Gestational diabetes

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Abstract

Gestational diabetes mellitus (GDM) is defined as hyperglycaemia that is diagnosed for the first time in the second or third trimester of pregnancy. It occurs in 1 in 7 pregnancies worldwide and is associated with increased risk of adverse perinatal outcome, in particular, infant birth weight that is large for gestational age, increased infant adiposity, preeclampsia and preterm delivery, and increased delivery by caesarean section. This review focuses on the controversy regarding screening and diagnosis of GDM following development of the International Association of Diabetes and Pregnancy Study Groups (IADPSG) guidelines and the National Institute of Clinical Excellence (NICE) 2015 guidelines. It reviews the most recent research in to diet and exercise modification in prevention and management of GDM, pharmacological management and post-partum management to delay and/or prevent progression to type 2 diabetes.

Keywords

Diabetes, gestational diabetes, hyperglycaemia in pregnancy, screening, pregnancy complications, large for gestational age, blood glucose, pregnancy

Introduction

Gestational diabetes mellitus (GDM) is defined by the World Health Organisation as hyperglycaemia that is first recognised during pregnancy, or by the American Diabetes Association as "diabetes diagnosed in the second or third trimester of pregnancy that is not clearly overt diabetes". It is associated with increased risk to the mother of preeclampsia, preterm delivery, caesarean section delivery and later development of overt diabetes. Risks to the offspring include increased adiposity and large for gestational age (LGA) defined as infant birth weight, adjusted for sex and gestational age, that is above the 90th percentile. While the severe perinatal complications associated with LGA, including asphyxia and death are rare, LGA infants are at increased longer-term risk of insulin resistance, obesity and diabetes later in life, with female offspring having an increased chance of developing GDM during future pregnancy.

Epidemiology

Gestational diabetes mellitus affects up to 5% of pregnancies in England and up to 1 in 7 pregnancies worldwide. Recognised risk factors include obesity and family history of type 2 diabetes mellitus (T2DM) which are steadily increasing in the background maternity population. The National Institute of Clinical Excellence (NICE) recognise additional risk factors including maternal ethnicity, advanced maternal age, multiple pregnancy and previous history of GDM or macrosomia (birthweight ≥ 4.5 kg). NICE guidance recommends that women with any one of these risk factors should undergo further diagnostic testing for gestational diabetes mellitus (Table 1).

Screening

There has been a longstanding debate about which women should be screened for GDM, all women (universal screening) or only high risk women (selective screening). The importance of screening was highlighted in the MBRRACE UK Confidential Enquiry into Antepartum Stillbirth two decades ago. However despite this, along with screening process being widely accepted by patients (1) and cost-

effective, women are not always screened. In 2015 the MBRRACE UK enquiry identified that out of 133 stillbirths, 69 (52%) women had one or more risk factors for GDM, but only 32 (46%) of women with risk factors were offered diagnostic testing. This discrepancy may not have been helped by the continued controversy between screening and diagnostic criteria, with no consensus among international bodies. The two main approaches of 'universal' and 'selective' screening and one step versus two step testing vary between clinics and across countries.

One vs two step GDM screening

The International Association of Diabetes and Pregnancy Study Groups (IADPSG) Consensus Panel supported by the World Health Organisation (WHO), the Australian Diabetes in Pregnancy Society (ADIPS) and the International Federation of Gynaecology and Obstetrics (FIGO) advise a universal diagnostic testing of all pregnant women at 24-28 weeks of gestation using a one-step approach of a 75g oral glucose tolerance test (OGTT). The American Diabetes Association (ADA) also recommends a 75g OGTT at the same gestation, or alternatively a two-step 50g glucose challenge test (GCT) followed by diagnostic 100g OGTT for women who screen positive. The two step approach can result in short delays to diagnosis and onset of treatment. However, a recent study of more than 81,000 women described only minimal delays, on average 10 days after the initial screen (1). A benefit of the two-step approach is that women who screen negative to the 50g GCT, do not have to undergo an OGTT.

Selective vs universal GDM screening

The UK NICE guidelines suggest one step selective screening using identifiable risk factors. Women's risk of developing gestational diabetes is assessed at a booking visit (table 1) and only those with recognised risk factors are offered a 2 hour 75g OGTT at 24-28 weeks gestation. An exception is women with previous GDM, who are offered self-monitoring of blood glucose or an early 75-g two-hour OGTT, with a repeat 75g two-hour OGTT at 24-28 weeks if the early OGTT is normal. Selective risk factor screening approaches miss women with no apparent risk factors meaning that a proportion of women with GDM will not be treated. The proportion of women missed varies between populations

but can be up to 50%. Griffin et al randomised 3742 Irish women to either a group screened for GDM if a risk factor was present, or to a universal screening group. Prevalence of GDM was 2.7% in the universal screening group compared to 1.45% in the risk factor screened group (P<0.03). The universal screening group also had higher rates of spontaneous vaginal delivery and lower rates of macrosomia. The universal screening group were diagnosed approximately 3 weeks earlier than the risk-factor screened group (30 versus 33 weeks' gestation), which may have contributed to the differences in outcomes.

The American Congress of Obstetricians and Gynaecologists (ACOG) guidelines agree that all women should be screened, but suggest this could be performed by assessment of the patient's medical history, clinical risk factors or laboratory screening tests.

Gestation of GDM screening

The recommended gestation at which women are screened for GDM is 24-28 weeks gestation. The U.S Preventive Services Task Force (USPSTF) found little evidence on the benefits and detriments of screening prior to 24 weeks' gestation. Sovio et al investigated fetal growth in 4069 women who took part in the Pregnancy Outcome Prediction study in Cambridge, UK. In women who developed GDM, excessive growth of fetal abdominal circumference was identified between 20 and 28 weeks gestation, preceding the diagnosis of GDM (2). Therefore screening at 28 weeks may be too late to prevent fetal overgrowth especially in overweight and obese women, who had increased abdominal circumference by 20 weeks gestation. As the proportion of women with overweight and obesity increases the risks and benefits of earlier screening will need to be re-evaluated.

Random plasma glucose for GDM screening

A national survey from the UK identified that 52% of respondents used random plasma glucose (RPG) measurements to screen for GDM, despite not being supported in clinical guidelines. Meek et al studied the use of random plasma glucose (RPG) to detect GDM in 17736 births in the UK. Women

were invited to have a random plasma glucose test at booking (typically 12-16 weeks gestation) as part of their usual care. The RPG at booking was more predictive than maternal age or BMI for identifying women at high risk of GDM. Even though it cannot replace the oral glucose tolerance test for screening of GDM, it may be useful in prioritising those who would benefit from early OGTT or to exclude women who do not need further investigation. NICE do not recommend the use of fasting plasma glucose, random blood glucose, glucose challenge test, HbA1c or urinalysis for GDM screening.

Diagnosis

As for screening there is no international consensus on diagnostic criteria for gestational diabetes. The landmark Hyperglycaemia and Adverse Pregnancy Outcome study (HAPO) published in 2008 described the risks of adverse outcomes associated with various degrees of maternal hyperglycaemia. This was a multinational, multicultural study of 25,000 women who had a 75-g oral glucose tolerance test (OGTT) during their third trimester of pregnancy. Results indicated strong, continuous associations of maternal glucose levels below those diagnostic of diabetes with increased birth weight and increased cord-blood serum C-peptide levels, suggesting that maternal glycaemia and associated maternal-fetal outcomes is a continuum, as opposed to an association reached at a particular threshold (3).

Following the HAPO study, the International Association of Diabetes in Pregnancy Study Group (IADPSG) produced new guidelines in 2010 recommending lower fasting plasma glucose thresholds at 1-hr (≥ 5.1 mmol/mol), 2-hr (≥ 10.0 mmol/mol) and 3-hr (≥ 8.3 mmol/mol) after 75-g OGTT (table 2). Implementation of the one-step IADPSG criteria in Madrid, was associated with a 3.5 fold increased prevalence of GDM but was considered to be both clinically and cost effective compared to the traditional two-step Carpenter Coustan approach. There were reduced rates of caesarean section, large for gestational age infants and infant admission to neonatal intensive care units .

The IADPSG diagnostic values have been adopted by the WHO and also by ADA who give the option of using either IADPSG criteria or diagnostic values using a two-step approach for diagnosing GDM . The National Institute of Clinical Excellence (NICE) produced new diagnostic guidelines for GDM in 2015 varying from those recommended by the WHO and IADPSG. NICE recommends a higher threshold for fasting glucose ≥ 5.6 mmol/mol and a lower 2-hr value ≥ 7.8 mmol/mol, with no diagnostic threshold at 1 hour post OGTT .

The IADPSG and NICE criteria were compared in a retrospective study of 25,543 births in the UK where originally 3848 OGTTs were performed. Retrospectively applying the 2015 NICE diagnostic and IADPSG criteria in these women, suggested that NICE criteria would have missed only a small number of women with GDM, who would have been detected using IADPSG criteria (0.5%). However, this group of women had a higher risk of having a large-for-gestational age infant, caesarean delivery and polyhydramnios compared with women with normal glucose tolerance. Women with the highest risk of having an LGA infant were those who "fell through the net", suggesting that the IADPSG criteria identify women at substantial risk of complications who would not be identified by NICE 2015 criteria. Alternatively, 261 women were identified as GDM positive using the 2015 NICE criteria, but negative using IADPSG, with 2-hr post OGTT glucose values between 7.9-9.9mmol/l. These women did not have increased risk of pre-eclampsia or large for gestational age but they had an increased risk of polyhydramnios, compared to the reference population .

GDM Management

Following diagnosis of Gestational Diabetes Mellitus (GDM) the woman should be seen in a joint diabetes antenatal clinic within one week. The implications of the diagnosis of GDM, including short and long term risks to the mother and baby need to be explained as well as the importance of good blood glucose control to reduce pregnancy complications. There is good evidence from randomised clinical trials for benefit of providing clinical treatment even to women with mild gestational diabetes

as this can reduce the risks of fetal overgrowth, shoulder dystocia, caesarean delivery and preeclampsia and, among women with more severe hyperglycaemia, treatment also reduces serious perinatal complications .

Self-monitoring of blood glucose

Recommended glucose control targets vary between organisations, but all are in agreement that blood glucose levels should be tightly controlled. Women with gestational diabetes should be taught how to self-monitor their blood glucose and use the same capillary plasma glucose targets as those with pre-existing diabetes. NICE recommends a fasting blood glucose of <5.3 mmol/l, 1 hour post-meal ≤ 7.8 mmol/l and ≤ 6.4 mmol/l two hours after meals. The ACOG recommends the same fasting blood glucose as NICE, with a 1 hour post-meal target of <7.2 mmol/l, whereas the International Diabetes Federation (IDF) recommends fasting capillary glucose levels of 5.0-5.5 mmol/l, 1-hour post prandial <7.8 mmol/l and 2-hour post prandial of 6.7-7.1 mmol/l . Organisations are in agreement that it is important to maintain capillary plasma glucose levels above 4 mmol/l to avoid maternal hypoglycaemia .

Diet and Lifestyle modification for treatment of GDM

The best dietary intervention for GDM treatment is unclear. A 2013 Cochrane review of studies comparing low and high GI diets, high-fibre and energy restricted diets, high monounsaturated fat diets and high carbohydrate diets in a total of nine studies found no significant differences in benefit between the different dietary approaches . In clinical practice, diet recommendations tend to be towards a low carbohydrate-higher fat diet. However, these recommendations were recently challenged by a thought provoking pilot study of 12 diet-controlled overweight/obese women with GDM. Participants were randomised to a higher-complex carbohydrate/lower-fat (CHOICE) diet with 60% carbohydrate, 25% fat, 15% protein or an isocaloric conventional low-carbohydrate/higher-fat (LC/CONV) diet with 40% carbohydrate, 45% fat, 15% protein. The aim was to explore potential differences in maternal insulin resistance, adipose tissue lipolysis and infant adiposity before

embarking on a longer term trial. After seven weeks women on the high carbohydrate/low fat CHOICE diet had decreased fasting glucose and free fatty acids with consistent or improved insulin resistance compared to women on the conventional low carbohydrate/high fat diet .

Thus as in other aspects of GDM screening and diagnosis, there is no consensus about what are the most effective dietary approaches for optimal maternal and fetal health outcomes during GDM pregnancy.

Pharmacological treatment (Insulin and oral hypoglycaemic agents)

Metformin improves insulin sensitivity, is not associated with hypoglycaemia or maternal weight gain and is orally administered which is often more acceptable for women than insulin injections. However, metformin does cross the placenta and has wide ranging actions which affect a diverse range of mitochondrial, proliferative, hepatic, and metabolic signalling pathways for which the longer term consequences and potential for fetal programing effects are largely unknown.

A randomised control trial comparing metformin with insulin treatment in 751 women in Australia and New Zealand found that the incidence of neonatal complications did not differ between groups, however the metformin group had less episodes of hypoglycaemia and increased rate of preterm birth (before 37 weeks). There was no difference in neonatal anthropometic measures or measurements of umbilical-cord serum insulin concentrations suggesting that both metformin and insulin had the same effect on fetal growth and hypoglycaemia. Women in the metformin treated group experienced less weight gain during pregnancy which may be beneficial in reducing women's future risk of developing T2DM. Interestingly 46% of women taking metformin required supplemental insulin suggesting that many women are unable to maintain target glucose levels on metformin alone. Additionally, children of women in the metformin group at two years old had increased fat stored in subcutaneous sites (larger upper-arm circumferences and subscapular skinfolds) which may in turn mean there was lower visceral body fat compared to children of women randomised to insulin, despite similar birthweight . Offspring of mothers who were treated with metformin for polycystic ovarian syndrome have also

shown a reassuring lack of effect on motor or social development at 18 months . A more recent review of metformin in 2165 women with GDM or type 2 diabetes found that metformin lowered the risk of neonatal hypoglycaemia, large for gestational age babies, pregnancy-induced hypertension and gestational weight gain with no short-term adverse effects on maternal-infant health outcomes, but limited long-term follow-up information .

NICE 2015 guidelines recommend using metformin in women with gestational diabetes mellitus if blood glucose targets do not meet the target ranges within 1-2 weeks of changes to diet and exercise. Insulin is recommended instead of metformin if metformin is contraindicated, cannot be tolerated or if glucose levels remain outside the target range. Immediate treatment with insulin is recommended for women with fasting plasma glucose level of 7.0 mmol/l and should be considered if 6.0 mmol/l in addition to complications of macrosomia or polyhydramnios. Glibenclamide is only recommended if insulin therapy is declined and blood glucose targets are not achieved with metformin or metformin is not tolerated . The ACOG guidance gives no preference to insulin or oral agent for management of GDM although a recent systematic review and meta-analysis involving 2509 women with GDM suggest that glibenclamide is “clearly inferior” to both insulin and metformin and should not be used for treatment of GDM if insulin or metformin are available (4).

More intensive dietary intervention and/or greater weight loss, performed in selected populations of women at highest risk for GDM are required to evaluate the efficacy of dietary intervention for GDM prevention.

Prevention of GDM

A western diet (high in calories, processed meat, saturated fat and refined carbohydrate) has been identified as a possible contributing factor for developing both type 2 and gestational diabetes mellitus. Diet and lifestyle modification is thus the first-line management for both treating women

with gestational diabetes and for GDM prevention. However a 2012 meta-analysis of 44 diet and lifestyle randomised-controlled trials in a total of 7,278 pregnant women found that even though diet, physical activity or a mixed diet and lifestyle approach reduced maternal gestational weight gain (up to 3.8 kg reduction with dietary intervention), there was no significant reduction in the incidence of gestational diabetes in these study populations .

Diet

Low glycaemic index foods are often recommended in management of type 2 and gestational diabetes mellitus to help manage glucose levels, however a low glycaemic index diet has not been seen to help prevent the onset of gestational diabetes. Markovic et al's study of 139 women who were identified as having a high risk of GDM were randomised to one of two healthy diets of similar macronutrient composition, however one group had a low GI (target GI ≤50) diet compared to a high fibre, moderate GI diet. There was no difference in rates of small or large for gestational age infants, mode of delivery or incidence of GDM.

Schoenaker et al's systematic review of observational studies investigating the role of energy, nutrients and dietary patterns in the development of gestational diabetes mellitus supported a diet limiting saturated fat and cholesterol as part of an overall balanced diet to reduce the risk of developing GDM, but concluded that further large prospective studies are necessary .

Lifestyle

Small studies that explored the use of physical activity in reducing the incidence of GDM such as The Finnish Gestational Diabetes Prevention Study (RADIEL) found beneficial results from those who had lifestyle counselling. RADIEL randomised 293 high-risk women with a history of GDM and or a pre-pregnancy BMI of $\geq 30 kg/m^2$ to an intervention or control group. The intervention participants received individualized lifestyle counselling with a study nurse on three occasions during pregnancy and one two-hour group session with a dietitian. They were encouraged to aim for a minimum of 150

minutes of moderate-intensity physical activity per week. Although the between group differences were small, women in the intervention group increased leisure time physical activity, had better diet quality and lower gestational weight gain (0.58kg). There were fewer new cases of GDM in the intervention group (20 versus 27; p=0.04) (5).

The DALI lifestyle study compared the effectiveness of three lifestyle interventions (healthy eating, physical activity and both together) with usual care in reducing the risk of developing GDM in 436 women. All participants were less than 20 weeks gestation and had a BMI ≥ 29 kg/m^2. Women who were in the healthy eating with physical activity group achieved less gestational weight gain throughout pregnancy than any of the other groups. There was no improvement in fasting, post-load glucose or insulin concentrations in any group, suggestive that lifestyle change alone is unlikely to prevent GDM in women who have a BMI ≥ 29 kg/m^2(6).

Unfortunately the potentially promising suggestion that a lifestyle intervention can prevent GDM in the RADIEL study was also not replicated in larger randomised controlled trials such as UPBEAT (7) and LIMIT .

<u>UK Pregnancies Better Eating and Activity Trial (the UPBEAT study)</u>

The objective of the UPBEAT study was to assess whether behavioural interventions would be able to reduce the incidence of gestational diabetes (GDM) and large-for-gestational-age infants in women who are obese. 1,555 women with a BMI ≥ 30kg/m^2 from eight hospitals in multi-ethnic, inner-city locations in the UK were randomised to either a behavioural intervention or standard antenatal care. Consisting of nine, one-hour group or individual sessions, the interventions addressed self-monitoring, identification, and problem-solving of barriers to behaviour change. Participants in the intervention group were given information recommending foods and, physical activity, a log book for recording SMART (specific, measurable, achievable, relevant, time-specific) goals and a DVD of an exercise regimen appropriate for pregnancy. GDM was measured by a 75-g oral glucose tolerance test (OGTT) at 28±1 weeks gestation and diagnosed using the IADPSG criteria (fasting glucose of ≥ 5.1 mmol/L, 1-

hr glucose ≥10.0 mmol/L or 2-hr glucose ≥8.5 mmol/L). They found that the incidence of gestational diabetes and of large-for-gestational age infants was similar between groups. There were 172 (26%) new GDM cases in standard care and 160 (25%) GDM cases in the intervention arm (P=0.68), with low rates of LGA (8% and 9% respectively). However, there were some potential benefits, as women in the lifestyle intervention group had less gestational weight gain and a lower sum of maternal skinfold thickness (7).

Similarly the Australian LIMIT randomised controlled trial recruited 2212 overweight and obese pregnant women (BMI >25kg/m^2) between 10-20 weeks gestation to either a comprehensive diet and lifestyle intervention or standard antenatal care. Women who were randomised to the intervention and control groups had similar rates of gestational diabetes (148 cases or 14% vs 120 cases or 11%; p=0.11) and large-for-gestational age infants (19% vs 20%; p=0.24) . The intervention did however reduce the risk of large infant birth weight (15% vs 19%; p0.04 for birth weight >4000g).

Pharmcological prevention of GDM

The effect of metformin on maternal and fetal outcomes in obese pregnant women were considered in the EMPOWaR (8) and MOP (9) trials. EMPOWaR randomised 449 women without diabetes but with a BMI ≥ 30kg/m^2 from 15 UK hospitals to receive metformin or placebo. Metformin 500mg or matched placebo tablets were taken in a dose of up to five tablets in two to three divided doses initiated between 12-16 weeks' gestation and continued until the delivery of the baby. In this setting metformin was ineffective for reducing offspring birthweight or maternal insulin resistance .

However, The Metformin in Obese Nondiabetic Pregnant Women (MOP) trial of 400 women without diabetes, but with a higher maternal BMI>35kg/m^2 found that maternal gestational weight gain (4.6 vs 6.3kg; p<0.001) and incidence of preeclampsia (3% vs 11%; p=0.001) were both significantly lower in the metformin group, possibly due to earlier metformin initiation, better compliance and/or higher maternal BMI at baseline (9).

Follow-up and prevention of type 2 diabetes mellitus

The incidence of type 2 diabetes mellitus (T2DM) in women with GDM is 70% higher than in the background population with a 50 % to 70% rate of progression from GDM to T2DM over 5-10 years of follow-up depending on ethnicity. NICE 2015 guidelines recommend testing blood glucose in women who were diagnosed with GDM to exclude persisting hyperglycaemia before they are transferred to community care. They advise that women be offered a fasting plasma glucose at 6-13 weeks postpartum to exclude diabetes, instead of routinely offering a 75 g OGTT .

The Gestational Diabetes effects on Moms (GEM) randomised control study of 2,280 women with GDM from 44 clinics compared strategies to minimise post-partum weight retention. Women who were in the diabetes prevention programme (DPP) lifestyle intervention group received a letter and up to 13 follow up phone calls between six weeks and six months after delivery. The intervention incorporated personalised weight, exercise and diet goals although the methods used to achieve these goals were in line with women's preferences using motivational interviewing. At six months post-partum, women in the intervention group retained less weight (0.4 vs 1.0kg); were more likely to meet their pre-specified weight goals than women in usual care (31% vs 24%), and did more vigorous-intensity physical activity (15 minutes/week) suggesting that there is potential benefit of intensive diet and lifestyle interventions for weight loss after pregnancy (10).

Another study of 4,502 women with a history of gestational diabetes were followed from 1991 to 2011 and 722 women developed type 2 diabetes mellitus. The authors observed that women who had a low-carbohydrate diet (40% carbohydrate) with high protein and fat intake mainly from animal source foods were at an increased risk of developing type 2 diabetes mellitus, and concluded that this particular diet may be associated with a higher risk of developing type 2 diabetes, whereas low carbohydrate diet with high protein and fat from plant-source foods was not significantly associated with risk of type 2 diabetes .

Conclusion

The incidence of gestational diabetes is increasing and is associated with increased maternal and neonatal risks. Recommended screening and diagnostic criteria guidelines vary between organisations. First line management of gestational diabetes is diet and lifestyle modification, which seems modestly effective for limiting maternal gestational weight gain despite limited research pointing to which dietary and/or behavioural interventions are most effective. Metformin and/or Insulin are recommended as second line treatments if glucose levels remain above target. Behavioural interventions may be beneficial at reducing the risk of developing type 2 diabetes in this high risk cohort of women and follow-up with prevention of developing type 2 diabetes is an important part of the management for gestational diabetes.

Practice Points

- Screening for GDM is recommended, however there is controversy as to whether selected risk-factor based screening or universal screening approaches should be used
- Diagnostic criteria for GDM vary between organisations.
- Fetal growth acceleration is already apparent at 28 weeks gestation so earlier detection and treatment of GDM may be needed for optimal infant outcomes.
- Current recommendation for GDM is diet and lifestyle modification with pharmacological treatment (metformin and/or insulin) if glucose targets are not achieved.
- Glibenclamide should not be used for treatment of GDM if insulin or metformin are available (4)

- Large RCTs have found little benefit from diet and lifestyle modification or pharmacological treatment with metformin for obese women without diabetes either for GDM prevention and/or reducing neonatal growth acceleration.
- Whilst metformin appears effective at limiting maternal weight gain, more data are required regarding longer term impacts on embryonic, placental and placental development
- Women who have had gestational diabetes should be followed up after pregnancy and advised on diet and lifestyle modifications in order to reduce their risk of recurrent gestational diabetes and/or developing type 2 diabetes.

Further reading - https://www.nice.org.uk/guidance/ng3

1. **If fasting glucose levels are above target after 1-2 weeks of dietary intervention what is the recommended first line treatment in GDM pregnancy**
    a. Increased physical activity
    b. Glibenclamide
    c. Long or intermediate acting insulin
    d. Metformin
    e. Fast acting insulin before evening meal
2. **In a woman with previous GDM which of the following is effective for reducing recurrent GDM/risk of progression to type 2 diabetes**
    a. Metformin
    b. Glibencalmide
    c. Diet and Lifestyle
    d. Exclusive breastfeeding for 6 months duration
    e. Insulin

Table 1: National Institute of Clinical Excellence screening criteria for gestational diabetes mellitus

- BMI above 30 kg/m^2
- Previous macrosomic baby weighting 4.5 kg or above
- Previous gestational diabetes
- Family history of diabetes (first-degree relative with diabetes)
- Minority ethnic family origin with a high prevalence of diabetes

Table 2: Screening and Diagnostic criteria for GDM

Organisation	Year proposed	Approach	Gestation	Glucose Challenge	Glucose threshold mg/dL (mmol/L)			
					Fasting	1 hr	2 hr	3 hr
American Diabetes Association (ADA)	2016	1 or 2 step	24-28 weeks	1 step: 75g OGTT OR 2 step: 50g (nonfasting) screen followed by a 3h 100g OGTT for those who screen positive	≥ 92 (5.1) ≥ 95 (5.3)	≥ 180 (10.0) ≥ 180 (10.0)	≥ 153 (8.5) ≥ 155 (8.6)	 ≥ 140 (7.8)
World Health Organization (WHO)	2013 (revised, same as IADPSG)	1 step	Any gestation	75g OGTT	92-125 (5.1-6.9)	≥ 180 (10.0)	153-199 (8.5-11.0)	
National Institute for Health and Care Excellence (NICE)	2015	1 step	Previous GDM: booking and again at 24-28 weeks No Previous GDM but other risk factors: 24-28 weeks)	75g OGTT 2 hour	≥ 120 (5.6)		≥ 160 (7.8)	
International Association of Diabetes and Pregnancy Study Groups (IADPSG)	2010	1 step	24-28 weeks	75g OGTT	≥ 92 (5.1)	≥ 180 (10.0)	≥ 153 (8.5)	
American College of Obstetricians and Gynecologists (ACOG)	2013	2 step		50g (nonfasting) screen followed by a 3h 100g OGTT for those who screen positive	≥ 95 (5.3)	≥ 180 (10.0)	≥ 154 (8.6)	≥ 140 (7.8)

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