

Screening for Gestational Diabetes Mellitus: Are Guidelines From High-Income Settings Applicable to Poorer Countries?

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Gestational diabetes mellitus (GDM) is increasingly acknowledged as a public health problem in developing countries, resulting in both immediate and long-term health effects for mothers and their newborns (1,2). Maternal and fetal complications of GDM range from adaptation problems of the newborn (e.g., asphyxia, respiratory distress, and hypoglycemia) to major obstetric complications such as shoulder dystocia, prolonged or obstructed labor, preeclampsia, or postpartum hemorrhage (2,3). In low-resource settings, where shortages of health care providers as well as lack of skills to manage such complications prevail (4), untreated GDM and its associated conditions can endanger the life of mothers and their newborns.

Screening and management of GDM often is not part of routine care in the majority of low-resource settings. Because of this, data on the prevalence of GDM and the incidence of related obstetric and newborn complications are scarce. Most of the research on GDM to date has been conducted in high-income countries where GDM screening is already an established part of antenatal care, and specific procedures are clearly defined in national guidelines.

Such guidelines are often absent in low-resource settings where, until now, GDM has played a minor role in the shadow of more obvious determinants of maternal and perinatal morbidity and mortality. Where guidelines are available, they

often are not standardized. In various GDM projects in low-resource settings, different guidelines have been used for screening and subsequently had to be adapted to fit into the local context (5). Based on the results of the Hyperglycemia and Adverse Pregnancy Outcome study (6), the World Health Organization (WHO) modified previously recommended criteria for the diagnosis of GDM (7) to serve as a basis for universal guidelines.

This review will assess which criteria are applied by countries with routine screening for GDM in place and how congruent their guidelines are in terms of key messages. We hope that the findings of this review will stimulate the development of applicable guidelines for low- and middle-income countries in view of existing challenges.

Materials and Methods

For this comparison, we reviewed guidelines or consensus statements from high-income settings that were accessible online and published either in English, French, Flemish, or German. Websites of the following diabetes associations were searched for available guidelines: Canadian Diabetes Association (<http://www.diabetes.ca>), Société Francophone du Diabète (<http://www.sfdiabete.org>), Deutsche Diabetes Gesellschaft (<http://www.deutsche-diabetes-gesellschaft.de>), Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften ([Institute of Tropical Medicine, Department of Public Health, Antwerp, Belgium](http://www.</p>
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awmf.org), Oesterreichische Diabetes Gesellschaft (<http://www.oedg.org>), Schweizerische Gesellschaft fuer Endokrinologie und Diabetologie (<http://www.sgedssed.ch>), National Institute for Health and Care Excellence (<http://www.nice.org.uk>), American Diabetes Association (<http://www.diabetes.org>), Vlaamse Vereniging voor Obstetrie en Gynaecologie (VVOG; <http://www.vvog.be>), and Groupement des Gynécologues Obstétriciens de Langue Française de Belgique (<http://www.ggolfb.be>). We also explored the Trip database (<http://www.tripdatabase.com>) for additional guidelines from high-income settings.

Guidelines and consensus statements from the following nine high-resource settings were reviewed: Australasia/Australia (8,9), Austria (10), Belgium (11,12), Canada (13), France (14), Germany (15,16), Switzerland (17), United Kingdom (18), and the United States (19,20). All available guidelines and consensus statements were assessed for type of screening and specific management of GDM during pregnancy, delivery, and the postpartum period.

Limitations

We only reviewed guidelines and statements accessible online in English, French, Flemish, and German. We do not claim that the guidelines and consensus statements covered in this review are exhaustive of all internationally available material; rather, they merely reflect some common issues. Not all aspects of screening and management were addressed in each reviewed document.

Results

Screening

Guidelines from the majority of countries (8–10,12,13,15,17,19) recommend universal screening. Timing of screening focuses on gestational week 24–28 for all women not known to have preexisting diabetes, although one consensus statement advises screening specifically in week

24 (11). Guidelines from two countries (14,18) advise selective screening in the presence of risk factors only. Approaches differ and range from a one-step screening approach using the 75-g oral glucose tolerance test (OGTT) (8–11,13,15,19) to sequential two-step approaches starting with the nonfasting 50-g glucose challenge test (GCT), followed by a 75-g (13,15) or 100-g OGTT (12,19). A1C to detect previously undiagnosed diabetes could be used for remote settings where OGTTs are logistically difficult to perform (9). The different approaches are displayed in Table 1.

Screening in the Presence of Risk Factors

Selective screening in week 24–28 in the presence of risk factors is the recommended screening strategy in two country guidelines (14,18), with the 75-g OGTT being the preferred screening test. However, in the presence of risk factors, screening during early pregnancy is generally advised. If early screening results are negative, a repeat test in week 24–28 is recommended. Screening in early pregnancy can be done by assessing either fasting glucose (10–12,14,15) or random glucose (10,11,15) or with an OGTT (10,15) or, alternatively, with an A1C test (10,11).

Common risk factors in all guidelines are adiposity (although BMI thresholds differ), past GDM, and history of having had a macrosomic baby. Most of the guidelines also include older maternal age, family members with diabetes, and high-risk ethnicity (Table 2).

Specific Management During Pregnancy

Patient review intervals differ, and guidelines advise meetings (face to face or, alternatively, by phone) weekly to monthly in the first 30 weeks, followed by weekly to fortnightly intervals until delivery (8); every 1–2 weeks (18); or as often as 1–3 times per week (10). Other recommendations advise no specific mon-

itoring if GDM is well controlled (14). Consultations should generally include assessments of glucose levels, ultrasound examinations, and monitoring for retinopathy and proteinuria, particularly for patients with preexisting diabetes (18).

Ultrasound

At least three ultrasound examinations are recommended: for the assessment of gestational age and nuchal translucency in the first trimester; for fetal morphology in the second trimester; and for assessing fetal growth in the third trimester. Timing for ultrasound examinations is explicitly mentioned in three of the guidelines: in week 28–30 and 34–36 (8), every 2–3 weeks (15), or every 4 weeks (18). Other guidelines recommend measurement of the abdominal circumference early in the third trimester (19) or an additional ultrasound (besides routine controls) at the end of the pregnancy (14).

Self-Monitoring of Blood Glucose

Self-monitoring of blood glucose (SMBG) is mandatory in most guidelines, and 4–7 measurements of fasting and postprandial values are recommended daily. Glucose targets range from <90 to 99 mg/dL fasting to <121 to 126 mg/dL 2 hours postprandially (Table 3).

Diet and Physical Exercise

Dietary management is recommended as first-line therapy in all guidelines and statements. A caloric intake between 24 and 35 kcal/kg/day depending on BMI is advisable, but total intake should not be <1,600 kcal/day (14,15,17). In women with higher BMIs, calorie intake should be restricted to 25 kcal/kg/day for those with a BMI >25 kg/m² (15,17), 27 kg/m² (18), or 30 kg/m² (19). Diet should consist of 40–50% carbohydrate (10,14,15), with total intake divided into three meals and three snacks (13,14,15,17). Restricting carbohydrate in obese women (>30 kg/m²) to 35–40% of total intake is

TABLE 1. GDM Screening: Diagnostic Plasma Glucose Thresholds of WHO and in Reviewed Country Guidelines (mg/dL) (7–19)

		GDM									
		US 2014	Switzerland 2009	Canada 2013	Australia 2013	UK 2008	France 2011	Germany 2011	Austria 2012	Belgium 2012	WHO 2013
Diabetes in Pregnancy (US 2014, WHO 2013)											
Test specifics	75-g OGTT	IADPSG: (1 step): 75-g OGTT; 1 positive value required NIH (2 steps): 50-g GCT followed by 100-g OGTT; 2 positive values required Step 1: 50-g GCT Step 2: 100-g OGTT*	75-g OGTT, 1 positive value required	50-g GCT (2 steps) (as part of 2-step approach with GCT or as 1 step only, but different threshold)	75-g OGTT; 1 positive value required	Refer to WHO guidelines	75-g OGTT; 1 positive value required	50-g GCT (2 steps) 75-g OGTT; 1 positive value required	75-g OGTT; 1 positive value required	V DV-VVOG 2 step: 50-g GCT followed by 100-g OGTT or 75-g OGTT	GGOLFB 75-g OGTT; 1 positive value required
Fasting	≥126	≥92	≥92	Non-fasting	≥92	—	≥92	—	≥92	≥92	92–125; 75-g OGTT
1-hour	—	≥180	≥180	140–198; OGTT; >198: GDM	≥180	—	≥180	≥135	≥180	≥140	≥180
2-hour	≥200	≥153	≥153	—	≥153	—	≥153	—	≥153	—	153–199
3-hour	—	—	—	—	—	—	—	—	—	—	—
Random	≥200	—	—	—	—	—	—	—	—	—	—

GCT, glucose challenge test; GGOLFB, Groupement des Gynécologues Obstétriciens de Langue Française de Belgique; IADPSG, International Association of Diabetes and Pregnancy Study Groups; NIH, National Institutes of Health; OGTT, oral glucose tolerance test; UK, United Kingdom; US, United States; VDV, Vlaamse Diabetes Vereniging; WOG, Vlaamse Vereniging voor Obstetrie en Gynecologie.

*This guideline includes two differing sets of diagnostic glucose thresholds, referred to as ^aCarpenter/Coustan and ^bNational Diabetes Data Group.

advised (17,19). Moderate physical exercise is suggested in most guidelines (10,12,15,17,19), with specified intervals of 30 minutes (14,15,18) 3–5 times per week (14,15).

Insulin Requirements

If glycemic targets are not achieved within 1–2 weeks of nutrition therapy, insulin is advised. Only one oral antidiabetic agent—metformin—is recommended for difficult situations (e.g., women who are noncompliant with other treatment) as an off-label use (13,15,17).

Delivery

Most countries recommend vaginal delivery if no obstetric or medical contraindications prevail. Caesarean section is advised for those with birth weights exceeding 4,250 g (14) or 4,500 g (15) to avoid potential shoulder dystocia. Labor induction at term is suggested for women with poorly controlled diabetes (14). Some countries recommend delivery in week 38 by induction or by caesarean section (18,20).

Recommendations for glucose monitoring during delivery range from hourly (18), to every two hours for insulin-dependent mothers (15), to no specific monitoring schedule for mothers with good glucose control (14,15). Recommended glucose targets range from 72–126 mg/dL (13,18) to 79–130 mg/dL (15). One guideline advises provision of glucose to women during labor to avoid hypoglycemia in the newborn (13). In another guideline, no specific monitoring or insulin therapy is indicated during labor except for patients on high-dose insulin for whom decisions should be based on the advice of a diabetologist (14).

Postpartum Management

Glucose levels should be monitored closely in the immediate postpartum period (13) and in the first weeks after delivery (8). A 75-g OGTT is recommended 6–12 weeks postpartum (9–12,15,19), at 6 weeks (17), or 6 weeks to 6 months after delivery (13).

Further screening is recommended by fasting glucose test or OGTT annually for all women (11,17), for women planning another pregnancy (9), or in cases of impaired glucose tolerance or prediabetes (19). Other guidelines also include larger intervals and recommend general screening every 1–2 years (9), every 2–3 years (10,15), at least once every 3 years (12,19), or every 1–3 years for the next 25 years and before a new pregnancy (14).

Newborn Management

Glycemic control of newborns is recommended if mothers receive insulin, if birth weight is below the 10th or above the 90th percentile, or if clinical signs are indicative of hypoglycemia (14). Guideline recommendations include glycemic controls of newborns of mothers with diabetes 30 minutes and 2 hours after delivery, aiming for glucose targets of 36–45 mg/dL (16); other guidelines suggest controls 1 hour postpartum but as early as 30 minutes after delivery in newborns of mothers with poorly controlled diabetes, with further controls after 3, 6, and 12 hours (10); or 2–4 hours after birth or if there are signs of hypoglycemia (18). Feeding of newborns is essential within the first 30 minutes after delivery (13,14,16,18) and frequently (at 2- to 3-hour intervals) (14,18). If the child is not feeding, a glucose solution should be given (16). Glucose (intravenously or by nasogastric tube) is advised in cases of ineffective oral feeding and hypoglycemia of <36 mg/dL (18). Some guidelines recommend the provision of a glucose solution if the glucose level falls to <45–47 mg/dL and if the newborn is symptomatic (10,13,16).

Discussion

These findings indicate that, although guideline recommendations of high-income countries are similar in various aspects of GDM screening and management, differences, particularly regarding screening approach, risk factor definition, and labor management, do exist. The lack of uniformity in recommendations from

high-resource settings and rather complex screening and management approaches in terms of resources required will render guideline adaptations to low- and middle-income countries challenging.

Universal screening is the recommended approach in nearly 80% of the reviewed guidelines, with only two recommending selective screening. Although settings with weak health systems might struggle to implement a universal screening approach, selective screening would risk missing up to 43% of cases (21), and selection would be complicated given the nature of some of the most common risk factors used to determine the need for screening. For example, in settings that do not perform routine screening, women's history of previous GDM is likely to be underreported. Likewise, ethnicity as a risk factor would qualify all patients in African, Asian, and Latin American settings as high risk. Situations such as these underscore the importance of universal screening in such populations. Furthermore, studies have shown that there is low compliance to risk factor-based screening guidelines, which has resulted in 70% of pregnant women with existing risk factors not being screened for GDM (22).

Utilization rates of antenatal care in low-resource settings differ substantially from those in high-income settings. A screening approach that targets mothers in weeks 24–28 might cause logistical problems when taking into account that, of 70% of pregnant women who attend one antenatal consultation, 68% are at <20 weeks' gestation, and only 44% return for a repeat visit (23). Uncertainty about gestational age in the absence of early ultrasounds and unawareness of the dates of the last menstrual period might render exact planning of an OGTT—the gold standard for detecting GDM—difficult. Age estimation often relies on palpation and fundal height, measurements that can be misleading

TABLE 2. Defined Risk Factors

	Australia	Belgium ¹	Canada	Germany	France	UK	US	Austria	Switzerland
BMI (kg/m ²)	>25 (MR) >35 (HR)	>25	≥30	≥30	≥25	>30	≥25 + additional risk factor below	"Adiposity"	>25
Age (years)	≥40 (HR)	≥35	≥35	≥45	≥35			>45	>25
History of GDM	✓ (HR)	✓	✓	✓	✓	✓	✓	✓	✓
Family history of diabetes (first-degree relative)	✓ (HR)	✓	✓	✓	✓	✓	✓	✓	✓
Prediabetes		✓		✓			✓	✓	
Ethnicity	Aboriginal, Asian, Middle Eastern, Black African (MR)	✓	Aboriginal, Hispanic, Asian, African	Asian, Hispanic (*Middle Eastern, *African)		South Asian, Black, Caribbean, Middle Eastern	African American, Latino, Native American, Asian Islander	Specific ethnic groups (e.g., Asian)	Specific ethnic groups: Asian, Latin American
History of macrosomic baby	✓ (HR)	✓	✓	✓	✓	✓	✓	✓	✓
Current macrosomic baby			✓	✓*	†			✓	
History of fetal malformation				✓*				✓	
History of stillbirth							✓	✓	
Current polyhydramnios			✓	✓*	†			✓	
Repeated abortion (≥3)				✓*				✓	
History of obstetric complications									✓
Polycystic ovarian syndrome	✓ (HR)		✓	✓			✓		✓
Steroid use	✓ (HR)		✓	✓					
Antipsychotic use	✓ (HR)			✓					
Hypertension	✓ (HR)			✓			✓	✓	
Physical inactivity				✓			✓		
Dyslipidemia, hypertriglyceridemia				✓			✓		✓
History of cardiovascular disease				✓			✓		✓
Glucosuria								✓	
Metabolic syndrome								✓	
Diabetes symptoms								✓	

HR, high risk; MR, moderate risk.

*Mentioned in text but not in flowchart.

†Not listed as specific risk factor but requires screening for GDM.

¹GGOLFB, Groupement des Gynécologues Obstétriciens de Langue Française de Belgique.

in the presence of other factors such as excessive amniotic fluid, growth retardation, macrosomia, or multiple pregnancies. Fasting, a requirement for the OGTT, can be difficult to sustain in settings where mothers have to spend a substantial amount of time traveling to and waiting to receive antenatal services. Because of these practical problems, some centers in low-income countries perform OGTTs irrespective of gestational age and fasting state (5). In a study from India, testing women irrespective of their fasting state did not reveal statistically different results compared to the WHO-recommended 75-g OGTT (24).

Management of GDM during pregnancy differs and ranges from no specific management for well-controlled cases to weekly, fortnightly, or monthly consultations. Although regular visits to a specialist care team are important, in settings where access to health care is a major obstacle, alternative solutions need to be developed. Phone consultations were mentioned in one of the guidelines (8), although these would require autonomous patients who are able to perform SMBG. Daily SMBG is feasible in high-income settings, but not necessarily in low-income settings where glucose meters and testing strips are costly. SMBG also requires women to be able to read and write, which is a challenge in many sub-Saharan African and South Asian countries with high rates of female illiteracy (25). Home visits by community health agents (26) or local support through members of community-based diabetes groups could play an increasing role in monitoring of women with GDM, although the evidence for such recommendations is lacking.

Most of the guidelines from high-income settings call for testing plasma glucose levels, which requires functioning onsite laboratories. Health facilities providing antenatal services in resource-poor countries do not always have a laboratory and there-

fore rely on rapid tests. If a laboratory is available, testing venous blood samples in contrast to performing rapid tests using capillary blood might add to the already long waiting time of 2 hours for the OGTT, resulting in more patients dropping out of antenatal care. Where capillary glucose testing is performed with meters, supply ruptures and shortages of appropriate test strips threaten continuity. Although prices for meters are usually quite low, consumables such as test strips are generally expensive, device-specific, and not always easy to obtain in developing countries.

Dietary recommendations are similar in most guidelines, although BMI thresholds for reducing caloric intake vary and are highest in the United States. Dietary requirements must be translated and adapted to local eating patterns and product availability. Metformin is not yet recommended as an oral alternative for insulin despite its proven comparability (27,28). Metformin's ease of use and the fact that it does not increase the risk of hypoglycemia would make it a better and safer alternative for developing countries, allowing for less strict glucose monitoring, costing less, and having no particular storage and refrigeration requirements.

Induction of labor is not advised in the majority of guidelines, although those of some countries recommend expediting delivery in week 38. In low-resource settings, uncertainty about exact gestational age is coupled with insufficient monitoring during labor because of shortages of staff and lack of skilled providers. Early induction of labor under such substandard conditions could cause more harm than good (29). Although postnatal care coverage is low in the majority of resource-poor settings (30), postpartum glucose testing, recommended 6–12 weeks after delivery, could be incorporated easily into routine child vaccination visits, assuming mothers accompany their child to these appointments.

TABLE 3. SMBG Targets

	Australasia	Australia	Belgium	Canada	Germany	France	UK	US	Austria	Switzerland
Fasting (mg/dL)	72–99	≤90	≤95	<95	65–95	<95	63–106	≤95 ¹ ≤105 ²	65–95	<95
1 hour postprandial (mg/dL)	144	≤133	≤140	<140	<140	<140	<140	≤140 ¹ ≤155 ²	<140	<145
2 hours postprandial (mg/dL)	126	≤120	≤120	<120	<120	<120	<120	≤120 ¹ ≤130 ²	<120	<125

UK, United Kingdom; US, United States.
¹Whole blood.
²Plasma.

The transferability of guidelines from highly to poorly resourced settings is limited and, coupled with the lack of uniformity on key recommendations, will add further confusion to guideline development in such contexts. More efforts are needed to standardize and simplify tools and procedures to increase their applicability for the developed and developing worlds.

Duality of Interest

No potential conflicts of interest relevant to this article were reported.

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