Gestational Diabetes Mellitus (GDM), Diagnostics, Therapy and Follow-up Care

Summary of the S3 Guideline (AWMF register number: 057-008)

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NOTICE OF UPDATE

The DDG clinical practice guidelines are updated regularly during the second half of the calendar year. Please ensure that you read and cite the respective current version.

UPDATES TO CONTENT AND DIFFERENT RECOMMENDATIONS COMPARED TO THE PREVIOUS YEAR'S VERSION

Change 1:
Prevalence increased to 9.6 %.

Reason:
Annual survey of prevalence via the perinatal survey.

If applicable, supporting references:
IQTiG 2023 Quality Report.

Introduction

This clinical practice guideline on gestational diabetes is an action-oriented summary of the evidence-based S3 Guideline (https://www.awmf.org/uploads/tx_szleitlinien/057-008p_S3_Gestationsdiabetes-mellitus-GDM Diagnostik-Therapie-Nachsorge_2020-01.pdf), which can be viewed on the Internet, published by the German Diabetes Society (DDG) and the German Society for Gynaecology and Obstetrics (DGGG), Working Group Obstetrics and Prenatal Medicine (AGG). It replaces the clinic practice guidelines of the DDG and DGGG for the diagnosis and therapy of gestational diabetes dated 2011 and was first published in 03/2018. The guideline is currently being comprehensively updated, and publication is planned for early summer 2025. The primary goal of the guideline is to improve and standardise the prevention, screening, diagnosis, therapy and follow-up care of gestational diabetes through evidence-based recommendations for the outpatient and inpatient sectors.

Definition

Gestational diabetes mellitus (GDM, ICD-10: O24.4G) is defined as a glucose tolerance disorder first diagnosed in pregnancy with a 75 g oral glucose tolerance test (oGTT) under standardised conditions and a quality-assured glucose measurement from venous plasma. The diagnosis is already possible with an elevated glucose value. The definition of manifest diabetes corresponds to that outside a pregnancy; it does not belong to the category of gestational diabetes but is referred to as "diabetes diagnosed during pregnancy".

Pathophysiology

The pathophysiology of GDM is largely similar to that of type 2 diabetes. GDM is a variant of pre-type 2 diabetes and can today be described as a chronic dysfunction characterised by increasing insulin resistance with decreasing β-cell compensation. Adverse pregnancy outcomes in women with GDM can be mitigated or prevented by timely diagnosis and intensive treatment.

Epidemiology

In Germany, the GDM prevalence in the perinatal statistics was 9.6 %, which means that the prevalence is increasing.

Prevention

For the prevention of GDM, there are numerous studies on lifestyle changes (change in eating habits, increase in physical activity) without a clear influence on GDM prevalence or pregnancy outcome. There are now studies with positive results for the intake of supplements such as myoinositol, vitamin D, but not for probiotics or fish oil. However, women who are overweight and obese should be advised to make healthy lifestyle changes to lose weight when planning their pregnancy and continue this during pregnancy.

Consequences for mother and child

Acute consequences for the mother

There is an increased risk of urinary tract and vaginal infections with a resulting increase in premature births, pregnancy-induced hypertension, preeclampsia, delivery by C-section, shoulder dystocia, higher-severity birth injuries, postpartum bleeding requiring transfusion and depression. Independent of GDM, pre-conception obesity (body mass index [BMI] > 30 kg/m^2) per se leads more often to births by C-sections and babies with macrosomia.

Long-term consequences for the mother

Diabetes risk in later life

After GDM, 35–60 % of women develop diabetes within 10 years (7–8-times higher risk than that of glucose tolerant pregnant women). Already in the first year after pregnancy about 20 % of European women show different forms of disturbed glucose metabolism. The risk of progression to manifest diabetes is increased in pre-conception obese women, Asian women, GDM diagnosis < 24th week of gestation (WG), insulin therapy, an oGTT value after the one-hour test ≥ 200 mg/dl (11.1 mmol/l) during pregnancy, HbA1c ≥ 5.7 % at the time of GDM diagnosis. The incidence of type 1 diabetes in risk groups 5–10 years after GDM is 2.3–10 %.

Cardiovascular risk profile

Post-GDM women have a higher risk of developing metabolic syndrome. This is associated with a higher risk of cardiovascular disease (coronary heart disease with myocardial infarction, coronary bypass, coronary angioplasty/stenting, stroke, peripheral arterial occlusive disease [PAOD]) at a young age.

Risk of recurring GDM

Women of Caucasian origin: Risk of recurrence 35–50 % for GDM in subsequent pregnancies. Risk factors: Obesity (BMI > 30 kg/m^2), number of pregnancies, GDM diagnosis before 24th WG in previous pregnancies, insulin therapy, less than 24 months between pregnancies, weight gain of more than 3 kg between pregnancies,

increased fasting blood glucose 2 months postpartum. Risk increases to 50–84 % for ethnic groups with a high risk of diabetes (Asia, Latin America).

Acute consequences for the child

The increased intrauterine glucose supply leads to increased foetal insulin secretion (foetal hyperinsulinism), deposition of glycogen in the heart muscle, formation of white adipose tissue and reduced foetal surfactant formation. Foetal haematocrit increases as a result of increased intrauterine erythropoietin levels. At birth, diabetic fetopathy is manifested to varying degrees with hypoglycaemia, respiratory disorders, polycythaemia, hypocalcaemia, hypomagnesaemia and hyperbilirubinemia.

Long-term consequences for the child

While it is unclear whether GDM as such is associated with long-term metabolic consequences for a child, factors associated with GDM in particular (maternal as well as paternal obesity, family eating and exercise habits) increase the long-term risk of childhood obesity and the development of impaired glucose tolerance. Interventions during pregnancy to reduce elevated glucose levels alone are not sufficient to prevent subsequent childhood obesity. Postnatal measures in the area of lifestyle optimisation (breastfeeding, type of infant and toddler nutrition, encouragement of early exercise) must follow.

Screening and diagnostics

Screening for risk of diabetes at first medical appointment in pregnancy

At the first presentation in early pregnancy (before 24 weeks of gestation), pregnant women with an increased risk (▶ **Tab. 1**) should be examined for the presence of a glucose tolerance disorder or pre-existing (as yet undetected) diabetes mellitus (type 1 or 2). In the case of diabetes-specific symptoms (polyuria, polydipsia, pronounced glucosuria in spontaneous urine), tests should be performed to determine whether previously undetected pre-conception diabetes mellitus is present. For this purpose, reference is made to the annually-updated clinic practice guidelines for diagnosing diabetes mellitus issued by the Commission for Laboratory Diagnostics in Diabetology of the German Diabetes Society (Kommission Labordiagnostik in der Diabetologie der Deutschen Diabetes Gesellschaft – DDG) and the German Society for Clinical Chemistry and Laboratory Medicine (Deutschen Gesellschaft für Klinische Chemie und Laboratoriumsmedizin – DGKL) (see DDG homepage: https://www.deutsche-diabetes-gesellschaft.de/home.html). Two methods are possible (▶ **Fig. 1**):

- Measurement of fasting glucose. Blood glucose levels in venous plasma ≤ 92 mg/dl (5.1 mmol/l) exclude diabetes mellitus and GDM. If the blood glucose value in venous plasma is ≥ 92 mg/dl (5.1 mmol/l), a second measurement is performed. This must be done on a different day. The blood glucose measurements must meet laboratory standards. The result of the second measurement is decisive; measurements must be above the threshold value, otherwise the diagnosis cannot be made. According to International Association of the Diabetes and Pregnancy Study Groups (IADPSG) and the World Health Organization (WHO), blood glucose values of 92–125 mg/dl (5.1–6.9 mmol/l) indicate GDM in early pregnancy. Nutritional counselling and blood glucose self-monitoring are recommended. Diabetes mellitus is present at plasma glucose levels ≥ 126 mg/dL (7.0 mmol/l) (likely pre-conception diabetes mellitus).
- Measurement of the HbA1c value. An HbA1c value of ≤ 5.9 % does not confirm diabetes but also cannot exclude early GDM, therefore an additional fasting blood glucose determination is necessary. For HbA1c values of 5.9–6.4 % an oGTT is recommended for further clarification with assessment in accordance with IADPSG and WHO. Values of ≥ 6.5 % indicate diabetes.

▶ **Tab. 1** Independent risk factors for the development of GDM during pregnancy. GDM: gestational diabetes mellitus; OR: odds ratio; CI: confidence interval.

	OR	95 % CI
Pregnancies with previous GDM		
Previous GDM	50.4	42.1–60.3
Weight (> 69 kg)	1.02	1.01–1.03
Pregnancies without previous GDM		
No GDM in previous pregnancy	0.45	0.4–0.5
Age (compared to 35 years)	1.08	1.07–1.09
Weight (> 69 kg)	1.03	1.03–1.04
Height (> 1.64 m)	0.94	0.93–0.95
1st degree relatives with diabetes	2.5	2.2–2.8
2nd degree relatives with diabetes	1.7	1.4–2.1
Ovulation induction	1.6	1.1–2.3
Origin: East Asian region	2.9	2.2–3.8
Origin: South Asian region	2.3	1.8–2.8
Z-score of birth weight of previous children	1.25	1.1–1.3

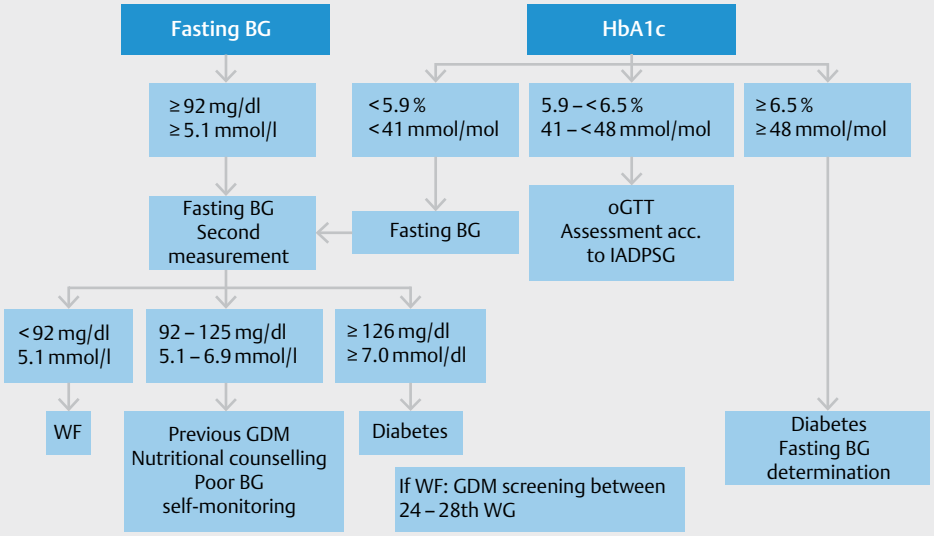
New studies on early screening will be included in the update and possibly lead to a modification of the procedure. The problem is that 1.) the IADPSG criteria are not evaluated in early pregnancy and 2.) the benefit of early intervention has not been evidence-based.

In the case of a negative test in early pregnancy, a regular GDM screening according to maternity guidelines, preferably with a 75-g-oGTT, is performed in the period from 24th WG + 0 to 27th WG + 6 (▶ **Fig. 2**).

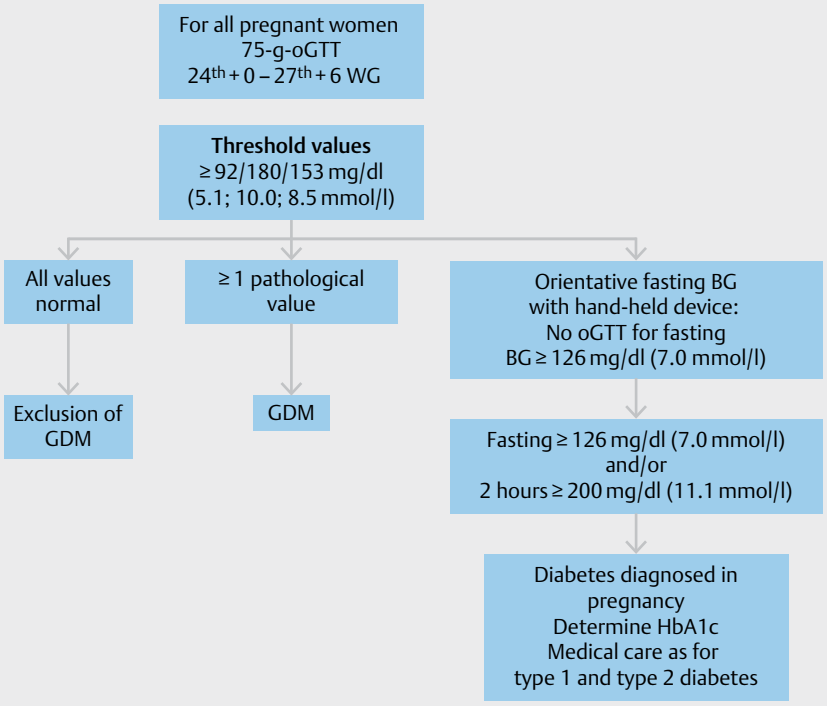
Screening for GDM in the period 24th WG + 0 to 27th WG + 6

According to the available evidence, screening for GDM in all pregnant women should preferably be performed as a one-time procedure with a 75-g-oGTT between 24th WG + 0 and 27th WG + 6 (▶ **Fig. 2**). New studies on one-time versus two-time screening procedures will be included in the update and may lead to a re-evaluation/or individualised modification of the procedure.

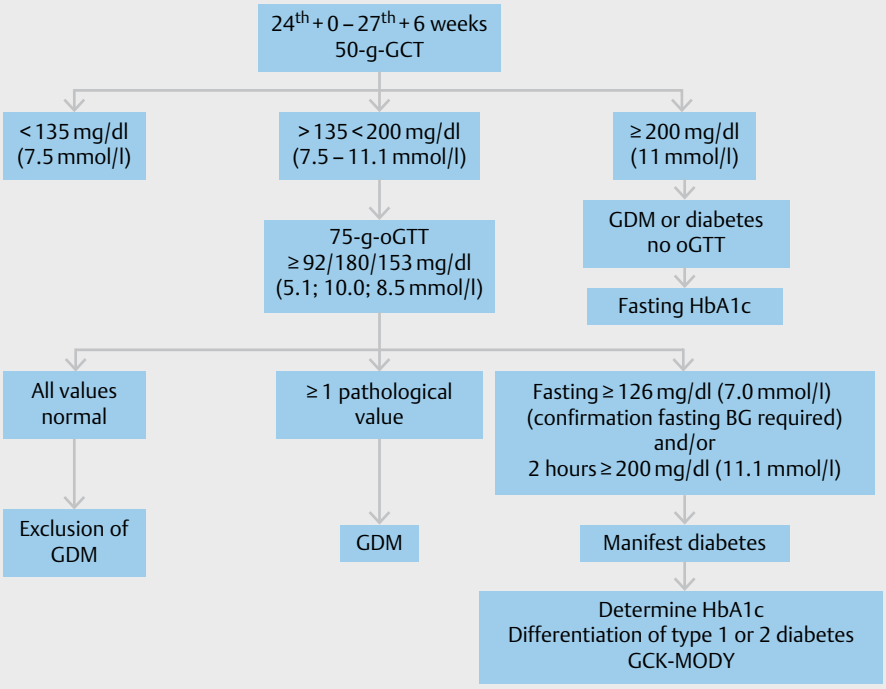
According to the German maternity guidelines, a primary screening for GDM can be performed with a 50-g-Glucose Challenge Test (GCT) (▶ **Fig. 3**). The 50-g-GCT is performed in a non-



▶ **Fig. 1** Diabetes screening in early pregnancy at risk for DM (HbA_{1c}) or GDM (HbA_{1c}). GDM: gestational diabetes mellitus; BG: blood glucose; oGTT: oral glucose tolerance test; IADPSG: International Association of the Diabetes and Pregnancy Study Groups; WG: week of gestation; fasting BG: fasting blood glucose. Source: Gestational Diabetes Mellitus (GDM), Diagnostics, Therapy and Follow-up Care Guideline of the DDG and DGGG-AGG. (S3 level, AWMF registration number: 057-008, March 2018) [rerif]. WG: week of gestation



▶ **Fig. 2** Evidence-based screening and diagnostic procedure. WG, week of gestation. Source: Gestational Diabetes Mellitus (GDM), Diagnostics, Therapy and Follow-up Care Guideline of the DDG and DGGG-AGG. (S3 level, AWMF registration number: 057-008, March 2018) [rerif]. fasting BG fasting blood glucose; oGTT: oral glucose tolerance test [rerif]. WG: week of gestation



▶ **Fig. 3** Screening for gestational diabetes in the 3rd trimester according to German maternity guidelines BG: blood glucose; oGTT: oral glucose tolerance test; GCK-MODY: Glucokinase-Maturity Onset Diabetes of the Young; fasting BG: fasting blood glucose. Source: Gestational Diabetes Mellitus (GDM), Diagnostics, Therapy and Follow-up Care Guideline of the DDG and DGGG-AGG. (S3 level, AWMF registration number: 057-008, March 2018) [rerif].

fasting state, independent of time of day and food intake. 50 g of glucose is drunk in 200 ml of water. A blood glucose value in venous plasma of ≥ 135 mg/dl (7.5 mmol/l) after one hour is considered positive and requires a subsequent diagnostic 75-g-oGTT. A blood glucose value in venous plasma ≥ 200 mg/dl (11.2 mmol/l) is diagnosed as GDM and the 75-g-oGTT is omitted.

According to the HAPO study, 33 % of women with GDM only had an increase in the fasting value, which is not detected by the 50-g-GCT. However, since the fasting value is the most closely correlated with an unfavourable pregnancy outcome, it is recommended that fasting blood glucose also be determined in case of a negative 50-g-GCT between 24th WG + 0 and 27th WG + 6. This is not part of the maternity policy.

GDM screening procedures such as urine glucose, fasting glucose, random plasma glucose or HbA_{1c} are not recommended in this guideline; screening using fasting glucose is the norm in Switzerland (▶ **Fig. 2**).

Diagnostics of GDM using 75-g-oGTT

The 75-g-oGTT is performed under standard conditions in the morning on an empty stomach. If the intended time window (24th WG + 0 and 27th WG + 6) is exceeded, the test can be performed at a later time according to the medical team's instructions. If there are indications of GDM (polyhydramnios, macrosomia with abdominal circumference (AC) > head circumference (HC) or severe glucosuria), there is also an indication to retest for GDM with a diagnostic 75-g-oGTT in the third trimester if screening in the 24–28 WG is negative.

The standard conditions include:

- No acute illness/fever/hyperemesis/medically prescribed bed rest.
- No intake or parenteral administration of drugs with insulin-antagonistic effects in the morning before the test (e. g. glucocorticoids, L-thyroxine, β-mimetics, progesterone). Where there is a risk of premature birth, at least 5 days must have elapsed after the last injection of betamethasone to induce foetal lung maturity, and the pregnant woman must be at least partially mobile before the oGTT can be performed.
- No previous surgery on the upper gastrointestinal tract (e. g. bariatric surgery with ablative-malabsorptive procedures) – alternative: individual blood glucose measurements, especially fasting.
- No excessive physical strain before the test.
- Normal, personal eating and drinking habits with the usual amount of carbohydrates in the last 3 days leading up to the test (the pregnant woman should not prepare for the test by changing her eating habits, especially by omitting carbohydrates).
- On the evening before the test from 10:00 p.m. on, a fasting period of at least 8 hours must be observed.

▶ **Tab. 2** Threshold values in venous plasma according to IADPSG consensus recommendations.

Time frame: 24 WG + 0 to 27 WG + 6	IADPSG venous plasma threshold values (mg/dl)	(mmol/l)
Fasting	92	5.1
After 1 hour	180	10.0
After 2 hours	153	8.5

IADPSG: International Association of the Diabetes and Pregnancy Study Groups. WG: week of gestation.

- The test should not start before 6:00 a.m. and not after 9:00 a.m. the following morning (glucose tolerance dependency on time-of-day).
- During the test, the pregnant woman should remain seated close to the test laboratory and not move around unnecessarily.
- Smoking is not allowed before and during the test.

Immediately prior to the start of the test, venous fasting plasma glucose is measured. The pregnant woman then drinks 75 g anhydrous glucose dissolved in 300 ml water or a comparable oligosaccharide mixture in sips within 3–5 min. Further glucose measurements: one and two hours after finishing the glucose solution. In case of severe morning sickness or vomiting, the test must be postponed by a few days.

Threshold values for the evaluation of the test results of the 75-g-oGTT

The IADPSG criteria are uniformly used as diagnostic threshold values according to the maternity guidelines. If at least one of the three threshold values in venous plasma is reached or exceeded, GDM is diagnosed (▶ **Tab. 2**). The threshold values, in particular the threshold value for fasting glucose, have been re-evaluated in new studies that will be included in the update.

A fasting blood glucose value ≥ 126 mg/dl (7.0 mmol/l) is considered manifest diabetes mellitus. A second measurement of fasting blood glucose on another day and of HbA_{1c} is indicated for confirmation. The diagnosis of a manifest diabetes mellitus is confirmed or excluded by the second blood glucose measurement, both values must be ≥ 126 mg/dl. If a manifest diabetes mellitus is confirmed by the second fasting blood glucose measurement ≥ 126 mg/dl, the 75-g-oGTT should not be performed.

A value of ≥ 200 mg/dl (11.1 mmol/l) after two hours also confirms the diagnosis of diabetes mellitus. An additional HbA_{1c} measurement is then useful. Further care is then provided in the same way as for pre-conception already-diagnosed type 1 or type 2 diabetes.

According to HAPO, if the oGTT is limited to the duration of only one hour (measurement fasting and after 1 hour), GDM is not detected in 2.1 % of all pregnant women (▶ **Tab. 2**).

Blood samples and measurement quality requirements

For diagnosing GDM, blood glucose values are measured exclusively in venous plasma directly or in venous whole blood and converted into venous plasma values with a factor of 1.11 (+ 11 %), or a plasma-calibrated measuring system is used. Hand-held devices for capillary blood glucose measurement should not be used. Conversion of capillary measured values into venous values is not permitted. Blood glucose measurements for diagnosing GDM must meet the requirements for measurement quality according to the guidelines of the German Medical Association (Richtlinie der Bundesärztekammer – Rili-BÄK). When using unit-use reagents and associated measuring systems, these – as well as all other glucose measuring systems – should be expressly intended for medical use for diagnostic purposes according to the manufacturer's recommendations for the initial diagnosis of manifest diabetes in pregnancy or gestational diabetes. An external quality assurance according to Rili-BÄK guidelines should also be carried out for use in medical practices.

For detailed information on pre-analytics, methodology and evaluation for the determination of plasma glucose and HbA_{1c}, please refer to the DDG's clinical practice guideline "Definition, classification and diagnosis of diabetes mellitus" [1].

Blood glucose measurement: errors, interference factors

Venous whole blood or plasma measurements can be erroneous, especially in the case of different preanalytical procedures. The main problem is insufficient preanalytical glycolysis inhibition during sample shipment. For practical reasons, the immediate, close-to-patient glucose measurement from the venous whole blood sample should be carried out with a Rili-BÄK quality-assured measurement method using a point-of-care measurement system approved for diagnostics (convert to plasma equivalents with a factor of 1.11 (+ 11 %) or use an appropriately plasma-calibrated device; the collection vessel must contain anticoagulants). When shipping venous whole blood samples, the collection vessel should contain not only an anticoagulant and NaF but also the immediately-effective glycolysis inhibitor citrate/citrate buffer. When filling the vessels, the manufacturer's instructions must be observed in order to obtain valid measurement results.

Diagnosis of GDM after bariatric surgery

Diagnosing GDM using an oral glucose tolerance test is not possible (dumping phenomenon) after surgical procedures that influence resorption. Therefore, to clarify hyperglycaemia requiring treatment, monitoring of fasting and 1-hour postprandial blood glucose levels (2-hour values are not meaningful) with blood glucose daily profiles for 2 weeks under normal dietary conditions, for example in the 12th, 24th and 32nd weeks of gestation, is recommended. If the target values are then exceeded, appropriate diabetological care is recommended. There are no studies available to date for this procedure.

Therapy

First medical consultation after GDM diagnosis

An in-depth conversation in a low-fear atmosphere. The pregnant woman is confronted with the term "diabetes" for the first time. In order to meet the needs of migrant women or illiterate women, suitable interpreters or helpers are called in to ensure that the planned measures are understood and can be implemented. If the

pregnant woman is not ready or able to give her consent, information and treatment should be postponed.

The elements of the structured initial medical consultation include:

- Importance of the diagnosis for the child and the mother,
- Time frame of the measures to be implemented and the structure of the medical care,
- Reference to mostly out-patient therapeutic measures,
- The purpose of blood glucose self-monitoring,
- Necessity of possible nutritional modification and the goal of weight development according to the recommendations of the Institute of Medicine,
- Advantages of regular exercise (increasing insulin sensitivity),
- Reasons for the possible use of pharmacotherapy with insulin or metformin as off-label use,
- End the session with an open discussion including questions about concerns and worries.

Physical activity

Regular physical exercise, fitness programs or exercise reduce the risk of GDM, especially in pre-conceptionally obese women, and improve resilience during pregnancy and childbirth. In addition, the risk of LGA and C-section is reduced and the need for insulin treatment or daily insulin doses is decreased. Exercise can be continued during pregnancy, individual consultation with the gynaecologist is required and contraindications must be considered. Endurance or strength training can also be (re)started during pregnancy at a light to medium level. As the simplest form of physical exercise without aids, brisk walks of at least 30 minutes duration should be carried out at least 3 times a week or daily exercise with an elastic band. The physical activity/training should be started already pre-conceptionally or in the first trimester. Short exercise sessions in the first postprandial hour after main meals are beneficial.

Nutritional consultation

The first therapeutic measure is an individual nutritional evaluation and consultation. This should be based on instructing the principles of balanced, healthy eating habits for pregnant women. The network "Gesund ins Leben" (Healthy start to life) has developed a template for this purpose (Federal Centre for Nutrition – Bundeszentrum für Ernährung [BZfE] of the Federal Agency for Agriculture and Food – Bundesanstalt für Landwirtschaft und Ernährung [BLE], www.gesund-ins-leben.de/inhalt/handlungsempfehlungen-29378.html). Eating habits, daily rhythm, body weight and socio-cultural-religious status are taken into account in order to achieve the following therapy targets:

- Near-normal, pregnancy-specific blood glucose targets without ketosis or hypoglycaemia,
- The mother's weight gain recommended for the pregnancy,
- Normal growth of the foetus.

The diet should be adapted to the nutritional requirements of pregnancy and be calorically adequate. Recommended distribution of nutrients:

- Carbohydrates: 40–50 %
- Proteins: 20 %
- Fats: 30–35 %

Limiting the carbohydrates to 40–45 % daily energy calories lowers postprandial blood glucose levels. However, the carbohydrate percentage should not fall to below 40 % or 116 g/day. Carbohydrates with a high fibre content and a low glycaemic index are preferred. The recommendation for carbohydrates is to divide them into 3 not-too-large main meals and 2–3 smaller snacks (including one late meal) throughout the day, which may help to avoid insulin therapy. There is no evidence of this from any randomised control trials. The amount of carbohydrate should be lower at breakfast than at lunch and dinner (highest blood glucose increase). A late meal containing 1 carbohydrate unit prevents excessive ketone body formation during the night. A sufficient intake of vitamins and minerals (folic acid, vitamin B complex, calcium, vitamin D, magnesium, iron, iodine) should be ensured. Energy-free sweeteners (e. g. aspartame) can be used during pregnancy, taking into account the acceptable daily limits.

Recommended weight gain

Weight gain is also based on the pre-conceptional BMI. Weight gain within the IOM limits should be aimed for. A weight loss of 1–2 kg in the first weeks after a change in diet can occur and is harmless. Controlled weight gain improves the glucose metabolism/increases insulin sensitivity. An increased pre-conceptional BMI which then exceeds the specified weight limits increases the rate of pregnancy complications (preeclampsia, C-section, LGA (large-for-gestational-age) children). Falling below these limits increases the rate of foetal growth retardation. New studies show that in obese women with diabetes, minimum weight gain (0–5 kg total gain) or losing weight leads to an improvement in pregnancy outcome. Studies on this will be evaluated in the update. Pregnant women should check and document their weight weekly without clothing in the mornings on an empty stomach at home (▶ **Tab. 3**).

▶ **Tab. 3** Recommended range of weight gain during pregnancy

Pre-conceptional BMI (kg/m²/WHO)	Total weight gain during pregnancy (kg)	Weight gain/week 2nd and 3rd trimester[1] (kg)
18.5	12.5–18	0.5–0.6
18.5–24.9	11.5–16	0.4–0.5
25.0–29.9	7–11.5	0.2–0.3
≥ 30	5–9	0.2–0.3

[1] A weight gain of 0.5–2 kg in the first trimester is assumed. BMI: body mass index; WHO: World Health Organization.

Blood glucose monitoring

Individual blood glucose measurements

Measurement frequency at the beginning: 4-point profile for 1–2 weeks – in the morning on an empty stomach and 1 or 2 hours after the start of the main meals. If all values within the first 2 weeks are within the target range, the following is reduced to a single daily measurement in rotation or a 4-point profile 2 × /week. Additional targeted measurements according to the medical team's instructions are possible. Insulin therapy: daily measurements with a 4-point profile or only daily control of the value to be optimised by

▶ **Tab. 4** Blood glucose target values based on plasma-calibrated self-monitoring devices.

Time frame	Plasma equivalent	
	mg/dl	mmol/l
Fasting, preprandial	65–95	3.6–5.3
1 h postprandial	< 140	< 7.8
2 h postprandial	< 120	< 6.7

insulin therapy. Frequency and timing of self-monitoring are continuously adjusted to the effort and course of the therapy and according to the measured results in individual cases. The focus is on minimising the burden on pregnant women and limiting self-monitoring to a decision-making minimum. It is important to regularly check the patient's blood glucose self-monitoring as well the accuracy of the blood glucose measuring system. Pregnant women with GDM receive suitable diaries for documentation; they are shown how to document correctly.

Continuous glucose monitoring system (CGMS)

CGMS is not part of the routine care of pregnant women with GDM and does not improve the outcome of the pregnancy. Current studies on this will be evaluated in the update and possibly lead to a modification of the clinic practice guideline.

HbA_{1c}

Within the scope of early screening (≤ 24th WG), the HbA_{1c} value is used to diagnose a pre-existing glucose metabolism disorder/manifest diabetes mellitus (see section "Screening for risk of diabetes at first medical appointment in pregnancy"). After a confirmed GDM diagnosis, the HbA_{1c} value is only determined if diabetes mellitus (type 1 or 2) is suspected. HbA_{1c} is not relevant for monitoring or therapy control of gestational diabetes. In individual cases, however, it can be helpful as an additional parameter, e. g. in cases of non-compliance for blood glucose self-monitoring or if the quality of the measurements is questionable.

Blood glucose target values

The blood glucose target values based on plasma-calibrated self-monitoring devices are shown in ▶ **Tab. 4**. There are no preferences for postprandial measurements after either one or two hours, but the 1-hour values better correlate with foetal growth and are more practical in everyday life. Once a procedure has been established, it must be retained. The at-first limited experience of pregnant women with blood glucose measurements should be taken into account. Blood glucose self-monitoring by pregnant women should not be the sole criterium for therapy control. The accuracy of the pregnant woman's own blood glucose measurements must be checked regularly during the treatment process. The blood glucose target values are indicative; no adverse effects on children can be ascertained from occasionally exceeding these targets.

Insulin therapy

General indication for insulin therapy

If the metabolic targets cannot be reached after making maximum use of lifestyle measures (nutritional counselling, physical activity), there is an indication for insulin therapy. This will generally be given within 2 weeks, although depending on the level of blood glucose values, this may be necessary immediately or only during the course of pregnancy. Fasting blood glucose values ≥ 110 mg/dl (6.1 mmol/l) can hardly be influenced by diet during pregnancy. In case of repeated fasting glucose values of ≥ 110 mg/dl (6.1 mmol/l), immediate insulin therapy should therefore be considered. About 20–30 % of pregnant women with GDM require insulin. The indication for insulin therapy is constantly being reviewed. Insulin therapy is indicated if within one week ≥ 50 % of the self-measurements from the 4-point profiles are above the target values. This also applies if 50 % of all the isolated fasting glucose values (start with basal insulin) or the postprandial values after a meal, most often breakfast (rapid-acting insulin), are exceeded. Before starting insulin therapy, the correct implementation of nutritional counselling should be checked once again. The indication should be checked carefully and exactly, since insulin therapy not only causes stress for the pregnant woman, but also significant obstetric effects such as needing to be induced at the due date. Insulin adjustment can usually be started on an outpatient basis.

Insulin therapy with consideration of foetal growth in ultrasound

The effects of maternal hyperglycaemia on the foetus vary from individual to individual and are associated with different risks, depending on growth patterns. Therefore, the growth of the foetal abdominal circumference (AC) should be taken into account when determining the indication for insulin therapy by promptly obtaining ultrasound findings relevant for decision-making prior to the start of therapy (modified target value concept). A modification of the blood glucose target values depending on the growth pattern of the foetus should help to avoid either extreme of too high or low therapy. Insulin therapy should be started more quickly, and slightly lower blood glucose target values should be aimed for in asymmetric macrosomia with a foetal AC ≥ 75th percentile, especially in the presence of other risk factors for foetal macrosomia (BMI > 30 kg/m^2), previous birth of an LGA newborn, fasting blood glucose > 110 mg/dl in the daily profile at the start of therapy. During pregnancy, foetal growth parameters in ultrasound should also be taken into account when interpreting the measured blood glucose self-monitoring values and the consequences of therapy. In the case of normosomal development of the foetus in the < 75th percentile of AC, slight exceedances of the target values are tolerable and the indication for insulin should rather be strict.

Special therapeutic issues

Isolated elevated fasting glucose levels Fasting glucose seems to have a strong influence on neonatal complications, LGA and preeclampsia. After making maximum use of exercise and nutritional counselling, insulin adjustment should be performed if > 50 % of isolated fasting glucose levels are above the current threshold value of 95 mg/dl (5.3 mmol/l).

Late diagnosis of GDM – insulin therapy close to the due date

Starting therapy with insulin may still make sense even close to a due date in order to avoid neonatal hypoglycaemia.

Detecting a glucokinase gene mutation (GCK-MODY)

In about 2 % of all cases of a glucose tolerance disorder in pregnancy, a glucokinase gene mutation (GCK-MODY, MODY 2) with autosomal dominant inheritance is detected. MODY 2 diabetes should be considered in cases of persistently-elevated fasting blood glucose levels in the mother of 99–144 mg/dl (5.5–8.8 mmol/l), a low blood glucose increase in oGTT < 83 mg/dl (< 4.6 mmol/l), a normal or only slightly elevated HbA_{1c} level and a positive family history of "mild" type 2 diabetes over 3 generations. The suspected diagnosis of a GCK-MODY is confirmed by a genetic analysis (clarification and written consent according to the German Genetic Diagnostics Act – Gendiagnostik-Gesetz is required). Pregnant women with a fasting blood glucose value > 99 mg/dl (5.5 mmol/l) in combination with a preconceptional BMI < 25 kg/m² should be tested.

Only foetuses of pregnant women with GCK mutation who are not carriers of the GCK mutation have an increased risk of macrosomia and subsequent complications of increased maternal glucose during pregnancy. Insulin therapy should only be initiated in foetuses of pregnant women with GCK mutation if disproportionate growth (AC ≥ 75. percentiles) has been detected in ultrasound.

Implementation of insulin therapy

The indication for insulin should be checked for the first time within 1–2 weeks after the start of the basic therapy (diet, exercise), taking into account blood glucose self-monitoring, blood glucose laboratory tests and mother and foetal biometric data, and then continuously during the treatment process as determined by the medical team. Insulin should be set according to the intensified conventional insulin therapy (ICT) principle, but only basal or rapid-acting insulin may be necessary. If rapid-acting human insulins cannot reduce postprandial blood glucose levels in a targeted manner with sufficient dosage, a switch to insulin aspart or lispro should be considered. Both rapid-acting and long-acting insulin analogues can also be used primarily. Insulin adjustment should generally be started on an outpatient basis and should be reserved for experienced diabetologists and perinatal physicians with corresponding specialties in the care of diabetic pregnant women.

Oral antidiabetics and GLP-1 agonists

After therapeutic clarification of off-label use, the administration of metformin can be considered in pregnant women with GDM and suspected pronounced insulin resistance (insulin requirement > 1.5 IU/kg body weight) as well as according to individual indications. New studies will be evaluated in the update. Before beginning with metformin, internal medicine contraindications must first be clarified, and laboratory parameters, e. g. serum creatinine and creatinine clearance, must first be determined. A metformin daily dose of 2.0 g should not be exceeded. Sulfonylurea preparations should not be used during pregnancy. Alpha-glucosidase inhibitors, glitazones, glinides, dipeptidyl peptidase-4 (DPP-4) inhibitors and glucagon-like peptide-1 (GLP-1) agonists should not be prescribed to pregnant women with GDM due to lack of approval, lack of experience and insufficient studies.

Obstetrical care

Foetal monitoring

Foetal monitoring depends on additional risk factors and the severity of maternal hyperglycaemia.

Ultrasounds

1st trimester In the case of GDM diagnosed before 14 WG with additional risk factors (elevated blood glucose and HbA_{1c} values, history of heart malformations, obesity) or previous GDM, early detailed sonographic organ diagnostics and echocardiography should be used to rule out severe malformations of the foetus in the 11 + 0-13 + 6 WG. Requirements of the Deutsche Gesellschaft für Ultraschall in der Medizin (German Society for Ultrasound in Medicine (DEGUM)) Level II.

2nd trimester In case of GDM with a diagnosis before 24 WG and additional risk factors (elevated blood glucose and HbA_{1c} values, anamnestic heart malformations, obesity), a differentiated further organ diagnostic with echocardiography of the foetus should be performed in the 19th-22nd WG.

3rd trimester Biometry is performed at 2 to 3-week intervals (AC percentiles), in case of abnormal growth (macrosomia, intrauterine growth restriction [IUGR]) at correspondingly shorter intervals. Before delivery: Weight estimation and assessment of the ratio of abdomen to head is recommended (foetal macrosomia is a risk factor for shoulder dystocia). The extent of subcutaneous foetal fat tissue can be included in the assessment.

Doppler ultrasound

The usual indications for all pregnancies apply. Doppler ultrasound examinations are not indicated solely because of the GDM diagnosis.

Cardiotocography (CTG)

- For nutritional counselling: weekly CTG checks from the 36th WG with a frequency adapted to the individual situation.
- For insulin therapy: as for a pregnant woman with pre-conceptionally-known type 1 diabetes, in accordance with the guideline for the care of diabetic pregnant women (AWMF guideline 057/023), CTG checks from 32nd WG onward with a frequency adapted to the individual situation.

Antepartum monitoring of the mother

- Increased risk of preeclampsia: intensive therapy of GDM significantly reduces the risk.
- Increased risk of intrauterine death: if not treated or with poor blood glucose control

Preterm birth (induction of foetal lung maturity, tocolytics)

Betamethasone for induction of foetal lung maturity (before 34 + 0 WG): blood glucose levels increase, therefore strict indication. Adjust the insulin dose individually or initiate insulin treatment as of a blood glucose value ≥ 200 mg/dl (11.1 mmol/l) or hyperglycaemic symptoms.

Administer tocolytics preferably with an oxytocin or calcium antagonist and not with a beta-agonist (increase in maternal blood glucose, intensified by simultaneous bed rest).

Birth planning

Birth – Choice of maternity hospital

Pregnant women with GDM are high-risk pregnant women.

- GDM with nutritional counselling: delivery in a maternity hospital with diabetological experience and affiliated neonatology should be advised.
- GDM with insulin therapy: in order to ensure optimal primary care of the child, the delivery must be carried out in a maternity hospital with an affiliated neonatology department (perinatal centre level 1 or 2) and the delivery must be in accordance with guidelines.

Time frame of birth, indication for inducing

Inducing < 39th + 0 WG increases the neonatal morbidity and the transfer rate and should be avoided. Induction at 39 + 0 – 39 + 6 WG may be considered but is associated with a 50 % increase in the rate of inducing and does not reduce neonatal morbidity. Premature (before 38th + 0 WG) inducing due to poor BG adjustment should not be attempted due to the morbidity associated with preterm delivery. Instead, the focus should be placed on prenatal optimisation of blood glucose control. There is evidence that foetal morbidity in insulin-dependent GDM can be reduced by inducing at 40 WG; it should therefore be offered. For GDM and estimated ultrasonographic foetal weight > 95th percentile, possible benefits of inducing at 37th + 0 WG should be weighed against the effects of earlier gestational age at birth.

C-section delivery

- With an estimated birth weight of ≥ 4500 g, the risk of shoulder dystocia increases significantly: A planned C-section should be recommended.
- Estimated weight 4000–4499 g: pregnant women with an individually increased risk of shoulder dystocia according to foetal biometry, especially with a pronounced head/abdomen difference, should be informed of this risk. However, pregnant women should be aware of the inaccuracy of estimates which increases with increasing birth weight, the risk of C-section, and the consequences of placental nidation disorders in subsequent pregnancies.

Pregnant women after bariatric surgery

Pregnant women after bariatric surgery are considered high-risk pregnancies and must be closely monitored by obstetrics. It is important to pay attention to sufficient substitution according to the respective increased needs.

Postpartum support

Glucose control of the mother during birth and in the postpartum phase

If birth is induced, rapid-acting insulins should be used for better control.

The blood glucose target during birth in capillary plasma: between 90 and 140 mg/dl (4.4–7.2 mmol/l).

- Nutritional counselling (well adjusted): routine maternal blood glucose control during birth is not required.
- Insulin therapy: measurement of blood glucose levels for GDM insulin every two hours, adjusting the time intervals individually as needed; in the case of GDM, insulin is rarely needed during birth. Insulin therapy is terminated postpartum. Further control by means of a 4-point daily profile on the 2nd day postpartum, inform diabetologists in case of repeatedly high values. The same threshold values apply as for non-pregnant women. Insulin is indicated postpartum for blood glucose levels ≥ 200 mg/dl (11.1 mmol/l) or hyperglycaemic symptoms.

Follow-up care of the mother

After pregnancy, the glucose tolerance disorder does not regress in about 13–40 % of cases. There is a 7- to 8-fold increased risk of diabetes for women after GDM. The risk is particularly increased in the case of pre-conceptional obesity, positive family history of diabetes mellitus, insulin requirements for GDM, advanced age, Asian and black African women.

Postpartum 75-g-oGTT

Postpartum normal blood glucose levels: 6–12 weeks after birth: 75-g-oGTT independent of breastfeeding. Normal values for oGTT outside pregnancy with fasting blood glucose measurements and 2 hours in venous plasma after eating according to WHO guidelines:

- Normal: fasting < 100 mg/dl (5.6 mmol/l), 2 h after eating < 140 mg/dl (7.8 mmol/l),
- Diabetes mellitus: fasting ≥ 126 mg/dl (7.0 mmol/l) and or 2 h after eating ≥ 200 mg/dl (11.1 mmol/l),
- Impaired fasting glucose (IFG): 100–125 mg/dl (5.6–6.9 mmol/l),
- Impaired glucose tolerance after 2 h (IGT): 140–199 mg/l (7.8–11.05 mmol/l).

Primary determination of HbA_{1c} 6–12 weeks postpartum is not recommended for diagnostic purposes, even a fasting glucose measurement alone is not sufficient. In the presence of impaired glucose tolerance or other risks such as pre-conception obesity or GDM insulin therapy, women are given intensive advice on lifestyle measures to reduce the risk of conversion to manifest diabetes.

Further postpartum controls

The increased risk for women with GDM to develop postpartum diabetes within the next 10 years requires continuous follow-up with glucose metabolism controls. The clinic practice guidelines "Therapy of Type 2 Diabetes" [2] for diagnosing diabetes by the National Healthcare Guideline (Nationalen Versorgungs-Leitlinie Therapie des Typ-2-Diabetes) apply, usually with a measurement of fasting glucose and HbA_{1c}, if necessary oGTT every 2 years. After postprandial diagnosis of impaired fasting glucose (IFG) or impaired glucose tolerance (IGT), a yearly oGTT is recommended. The algorithm of postpartum controls according to GDM will be reassessed in the update on the basis of new studies. When planning a pregnancy, at least one HbA_{1c} and one fasting glucose measurement should be used to diagnose diabetes. For every subsequent pregnancy, perform an early hyperglycaemia diagnostic in the first trimester (first medical appointment) according to this guideline. In case of

development of type 1 diabetes (women with a BMI < 30 kg/m^2 and insulin therapy of GDM): Autoantibody screening (e. g., antibodies to glutamate decarboxylase [anti-GAD65], antibodies to tyrosine kinase IA-2 [anti-IA-2A], cytoplasmic islet cell antibodies (ICA), and antibodies to zinc transporter-8 [anti ZnT8]).

Peripartum depression

Compared to glucose-tolerant pregnant women, the rate of postpartum depression in women with GDM, especially from socially deprived backgrounds, is up to twice as high. The Edinburgh Postnatal Depression Scale (EPDS) in German is a suitable tool for searching for postpartum depression. According to this, all EPDS sum scores of at least 10 indicate a depressive mood. If suspected, this should be further clarified by a specialist in order to initiate therapy promptly. A suitable time for the use of the sensitivity sheet is the oGTT time frame 6–12 weeks after pregnancy.

Diabetes prevention

There is a 7- to 8-fold increased risk of diabetes for women after GDM. Lifestyle modification is considered a priority measure. Women with a glucose tolerance disorder after GDM benefit from lifestyle changes to prevent diabetes-related and macroangiopathic complications. They are advised and instructed to follow a diet adapted to their needs, to normalise their weight, to take part in smoking cessation training, if necessary, and to engage in regular physical activity. This can reduce the manifestation of diabetes by 50 % in 3 years and 35 % in 10 years. In addition, women who have not yet completed family planning should be made aware of the risks of unplanned pregnancy with diabetes.

Breastfeeding

After GDM, mothers breastfeed their children less frequently and for shorter periods than women without diabetes, especially in cases of excess weight and obesity, with insulin-treated GDM and lower educational levels. Mothers with GDM breastfeed more successfully if they have received breastfeeding counselling before birth and received both non-medical and medical care postnatally.

Breastfeeding and effects on the mother's health

Breastfeeding has short-term positive effects on maternal metabolism (improvement of glucose homeostasis, insulin sensitivity and lipid metabolism parameters). In addition, breastfeeding seems to significantly reduce the risk of type 2 diabetes and metabolic syndrome in mothers with GDM up to 15 years after delivery.

Breastfeeding and effects on the child's health

No or shorter breastfeeding (< 3 months) is associated with later childhood obesity, especially in children of obese mothers with gestational diabetics.

Women with GDM should therefore be strongly encouraged to breastfeed their children. In particular, obese pregnant women with GDM should be especially encouraged and given support in breastfeeding. Recommendation: all pregnant women with GDM should be informed about the advantages of breastfeeding for mother and child by a breastfeeding counselling service before giving birth, and strategies for a successful start of breastfeeding should be given; exclusive breastfeeding is encouraged for at least 4–6 months. Even after the introduction of baby food – at the earliest at the beginning of the 5th month, at the latest at the beginning of the 7th month – infants should continue to be breastfed for as long as possible.

Conflicts of interest

The authors state that there is no conflict of interest.

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