p>

of guidelines. A guideline was 'strongly recommended for use in practice' if most domains (four or more) scored above 60%. A guideline was 'recommended for use with some modification' if most domains scored between 30% and 60%. 'Not recommended for use in practice' implied that most of the domains of the guideline were scored below 30%.

A table comparing the recommendations from the selected guidelines were constructed and AGREE II domain scores were calculated as means and categorical variables with the number of cases and corresponding percentages. Agreement between reviewers on AGREE II scores was assessed using interclass correlation coefficient. Given the limited number of guidelines, only explorative quantitative analyses were possible.

RESULTS

A total of 459 citations were collected during the preliminary literature selection process, though most were excluded after applying the inclusion and exclusion criteria. Ultimately, 16 guidelines were identified for further evaluation (figure 1). The 16 guidelines included

in the present systematic review are from the following organisations:

WHO-2013,² IADPSG-2015,²¹ FIGO-2015,¹⁷ ADA-2018,²² Endocrine Society (ES-2013),²³ NIH-2013,¹⁹ ACOG-2018,²⁴ The United States Preventive Services Task Force (USPSTF-2014),²⁵ NICE-2015,²⁶ German Diabetes Association (DDG-2014),²⁷ European Board and College of Obstetrics and Gynecology (EBCOG-2015),²⁸ Indian-2014,²⁹ Queensland-2015, SOGC-2016,²⁰ Hong Kong College of Obstetricians and Gynaecologists (HKCOG-2016) and Australasian Diabetes in Pregnancy Society (ADIPS-2014). The majority of the guidelines (8 of 16) were developed in the USA and Europe.

Reproducibility of the two reviewers' average AGREE scores was good, with an intraclass correlation coefficient of 0.84. Results of the evaluation of the screening and diagnostic strategies for GDM performed using the AGREE II instrument are illustrated in table 2. The average AGREE II scores varied from 46% to 97%. Scores for each domain ranged as follows: scope and purpose domain from 61% to 100%; the stakeholder involvement domain from 33% to 90%; rigour of development domain from 33% to 96%, clarity of presentation domain from 64% to 100%,

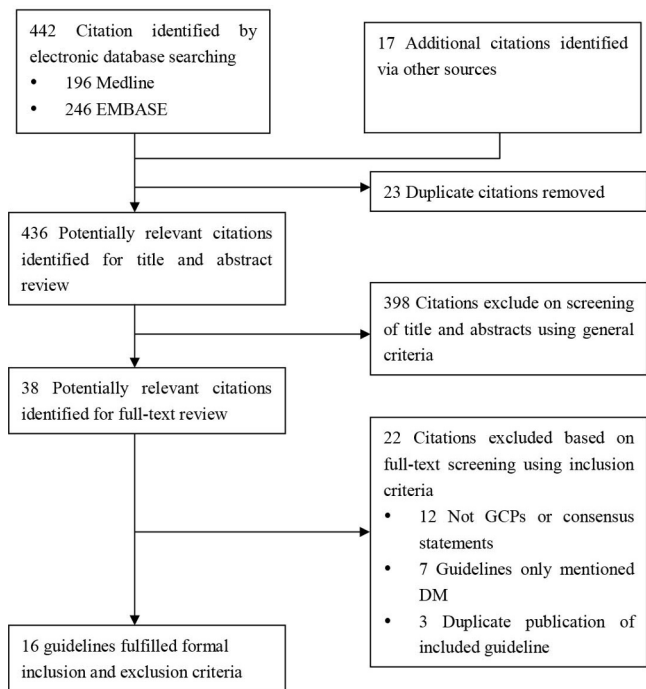


Figure 1 Flow diagram of the identification process for clinical practice guidelines and consensus statements on gestational diabetes mellitus (DM). GCP, good clinical practice.

applicability domain from 58% to 100% and editorial independence domain from 8% to 100%.

Calculated domain scores are shown in figure 2. These radar maps illustrate the final scores for every guideline in each of the six domains, expressed as a percentage. Higher domain scores are mapped towards the periphery, and lower domain scores are plotted towards the centre. The graph allows one to visually gauge the relative strengths or weaknesses of each guideline by domain, in comparison to the other plotted guidelines (worldwide guidelines, North American guidelines, European guidelines and guidelines from Asia and Oceania).

Considering the CPGs overall, 9 of the 16 guidelines were described as ‘strongly recommended’, 7 as ‘recommended with modifications’ and 1 as ‘not recommended’. The highest ranked guideline was produced by the WHO, with the guideline produced by the NICE ranking second. Guidelines receiving lower ranking was mainly due to limited confidence in development methods, lack of evidence summaries or concerns about readability.

For women with a high risk for hyperglycaemia in pregnancy, there is a consensus among most of the guidelines that a screen for GDM should be conducted during the first trimester, or at the first prenatal visit. Risk factors for GDM listed in guidelines were shown in table 3; among them, overweight/obesity, previous history of GDM or macrosomia, and family history of DM were the most common risk factors. Most guidelines recommend the OGTT for early screening, although with different criteria. WHO, NIH, ES and Indian criteria did not provide a list of risk factors; one potential reason is that

they recommend universal screening, rather than risk-based screening.

For low-risk pregnant women, the screening and diagnostic strategies for GDM are shown in table 4. There are mainly two kinds of methods for diagnosis: the first is the one-step strategy with 75 g glucose OGTT using the IADPSG criteria. This method is recommended in worldwide guidelines (WHO, IADPSG, FIGO), some American (ADA, ES), some European guidelines (DDG), some Asian guidelines (HKCOG) and the Oceanian guidelines. NICE and the guideline from India also use a one-step strategy but using different criteria.

The second method is the two-step strategy with 50 g GCT followed by a 75 g OGTT using C-C or NDDG criteria. This method is mainly recommended in some of the North American guidelines (ACOG, NIH and SOGC). USPSTF and EBCOG guidelines recommend both one-step and two-step methods with equal strength.

Regarding the timing of the OGTT, most guidelines recommend conducting the test between 24 and 28 gestational weeks. However, WHO guideline recommends conducting the OGTT any time, and FIGO guideline recommends 24–28 gestational weeks or any other time. USPSTF recommends conducting the OGTT after 24 gestational weeks. Indian guidelines did not specify the OGTT time.

As shown in table 4, guidelines that were strongly recommended share several advantages. Most of these guidelines recommend a one-step screening strategy with IADPSG criteria between 24 and 28 gestational weeks in low-risk pregnant women. Among seven strongly recommended guidelines, five list risk factors for GDM and four use Grading of Recommendations Assessment, Development and Evaluation (GRADE) criteria to select and evaluate evidence.

DISCUSSION

The present systematic review of clinical guidelines for the screening strategy of GDM included 16 guidelines published between 2013 and 2018.

To our knowledge, the present article is the first review of GDM guidelines that focus on the screening and diagnosis of GDM. In 2012, Greuter *et al* conducted a general evaluation of eight GDM guidelines but provided limited analysis on the screening and diagnosis of GDM.³⁰ Moreover, many guidelines were updated after 2012, with the consideration of the HAPO study.

Overall, the quality of the guidelines is improving. The average AGREE II scores of the guidelines in the present study ranged from 46% to 97%, which is much higher than reported by Greuter *et al*.³⁰ Four guidelines evaluated in both reviews, namely the ACOG (77 vs 41), ADA (94 vs 37), NICE (96 vs 87) and ADIPS (55 vs 49) all received higher scores in the present study. Improvement of guideline quality is beneficial for clinical practice and comparison of different options.

Table 2 Results of the assessment of recommendations regarding screening and diagnosis strategies for gestational diabetes mellitus using the Appraisal of Guidelines Research and Evaluation II instrument (domain scores in %)

	D1	D2	D3	D4	D5	D6	Average	Overall assessment
WHO	100	83	98	100	100	100	97	Strongly recommended
NICE	100	81	99	100	100	83	96	Strongly recommended
ADA	100	90	96	95	95	88	94	Strongly recommended
Endocrine Society	94	61	84	97	81	79	83	Strongly recommended
SOGC	86	90	88	100	89	36	82	Strongly recommended
FIGO	97	81	76	92	92	25	80	Strongly recommended
ACOG	94	57	84	97	96	36	77	Strongly recommended
USPSTF	78	67	71	89	88	79	77	Strongly recommended
IADPSG	64	89	60	81	75	75	71	Strongly recommended
India	94	58	73	78	88	8	71	Recommended
DDG/DGGG	64	47	68	92	100	33	70	Recommended
NIH	81	67	75	83	85	17	68	Recommended
Queensland	64	47	41	100	83	21	58	Recommended
HKCOG	76	43	38	90	60	29	56	Recommended
ADIPS	81	38	39	81	57	36	55	Recommended
EBCOG	61	33	33	64	58	42	46	Recommended

ACOG, American College of Obstetricians and Gynecologists Practice Bulletin, 2018; ADA, American Diabetes Association, 2018; ADIPS, Australasian Diabetes in Pregnancy Society, 2014; D, Domains; DDG/DGGG, German Diabetes Association/German Association for Gynaecology and Obstetrics, 2014; D1, scope and purpose; D2, stakeholder involvement; D3, rigour of development; D4, clarity of presentation; D5, applicability; D6, editorial independence; EBCOG, European Board and College of Obstetrics and Gynaecology, 2015; Endocrine Society, Endocrine Society Clinical Practice Guideline, 2013; FIGO, International Federation of Gynecology and Obstetrics, 2015; HKCOG, Hong Kong College of Obstetricians and Gynaecologists, 2016; IADPSG, International Association of Diabetes and Pregnancy Study Groups, 2015; India, India Clinical Guideline, 2014; NICE, National Institute for Health and Clinical Excellence, 2015; NIH, National Institutes of Health, 2013; Queensland, Queensland Clinical Guideline, 2015; SOGC, Society of Obstetricians and Gynaecologists of Canada, 2016; USPSTF, The United States Preventive Services Task Force Recommendation, 2014.

The majority of the guidelines provided a clear description of 'scope and purpose' as screening, diagnosis or classification of hyperglycaemia during pregnancy, and some guidelines also contained management of GDM. Recommendations from most of the guidelines were clear and user friendly, with a variety of options for different populations and resources. For these reasons, most of the guidelines received high scores in the domains of scope and purpose, 'clarity and presentation' and 'applicability'.

The difference of AGREE score among guidelines mainly arises from the domain of 'rigour of development'. WHO, FIGO, NICE and ES guidelines development groups all used the GRADE methodology to assess the quality of evidence and format recommendation. Other guidelines built a consensus using procedures designed differently. For example, ADA developed ADA evidence-grading system to update the guideline, NIH applied Agency for Healthcare Research and Quality to evaluate literature. The guidelines of EBCOG, ADIPS, HKCOG and Queensland received a low score for rigour of development, since the guideline did not include a clear description of the process of guideline development or the evidence assessment method.

In addition to rigour of development, the quality of guidelines also varied in the fields of 'stakeholder

involvement' and 'editorial Independence'. The guidelines of IADPSG, WHO, ADA and NICE all provided clear and detailed records of the members and independence of guideline developing group. Other guidelines did not describe a full list of guideline board or the independence of the board. A lack of information in the field of rigour of development, stakeholder involvement and editorial independence may reduce the reliability of a guideline, even if the recommendation is similar or the same as the guidelines that received high scores in these domains.

More than half of the guidelines evaluated in the present review, including WHO, IADPSG, FIGO, ADA, ES, DDG, HKCOG, ADIPS and Queensland guideline, adopt the IADPSG criteria (table 4) for GDM screening. They recommend a one-step 75 g glucose OGTT most commonly between 24 and 28 gestational weeks, and a diagnosis of GDM is made if one of the values in the OGTT was equal to or exceeding 5.1–10.0–8.5 mmol/L.

This strategy is different from the methods applied in the old versions of these guidelines. The reason for this change is due to the result of the HAPO study regarding mild hyperglycaemia and adverse clinical outcomes, including large for gestational age (LGA),

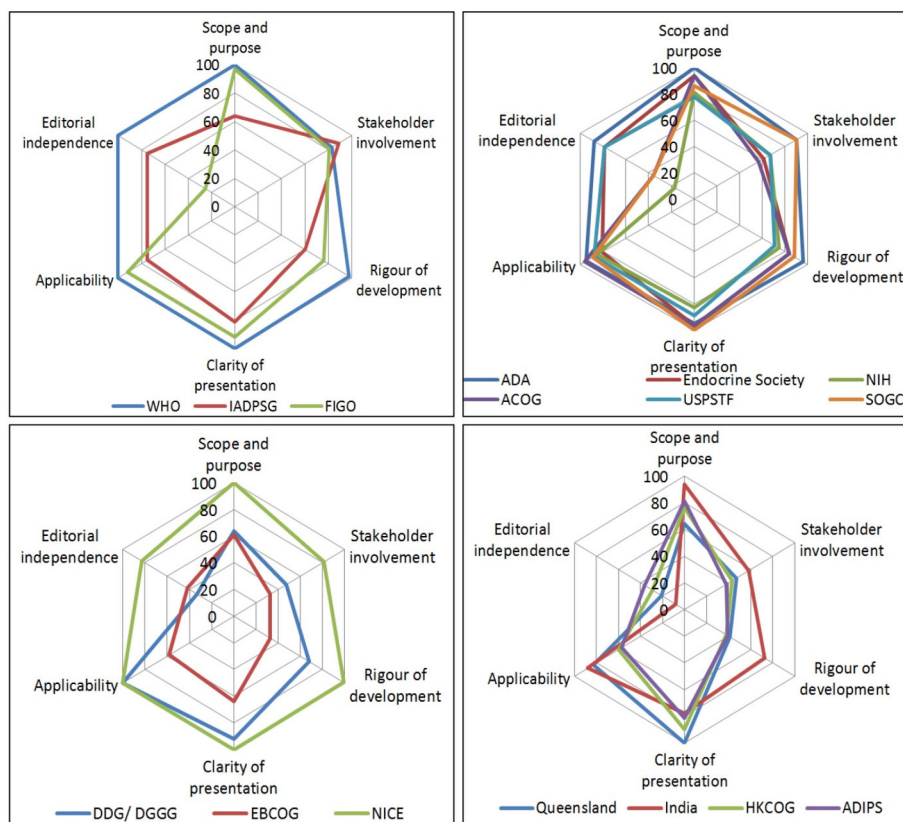


Figure 2 Radar maps of the final domain scores for each guideline. Higher domain scores are mapped towards the periphery (closer to 100%), and lower domain scores are plotted towards the centre. The radar maps illustrate a visual gauge of the relative strengths and weaknesses of each guideline by domain, in comparison to the other plotted guidelines: (A) Worldwide guidelines, (B) North American guidelines, (C) European guidelines, and (D) Asia and Oceania. ACOG, American College of Obstetricians and Gynecologists; ADA, American Diabetes Association; ADIPS, Australasian Diabetes in Pregnancy Society; DDG, German Diabetes Association; EBCOG, European Board and College of Obstetrics and Gynecology; FIGO, International Federation of Gynecology and Obstetrics; HKCOG, Hong Kong College of Obstetricians and Gynaecologists; IADPSG, International Association of Diabetic Pregnancy Study Group; NICE, National Institute of Health and Care Excellence; NIH, National Institutes of Health; SOGC, Society of Obstetricians and Gynaecologists of Canada; USPSTF, The United States Preventive Services Task Force.

primary caesarean, clinical neonatal hypoglycaemia, and C peptide in umbilical cord blood.¹⁴ Therefore, a more strict strategy may help reduce the frequency of these potential complications.

However, the guidelines of NIH, ACOG and SOGC still recommend the two-step strategy and the C-C or NDDG criteria for the OGTT. Reasons provided from the guideline developing groups are: (1) the benefit from the treatment of mild GDM in women is not well established; (2) additional healthcare costs will be generated by the increased prevalence; (3) caesarean delivery and intensive newborn assessment will increase; and (4) life disruptions and psychosocial burdens will be developed in patients with GDM. Therefore, these guidelines still recommend a two-step approach with NDDG or C-C criteria.

The guidelines using IADPSG criteria are certain to have more pregnant women diagnosed with GDM than those using C-C or NDDG criteria.³¹ Debates between these guidelines include the cost and effectiveness, and the benefit versus harm of diagnosing mild hyperglycaemia. Therefore, further studies may focus on the

comparison of multiple clinical outcomes and health cost of different strategies. In addition, it would be of great importance to study the screening strategy for specific populations and various resources.

The strength of the present review includes an integrated list of guidelines, and detailed insight into the screening and diagnosis strategies updated after 2012. The AGREE II criteria have been widely used to evaluate the quality of guidelines. The strength of AGREE is the constitution of six domains and 23 key items that represent all important aspects in guideline development and application.

Our study also has some limitations besides that imposed by AGREE II. First, the present review mainly focuses on guidelines that provided recommendations on the screening and diagnosis of GDM, and did not evaluate other fields, such as therapy, monitoring and obstetric consideration of GDM. This is because updates to the guidelines mainly focus on GDM screening and diagnosis following the HAPO study. Second, only guidelines and recommendations published in the English language were recruited in the present review. The majority of the

Table 3 Risk factors and early screening methods for high-risk women for gestational diabetes mellitus (GDM)

Risk factors and early screening methods	NICE	ADA	SOGC	FIGO	ACOG	USPSTF	IADPSG	DDG	Queensland	HKCOG	ADIPS	EBCOG
Maternal characteristics												
Increased maternal age (year)			>35			√	>40	≥ 45	≥40	>35	≥ 40	
High-risk race/ethnicity *	√	√	√		√	√	√	√	√	√	√	√
Overweight/obesity-body mass index (BMI) (kg/m ²)	>30	>25†	>30	√	>25†	√	>35	≥ 30	>30	≥ 25	>30	√
Excessive weight gain												
		√			√							
High parity												
		√			√							
Multifetal pregnancy												
		√			√				√	√		
Family history of diabetes mellitus												
	√	√	√	√	√	√	√	√	√	√	√	√
Maternal medical history												
History of GDM												
	√	√	√	√	√	√	√	√	√	√	√	√
Previously elevated blood glucose level												
	√	√	√	√	√	√	√	√	√	√	√	√
Previous macrosomia (4.5 kg or 9 lb)												
	√	√	√	√	≥4 kg	√	√	√	√	≥ 4 kg	√	√
Previous fetal loss												
				√					√			
Maternal current complications												
History of CVD												
		√						√				
Polycystic ovary syndrome												
	√	√	√	√	√	√	√	√	√	√	√	√
Hypertension/pre-eclampsia												
	√	√	√	√	√	√	√	√	√	√	√	√
Dyslipidaemia												
	√											
Physical inactivity												
	√				√							
Medications: corticosteroids, antipsychotics												
			√				√	√	√	√	√	√
Early screening methods for high-risk women												
	OGTT in women with previous GDM	OGTT and classified as T1DM or T2DM	Two-step method	Do not screen based on risk factor	BMI ≥ 25 and additional risk factor	One-step or two-step method	OGTT	OGTT	OGTT with IADPSG criteria	FPG, OGTT or HbA1c	OGTT or HbA1c	FPG ≥ 7.0 mmol/L or HbA1c ≥ 6.5% or random glycaemia ≥ 11.1 mmol/L

*High-risk race/ethnicity means African American, Latino, Native American, Asian American, Pacific Islander.

†BMI > 23 in Asian Americans.

‡FPG, fasting plasma glucose.

ACOG, American College of Obstetricians and Gynecologists; ADA, American Diabetes Association; ADIPS, Australasian Diabetes in Pregnancy Society; CVD, cardiovascular disease; DDG, German Diabetes Association; EBCOG, European Board and College of Obstetrics and Gynecology; FIGO, International Federation of Gynecology and Obstetrics; HKCOG, Hong Kong College of Obstetricians and Gynaecologists; IADPSG, International Association of Diabetic Pregnancy Study Group; NICE, National Institute for Health and Care Excellence; NIH, National Institutes of Health; OGTT, oral glucose tolerance test; SOGC, Society of Obstetricians and Gynaecologists of Canada; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus; USPSTF, The United States Preventive Services Task Force.

Table 4 Differences for screening and diagnosis strategies of low-risk pregnant women in the recommendation of current guidelines

Guideline	Year	Range	Recommendation	One step	Two step	OGTT criteria (mmol/L)	OGTT time (gestational weeks)	Risk factors list	Application of GRADE criteria
WHO	2013	Global	Strongly	✓		IADPSG	Any time		✓
NICE	2015	European	Strongly	✓		5.6 (fasting) or 7.8 (2 hours)	24–28	✓	✓
ADA	2018	American	Strongly	✓		IADPSG	24–28	✓	
Endocrine Society	2013	American	Strongly	✓		IADPSG	24–28		✓
SOGC	2016	Canadian	Strongly	✓	✓	C-C/NDDG	24–28	✓	
FIGO	2015	Global	Strongly	✓		IADPSG	24–28 or any other time	✓	✓
ACOG	2018	American	Strongly	✓	✓	C-C/NDDG	24–28	✓	
USPSTF	2014	American	Strongly	✓	✓	Not mentioned	after 24	✓	
IADPSG	2015	Global	Strongly	✓		IADPSG	24–28*	✓	
India	2014	Asian	Yes	✓		7.8–11.1 (2 hours)†	Not mentioned		
DDG	2014	European	Yes	✓		IADPSG	24–27* ⁶	✓	
NIH	2013	American	Yes	✓	✓	C-C/NDDG	Not mentioned		
Queensland	2015	Oceanian	Yes	✓		IADPSG	24–28	✓	
HKCOG	2016	Asian	Yes	✓		IADPSG	24–28	✓	
ADIPS	2014	Oceanian	Yes	✓		IADPSG	24–28	✓	
EBCOG	2015	European	Yes	✓	✓	IADPSG‡	24–28	✓	

This table only includes the primary recommendation of each guideline. International Association of Diabetic Pregnancy Study Group (IADPSG), the oral glucose tolerance test (OGTT) threshold value of IADPSG criteria is 5.1–10.0–8.5 mmol/L. Carpenter and Coustan (C-C), the OGTT threshold value of C-C criteria is 5.3–10.0–8.6–7.8 mmol/L. National Diabetes Data Group (NDDG), the OGTT threshold value of NDDG criteria is 5.8–10.5–9.1–8.0 mmol/L.

*IADPSG recommends that fasting plasma glucose ≥ 5.1 mmol/L at early pregnancy be diagnosed as gestational diabetes mellitus.

†OGTT fasting or after meal, 75g OGTT, only use 2 hours result to diagnose.

‡No matter one or two steps, 75g OGTT with WHO criteria should be used.

ACOG, American College of Obstetricians and Gynecologists; ADA, American Diabetes Association; ADIPS, Australasian Diabetes in Pregnancy Society; DDG, German Diabetes Association; EBCOG, European Board and College of Obstetrics and Gynecology; FIGO, International Federation of Gynecology and Obstetrics; GRADE, Grading of Recommendations Assessment, Development and Evaluation; HKCOG, Hong Kong College of Obstetricians and Gynaecologists; NICE, National Institute for Health and Care Excellence; NIH, National Institutes of Health; SOGC, Society of Obstetricians and Gynaecologists of Canada; USPSTF, The United States Preventive Services Task Force.

worldwide guidelines were published using the English language, and thus multiple guidelines could be effectively compared in the review. The limitation of AGREE II is that the domains were not weighted by their importance in guideline development.³²

The present study provides information on how to use guidelines in three aspects. First, this systematic review will help clinicians to understand the content of different guidelines quickly, and to recognise the quality of guidelines easily. Second, for pregnant women, this review help them to choose guidelines that were reliable and reader friendly. Since most clinicians and pregnant women only acknowledge to the guideline in their country or region, this review will help them to choose an adequate screening approach for individual. Third, for policy-makers and researchers, this review will provide an insight into the strength and limitation of each guideline, which will help to improve the quality of guidelines.

In summary, the quality of guidelines for screening and diagnosis of GDM has significantly improved since 2012, likely due to high-grade scientific-based evidence on this topic and the application of an evidence assessment system. The guidelines of WHO-2013, NICE-2015, ADA-2018, SOGC-2016, ES-2013, FIGO-2015, USPSTF-2014, IADPSG-2015 and ACOG-2018 are strongly recommended in the present evaluation by AGREE criteria. Debates focus on the utility of the one-step or two-step diagnosis method, and IADPSG or C-C/NDDG criteria in low-risk pregnant women. However, high-quality guidelines tend to recommend a universal screening by one-step 75 g OGTT strategy with IADPSG criteria between 24 and 28 gestational weeks, and the majority of these guidelines are likely to contain a list of high-risk factors and to select evidence by GRADE criteria. Further research that compares benefits and limitations, cost and effectiveness will help to resolve the current debates.

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REFERENCES

- Zhu WW, Yang HX, Wei YM, *et al.* Evaluation of the value of fasting plasma glucose in the first prenatal visit to diagnose gestational diabetes mellitus in china. *Diabetes Care* 2013;36:586–90.
- WHO Guidelines Approved by the Guidelines Review Committee. *Diagnostic criteria and classification of hyperglycaemia first detected in pregnancy*. Geneva, 2013.
- Jovanovic L, Pettitt DJ. Gestational diabetes mellitus. *JAMA* 2001;286:2516–8.
- Clausen TD, Mathiesen ER, Hansen T, *et al.* Overweight and the metabolic syndrome in adult offspring of women with diet-treated gestational diabetes mellitus or type 1 diabetes. *J Clin Endocrinol Metab* 2009;94:2464–70.
- Kim SY, England JL, Sharma JA, *et al.* Gestational diabetes mellitus and risk of childhood overweight and obesity in offspring: a systematic review. *Exp Diabetes Res* 2011;2011:1–9.
- McMillen IC, Robinson JS. Developmental origins of the metabolic syndrome: prediction, plasticity, and programming. *Physiol Rev* 2005;85:571–633.
- Clausen TD, Mathiesen ER, Hansen T, *et al.* High prevalence of type 2 diabetes and pre-diabetes in adult offspring of women with gestational diabetes mellitus or type 1 diabetes: the role of intrauterine hyperglycemia. *Diabetes Care* 2008;31:340–6.
- O'Sullivan JB, Mahan CM. Criteria for the oral glucose tolerance test in pregnancy. *Diabetes* 1964;13:278–85.
- O'Sullivan JB, Mahan CM, Charles D, *et al.* Screening criteria for high-risk gestational diabetic patients. *Am J Obstet Gynecol* 1973;116:895–900.
- Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. National Diabetes Data Group. *Diabetes* 1979;28:1039–57.
- American Diabetes Association. Gestational diabetes mellitus. *Diabetes Care* 2000;23(Suppl 1):S77–9.
- Carpenter MW, Coustan DR. Criteria for screening tests for gestational diabetes. *Am J Obstet Gynecol* 1982;144:768–73.
- Metzger BE. Summary and recommendations of the Third International Workshop-Conference on Gestational Diabetes Mellitus. *Diabetes* 1991;40(Suppl 2):197–201.
- Metzger BE, Lowe LP, Dyer AR, *et al.* Hyperglycemia and adverse pregnancy outcomes. *N Engl J Med* 2008;358:1991–2002.
- Metzger BE, Gabbe SG, Persson B, *et al.* International association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. *Diabetes Care* 2010;33:e98–82.
- American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2011;34(Suppl 1):S62–S69.
- Hod M, Kapur A, Sacks DA, *et al.* The International Federation of Gynecology and Obstetrics (FIGO) Initiative on gestational diabetes mellitus: A pragmatic guide for diagnosis, management, and care. *Int J Gynaecol Obstet* 2015;131(Suppl 3):S173–S211.
- Committee on Practice Bulletins--Obstetrics. Practice Bulletin No. 137: Gestational diabetes mellitus. *Obstet Gynecol* 2013;122(2 Pt 1):406–16.
- National Institutes of Health consensus development conference statement: diagnosing gestational diabetes mellitus, March 4–6, 2013. *Obstet Gynecol* 2013;122(2 Pt 1):358–69.
- Berger H, Gagnon R, Sermer M, *et al.* Diabetes in pregnancy. *J Obstet Gynaecol Can* 2016;38:667–79.
- Gupta Y, Kalra B, Baruah MP, *et al.* Updated guidelines on screening for gestational diabetes. *Int J Womens Health* 2015;7:539–50.
- Introduction: *Standards of Medical Care in Diabetes-2018*. *Diabetes Care* 2018;41(Suppl 1):S1–S2.
- Blumer I, Hadar E, Hadden DR, *et al.* Diabetes and pregnancy: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab* 2013;98:4227–49.

24. Committee on Practice Bulletins—Obstetrics. ACOG Practice Bulletin No. 190: Gestational Diabetes Mellitus. *Obstet Gynecol* 2018;131:e49–e64.
25. Moyer VA. Screening for gestational diabetes mellitus: U.S. preventive services task force recommendation statement. *Ann Intern Med* 2014;160:414–420–20.
26. *Diabetes in pregnancy: management of diabetes and its complications from preconception to the postnatal period*. London: National Institute for Health and Care Excellence: Clinical Guidelines, 2015.
27. Kleinwechter H, Schäfer-Graf U, Bühler C, et al. Gestational diabetes mellitus (GDM) diagnosis, therapy and follow-up care: Practice Guideline of the German Diabetes Association (DDG) and the German Association for Gynaecology and Obstetrics (DGGG). *Exp Clin Endocrinol Diabetes* 2014;122:395–405.
28. Benhalima K, Mathieu C, Damm P, et al. A proposal for the use of uniform diagnostic criteria for gestational diabetes in Europe: an opinion paper by the European Board & College of Obstetrics and Gynaecology (EBCOG). *Diabetologia* 2015;58:1422–9.
29. Seshiah V, Banerjee S, Balaji V, et al. Consensus evidence-based guidelines for management of gestational diabetes mellitus in India. *J Assoc Physicians India* 2014;62(7 Suppl):55–62.
30. Greuter MJ, van Emmerik NM, Wouters MG, et al. Quality of guidelines on the management of diabetes in pregnancy: a systematic review. *BMC Pregnancy Childbirth* 2012;12:58.
31. Li KT, Naik S, Alexander M, et al. Screening and diagnosis of gestational diabetes in India: a systematic review and meta-analysis. *Acta Diabetol* 2018;55:613–25.
32. Holmer HK, Ogden LA, Burda BU, et al. Quality of clinical practice guidelines for glycemic control in type 2 diabetes mellitus. *PLoS One* 2013;8:e58625.