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RECCOMENDATIONS

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Guidelines of the Polish Society of Gynecologists and Obstetricians on the obstetric care of women with obesity

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Guidelines of the Polish Society of Gynecologists and Obstetricians present the most up-to-date treatment and management recommendations, which may be modified and altered after detailed analysis of a specific clinical situation, which in turn might lead to future modifications and updates.

INTRODUCTION

Recent decades have witnessed an epidemic of obesity, which has become a global health concern. According to the World Health Organization (WHO), overweight or obese adults outnumber the population of underweight individuals. In 2016, almost 2 billion people over the age of 18 were overweight (40% — women and 39% — men), and over half a billion were obese (15% — women and 11% — men) [1]. Excess body mass indices increased dramatically over the last four decades, predominantly in the developed and developing countries. If the current trends persist, an estimated 2.7 billion people will have been overweight and 117 million will have been diagnosed with Class III obesity (formerly known as morbid obesity) by 2025 [2]. With the increasing prevalence of obesity among the general population, the number of reproductive-age (15–44 years) women with obesity reached 100 million [1]. According to the epidemiological data from Poland, in 2019 obese individuals comprised 23% of the population, and the number of obese reproductive-age women increased significantly between 2009 and 2019 — by 53% and 42% among 15–19 and 20–29-year-olds, respectively and by 27% among people in their forties [3].

Obesity in pregnancy is defined as a maternal body mass index (BMI) of ≥ 30 kg/m^2 in the first weeks of gestation. Based on the BMI values, three classes of obesity have been distinguished (Tab. 1). The main causes of excess body weight include poor eating habits, low physical activity, and some endocrine syndromes [polycystic ovary syndrome (PCOS), Cushing's syndrome, hypothyroidism].

Due to its high prevalence and harmful effects on the mother and the child, obesity in pregnancy has become one of the greatest challenges of obstetric care. Obese women face more difficulty conceiving and more often experience complications in pregnancy (Fig. 1). They are at a particularly high risk for developing hyperglycemia, gestational hypertension, preeclampsia, and venous thromboembolism. Also, the literature demonstrated increased risk for obstetric interventions, genital tract trauma, perinatal hemorrhage, and mortality [4–6]. Maternal obesity affects fetal health and is associated with higher incidence of fetal abnormalities, congenital malformations, and abnormal fetal growth, including hypotrophy and macrosomia. That, in turn, increases the risk for intrauterine fetal demise or neonatal complications [7, 8]. Sleep apnea in pregnant women with obesity constitutes

Table 1. Classes of obesity

Class I Obesity	Class II Obesity	Class IIII Obesity (morbid obesity)
BMI 30.0–34.9 kg/m^2	BMI 35.0–39.9 kg/m^2	BMI ≥ 40 kg/m^2

BMI — body mass index = weight [kg]/height^2 [m]

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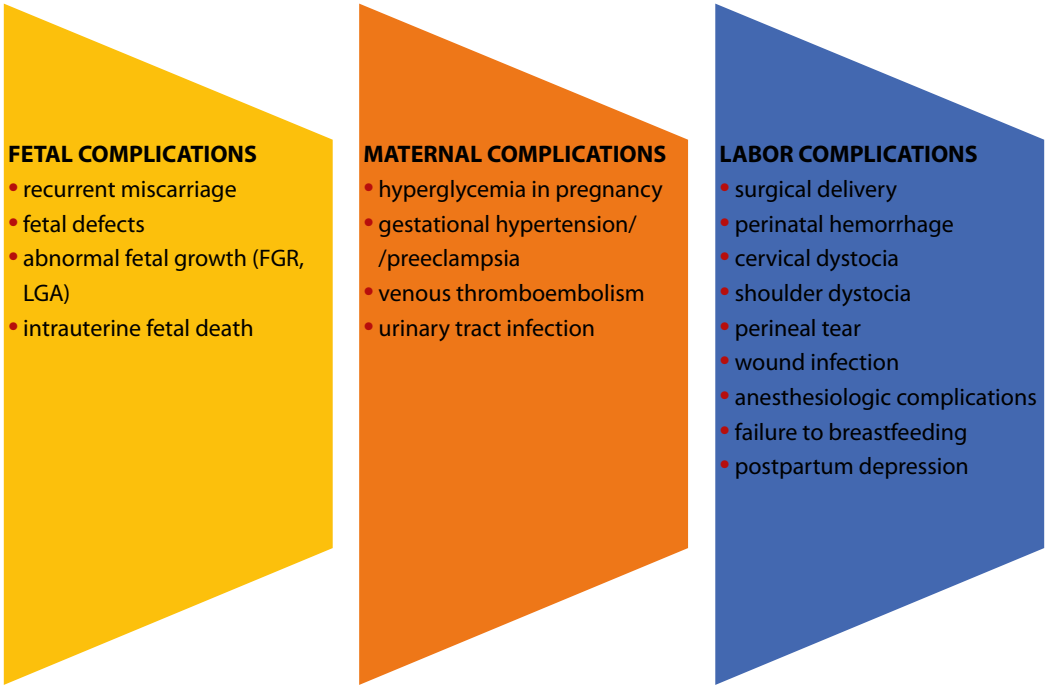

Figure 1. Complications in pregnancy among obese women; FGR —fetal growth restriction; LGA — large for gestational age

yet another negative prognostic factor for the obstetric outcome [9]. During the puerperium, obese women more often present with depression and problems with wound healing and/or breastfeeding [10, 11]. Moreover, excess body weight during pregnancy in the mother increases the risk for later obesity in the offspring [12].

The present guideline aimed to acquaint gynecologists and obstetricians with the most common problems as well as diagnostic-therapeutic management of pre- and post-conception care of women with obesity.

Recommendation

In light of a steadily growing number of reproductive-age women with obesity, all healthcare centers should be prepared, both in terms of knowledge and equipment, for providing care to obese mothers during pregnancy and labor. Only obese mothers with comorbidities and/or Class III — morbid obesity (BMI ≥ 40 kg/m^2) should be referred to a high level of care center (category D).

PRE-CONCEPTION CARE

Weight reduction is the primary therapeutic goal of pre-conception care of obese women. According to the literature, negative effects of excess weight on fertility and the incidence of complications in pregnancy are rarely addressed by physicians during the pre-conception period and infertility treatment [13, 14], **whereas decreased BMI, even by only one unit or a 10% body mass loss, may significantly increase the chances of conception and lower the risk for maternal and fetal complications [13, 14].** Therefore, it is vital to launch initiatives which will lead to lifestyle modifications, in particular those associated with eating habits and physical activity, among women with obesity. Alas, reviews of randomized trials found little, if any, evidence for successful non-pharmacological interventions in obese women [15, 16], probably due to the complexity of the etiopathogenesis of obesity, including the disturbed mechanism of central regulation of food intake. Also, the recommended low-caloric diets are associated with decelerated metabolic rate and increased the appetite, which contributes to ineffective weight reduction in the long run. Therefore, much attention has been paid to the importance of metabolism boosters and appetite suppressors in recent years. Also, normal intestinal flora, whose content depends on the diet, plays an essential role. Gut microbiota and physical activity affect the neuro-hormonal reward system, which is responsible for eating behaviors [17]. Women with obesity are more prone to food cravings for sweets, bread, fast-foods, and fatty foods [18]. Patients find it challenging to differentiate between the actual and the emotional hunger, and to stop eating once the hunger has been satiated. Hunger and satiety are regulated by a number of hormones excreted by the gastrointestinal system, *i.e.* ghrelin, glucagon-like peptide 1 (GLP-1), pancreatic peptide YY (PYY), cholecystokinin, insulin, and leptin, which is released by fat cells in the adipose tissue [17]. Obese individuals were found to present with higher fasting concentrations and impaired postprandial inhibition of ghrelin — an appetite-stimulating

hormone, as well as abnormal release of anorexigenic gastrointestinal peptides [17].

In light of the above, the role of methods which affect the activity of the gastrointestinal peptides has significantly increased as far as management of obesity is concerned. **Recent studies have demonstrated high effectiveness of incretins, drugs used to treat type 2 diabetes, in weight reduction** [19, 20]. Obese patients who received analogues of glucagon-like peptide 1 receptor agonists (GLP-1 RA) achieved a 6–8% body mass reduction in the course of one year [19]. Chronic medication is necessary to maintain this effect. So far, there have been no data on the safety of using GLP-1 RA drugs in pregnancy. Discontinuation of GLP-1 RA treatment is recommended if the patient attempts to conceive.

Bariatric surgeries have been used to treat Class II and III obesity for years. Typically, they help to achieve a long-term effect of up to even 20% reduction of the body mass. Apart from reducing stomach volume and ghrelin-releasing cells, these surgeries also stimulate the GLP-1 and PYY secretion. Women after bariatric surgeries are recommended to **postpone pregnancy for 12–24 months postoperatively, until the desired weight loss and stabilization are achieved,** and in order to lower the risk for macro- and microelement deficiency resulting from malabsorption. **Iron, folic acid, vitamin B and calcium** need to be supplemented in those women, if deficient. Shorter time interval between the surgery and conception increases the risk for prematurity, fetal hypotrophy, anemia, excess weight gain in pregnancy, and cesarean section [21].

The dumping syndrome, which usually occurs an hour after the consumption of simple carbohydrates, may be the consequence of decreased stomach volume in bariatric patients. Typical manifestations include lightheadedness, hot flashes, and tachycardia [21]. Therefore, it is recommended to avoid simple carbohydrate consumption and replace the oral glucose tolerance test (OGTT) with continuous glucose monitoring when diagnosing impaired carbohydrate tolerance.

Fertility disorders in women with obesity

Obese women are more likely to experience problems with conception, including the use of assisted reproductive techniques (ARTs), as compared to their non-obese peers [22]. Impaired function of the hypothalamus-pituitary-gonadal axis, low-quality oocytes, and decreased endometrial receptivity are the main causes of failure to achieve a pregnancy [22]. Higher concentrations of circulating insulin and ovarian overproduction of androgens are more often found in individuals with obesity. Enzymatic activity of excess adipose tissue contributes to aromatization of the androgens to the estrogens, which in turn, by reversible inhibition of the hypothalamus-pituitary axis, affect gonadotropin production and menstrual cycle disorders [22].

Hyperinsulinemia and insulin resistance play important roles in the pathogenesis of the polycystic ovary syndrome (PCOS). Management which aims at improving sensitivity to insulin increases the chances of spontaneous conception, also in ARTs, among obese women with PCOS. Inositol, which is insulin second messenger, and metformin are the first-line therapy [23, 24]. Also, recent years have brought attempts to use GLP-1 analogs in these patients [8]. **Metformin therapy in women with obesity lowers the risk for miscarriage during the periconception period, but it does not prevent other pregnancy-related complications and should not be continued after 12 weeks of gestation [25]**.

The effectiveness of ARTs decreases with increasing BMI values. Apart from the abovementioned mechanisms, it is also associated with poor quality embryos. In light of the above, and taking into consideration the high risk for complications, **women with Class II and III obesity should not be deemed eligible for *in vitro* fertilization procedures** [22].

Prevention of neural tube defects in the fetus

Numerous cohort studies demonstrated a positive correlation between class of obesity and the prevalence of neural tube defects (NTD) in the fetus [26, 27]. Insufficient maternal concentration of folic acid during fetal organogenesis in individuals with obesity is believed to be one of the main causes of NTD. Obese women are less likely to use supplements or consume foods with high folic content [26]. Metabolic disorders associated with obesity, including release of proinflammatory cytokines by adipose tissue, hyperinsulinemia, and hyperglycemia, are responsible for higher folic demand in the body. An imbalance in the normal gut microbiota in obese individuals also results in deficient levels of vitamin B12, a cofactor for the conversion of folates.

Folate and vitamin B12 supplementation seem to play a crucial role in preventing NTD in children born to obese mothers. Alas, the literature lacks reliable data about the effective dose of the folic acid. Various academic societies and associations recommend high daily doses (4–5 mg) of folic acid, which may cause a potentially neurotoxic accumulation in individuals with defective folate metabolism [26–28].

According to the Polish Society of Gynecologists and Obstetricians (PTGiP) guidelines, a **daily dose of 800 ug of folic acid, containing 400 ug of active folates,** is recommended in obese women who attempt to conceive, which is 2-fold higher as compared to the general population [29]. The experts emphasize that the dose needs to be tailored to the individual needs of women with BMI > 30 kg/m^2 by **measuring serum folic acid concentration after 4-6 weeks of**

supplementation [30]. If the concentration is < 28 nmol/L, an increased dose (max. 5 mg/day) is recommended until week 12 of gestation.

As far as NTD prophylaxis in children born to obese mothers is concerned, the role of myo-inositol should not be ignored. Folic acid supplementation does not prevent NTD in approximately 30% of the cases in the high-risk group [26]. Studies on small populations of women with history of infants born with spina bifida demonstrated the effectiveness of additional supplementation with **myo--inositol at a daily dose of 1000 mg** [31]. Lower concentrations of inositol were found in women who gave birth to spina bifida children. Supplementation with inositol preparations in pregnant women with obesity was also found to decrease the risk for gestational carbohydrate intolerance [31].

Recommended pre-conception diagnostics in women with obesity

Obesity, which is currently perceived as a chronic disease, affects the functioning of numerous systems and organs. During the pre-conception period, it is recommended to determine the efficiency of the cardiovascular system, and check for metabolic and endocrine disorders, which might increase the risk for maternal and neonatal complications. It is also necessary to take patient medication history to screen for possible teratogenic effects. The recommended diagnostic tests are presented in Table 2.

Pre-conception recommendations

1. Management of obese women with reproductive plans should include body mass reduction to improve fertility and lower the risk for pregnancy-related complications in the mother and the child (category B).
2. Pharmacotherapy for management of obesity should be discontinued during pregnancy (category D).
3. Pregnancy in women after bariatric surgeries should be delayed for 12–24 months after the optimal weight was achieved and stabilized (category B).
4. Folic acid supplementation at a daily dose of 800 ug, including 400 ug of active folates, is advised in obese women with reproductive plans. It is recommended to measure serum folic acid concentration after 4–6 weeks of supplementation and, if the level is < 28 nmol/L, to increase the dose to 5 mg/day, max. up to 12 weeks of gestation (category B).
5. Myo-inositol preparations should also be considered for pre-conception supplementation in women with obesity to lower insulin resistance and to prevent neural tube defects (category C).

Table 2. Recommended pre-conception diagnostic management in obese women

Condition	Test	Management
Gestational carbohydrate intolerance	OGTT (glycemic profile in patients after bariatric surgery) Fasting glycemia 100–126 mg/dL repeated (several times) HOMA fasting insulinemia (mU/L) × fasting glycemia (mmol/L)/22.5	Intensive treatment for carbohydrate intolerance HOMA > 2.5 — therapy implementation Diet, physical activity, myo-inositol supplementation, metformin, GLP-1 RA
Thyroid disorders	TSH in case of TSH > 2.5 mIU/mL Additional tests to measure FT4, FT3, aTPO, aTG	Depending on the test results, hormone replacement therapy is recommended, after a consultation with an endocrine specialist
Lipid disorders	Triglycerides Cholesterol fractions	Dietary modifications and physical activity are recommended if the levels are elevated; statin therapy needs to be stopped during the peri-conception period
Circulatory system disorders	Self-monitoring of the blood pressure and heart rate ECG Echocardiography	Cardiology consultation, if required; modification of hypotensive treatment with discontinuation of convertase inhibitors and angiotensin receptor inhibitors
Disorders of other systems	Transaminase Creatinine GFR general urine test	Specialist consultations, if required
Vitamin, macro- and micro-nutrient deficiency	CBC, ferritin, Folic acid Vitamin B12 Vitamin D	Supplementation for any deficiency Fetal NTD prophylaxis with folate supplementation (800 ug/day)

OGTT — oral glucose tolerance test; TSH — thyroid stimulating hormone; ECG — electrocardiogram; GFR —glomerular filtration rate, CBC —Complete Blood Count, NTD — neural tube defects

CARE DURING PREGNANCY

Pregnant women with obesity need to receive thorough and comprehensible information about the risk for complications and how to minimize it. Apart from the standard information given to all pregnant women, additional tips about nutrition and physical activity during pregnancy should be offered. In ambulatory and hospital care, special attention needs to be given to adequate training of the physicians and midwives. Also, healthcare centers need to be adequately equipped: blood pressure monitors with extra large cuffs, bariatric/obesity scales, extra large couches, wheelchairs, therapy (examination and treatment) chairs and operating tables, which are suitable for higher load capacity.

Monitoring of maternal weight gain

During the last months of pregnancy, maternal energy demand is only slightly (by 10%) elevated as compared to the pre-gestational values. Low weight gain in obese mothers decreases the risk for gestational diabetes, preeclampsia, cesarean delivery, and fetal macrosomia. **Maternal weight gain in women with obesity should not exceed 7 kg during the entire course of pregnancy [32].** A retrospective observational study demonstrated a lower risk for complications in mothers with Class III obesity (BMI > 40 kg/m^2), who lost weight during pregnancy, which is why weight reduction is recommended in that group of women [33]. However, the literature offers solid evidence that insufficient weight gain in pregnancy is often associated with fetal hypotrophy and preterm labor. In morbidly obese women, obstetric outcomes improved if the weight loss was 0.19 kg/day or 7.6 kg throughout the entire pregnancy [34]. A combination of diet and even moderate, but regular, physical activity is particularly effective in preventing excessive weight gain in pregnancy. Unlike in case of energy, maternal demand for vitamins and minerals/trace elements is significantly higher, so pregnant women should pay special attention to the quality of their food [35].

Dietary recommendations

A well-balanced and diversified diet is essential for maternal and fetal health, although it is important to bear in mind that the caloric demand in pregnancy increases by 250–300 calories/day as compared to the pre-pregnancy values. Regular meals not only contribute to maternal well-being, but also to optimal weight gain and fetal development. Recommendations for the quality and quantity of various nutrients in maternal diet are presented in Table 3.

Overweight and obese pregnant women should take special care to include vegetables, fruit, whole-grain products, low-fat milk as well as low-fat meat and fish products into their diet. Animal products should be consumed in moderation. Products with high content of saturated fats, sweets, and snacks which have high-energy but low-nutrient content should be consumed with caution or completely eliminated.

Table 3. Dietary recommendations for pregnant women

Fruit and vegatables	Cereal products	Proteins	Fats
Fruit and vegetables should be the base of all meals — source of vitamins, minerals, carbohydrates, and fiber **Daily recommended amount: 4–5* servings of vegetables** **Choose green vegetables, rich in folates and polyphenols, which stimulate the metabolic processes: kale, arugula, celery, parsley, lovage** **1–2* servings of fruit** **Choose fruits with lower content of sugar, preferably partially ripe. Fruits should be avoided in the evening due to high monosaccharide content and the possibility of fermentation, which leads to flatulence**	**Fiber** content is vital. It is necessary to choose whole-grain pastas, groats, bread, or brown rice It is advised to use earlier cooked and cooled rice, pasta, or groats in the salad for supper instead of bread. These products contain **resistant starch**, which slows down glucose absorption	It is advised to consume nutritious, easily digestible protein found in milk and fermented milk products, eggs, lean meat ,and fish **40% of the protein should be plant-based:** lentil, chickpeas, beans, peas, fava beans, soy	High-quality fats, with the best Omega-3:Omega-6 ratio, should be chosen: extra virgin olive oil, canola oil Other sources of good fats include avocados, seeds, and nuts **Consumption of saturated fats should be limited (< 10%) and trans isomers should be avoided.** Consumption of butter should be limited. Avocado or leguminous plant pastes may be used as bread spreads instead. **Omega 3 fatty acids, including DHA and EPA,** which are found in fatty fish, play an important role. Due to the risk for heavy metal contamination, it is advised to choose smaller fish: herrings, sardines, and mackerels
BEVERAGES: water 2–2.5 L/day, additionally: tea, coffee — weak infusions (up to 200 mg caffeine/day)			

*1 serving = 100 g; EPA — (omega 3-fatty acids (Eicosapentaeiconic acid)

Physical activity in pregnancy

Regular physical activity during pregnancy and after delivery is recommended to all pregnant women and parturients, unless contraindicated [36]. **At least 150 minutes of moderate-intensity aerobic physical activity per week as well as aerobic and muscle-strengthening exercises are advised**. Stretching exercises might also be beneficial. During pregnancy and postpartum, the patients should engage in physical activity, starting with light training and gradually increasing its intensity, and should also include pelvic floor exercises. Additionally, women who before pregnancy engaged in high-aerobic intensity physical activity on daily basis, or who were physically active, may continue to do so during pregnancy and puerperium, unless medically contraindicated [37].

The most recommended types of aerobic activity include walking, running, cycling (ideally on a stationary bike), and swimming. According to WHO, any kind of physical activity is better than no activity at all, and that engaging in physical activity is necessary to achieve optimal health results [36].

Tests recommended during pregnancy

Biochemical diagnostics in pregnant women with obesity should be carried out in accordance with the standards of care for pregnant women. The scope of testing should be extended (see: Tab. 2, with the exception of insulin resistance) if the diagnostic assessment of the systems in question had not been performed, or if the pregnancy was unintentional. Due to the high risk for carbohydrate intolerance, adequate diagnostic process and management are vital.

Diagnostics and management of gestational hyperglycemia

Pregnant women with obesity are at a higher risk for developing gestational hyperglycemia. Several-fold higher risk for that complication has been demonstrated in pregnant women with obesity as compared to their normal weight pregnant peers [38]. Timely diagnosis of hyperglycemia in obese pregnant patients and treatment (dietary recommendations, glycemia control, and insulin therapy, if necessary) significantly lower the risk for developing complications such as fetal macrosomia and shoulder dystocia [39].

The 75 g OGTT after earlier fasting glycemia test should be performed at the first antenatal visit in all pregnant women with obesity. If no glycemic abnormalities are found, the diagnostic test needs to be repeated between 24–28 weeks of gestation, or if the first symptoms indicative of diabetes have been observed. Hyperglycemia diagnosed first-time during pregnancy should be classified in accordance with the 2013 WHO recommendations:

Diabetes in pregnancy — if the general criteria for diagnosing diabetes are met, *i.e.*, fasting glycemia ≥ 7.0 mmol/L (126 mg/dL) or glycemia at 2 hours of the 75 g OGTT ≥ 11.1 mmol/L (200 mg/dL) or random glycemia ≥ 11.1 mmol/L (200 mg/dL) with accompanying clinical symptoms of glycemia. Gestational diabetes mellitus (GDM) — if at least one criterion from Table 4 is met.

Table 4. Diagnostic criteria for gestational diabetes based on the 75 g oral glucose tolerance test (OGTT) results according to 2010 International Association of Diabetes and Pregnancy Study Groups (IADPSG) and 2013 World Health Organization (WHO) reports

	Plasma glycemia	
	Mg/dL	Mmol/L
Fasting	**92–125**	**5.1–6.9**
After 1 hour	**≥ 180**	**≥ 10**
After 2 hours	**153–199**	**8.5–11.0**

If fasting glycemia of 126 mg/dL is observed twice, it is recommended to forgo the test and diagnose diabetes in pregnancy. If the OGTT result is normal, the test should be repeated between 24 and 28 weeks of gestation. In light of the fact that pregnant women with obesity are at a particularly high risk for hyperglycemia in pregnancy, even if the glucose test is negative, it is still advised to repeat it at 32 weeks of gestation in women with BMI of ≥ 35 kg/m^2. Regardless of gestational age, women with abnormal fasting or OGTT glycemia require specialist care. Routine management consists in self-monitoring of glycemic levels and low simple carbohydrate diet; if that fails it is necessary to implement insulin therapy.

Insulin is the only hypoglycemic drug recommended in pregnancy. According to the current state of knowledge, other medicines which decrease glycemia, oral or GLP-1 agonists and SGLT-2 inhibitors, are not recommended. **Metformin used in women with PCOS to treat insulin resistance or to induce ovulation should be stopped until the end of the first trimester** [40]. RCT (Randomized Clinical Trial) meta-analysis demonstrated that metformin treatment during pregnancy does not lower the risk for developing GDM in high-risk women with obesity, PCOS, or earlier diagnosis of insulin resistance [41]. If metformin is used in the first trimester, glycemia should be monitored by the patient, and the diagnostics for hyperglycemia needs to be performed at least one week after metformin was stopped. If self-monitoring reveals glycemic levels above the norm for pregnant patients during metformin therapy, further diagnostics is not necessary and hyperglycemia in pregnancy should be declared, and appropriate recommendations should be followed.

Hyperglycemia in pregnancy increases the risk for complications in the mother and the fetus, as well as further development of the child. Therefore, regardless of the type of

carbohydrate metabolism disorder, the goal of the therapy is to achieve glycemic levels which are normal for pregnant women.

According to the current state of knowledge, the target self-monitored glycemic values are as follows:

- fasting and before meals: 70–90 mg/dL (3.9–5.0 mmol/L);
- max. glycemia in the 1st hour since the meal has been started: < 140 mg/dL (< 7.8 mmol/L) or after 2 hours < 120 mg/dL (6.7 mmol/L);
- between 2.00 and 4.00 a.m.: 70–90 mg/dL (3.9––5.0 mmol/L).

Pregnant women should self-monitor their glycemia, after being instructed by a physician or a nurse with experience in caring for diabetic patients. The number of glucose concentration measurements and their timing should depend on the seriousness of the carbohydrate metabolism disorder and the treatment.

Continuous glucose monitoring (CGM) in pregnant women is also possible, in which case the patients should achieve > 90% of the target glycemic values, *i.e.*, 63–140 mg/dL (3.5–7.8 mmol/L). The management in case of diabetes or hyperglycemia should follow the PTGiP and PTD guidelines [42, 43].

Prenatal diagnostics

The recommended path for prenatal diagnostics in pregnant women with concomitant obesity does not differ much from a physiological pregnancy [44–46]. At least four ultrasound tests, at 11^{+0}–$13^{+6/7}$, 18–22, 28–32, and due date, are recommended.

As far as the technical aspects of ultrasound testing are concerned, it is advised to use lower-frequency ultrasounds as well as harmonic imaging, compound imaging and speckle reduction filters to improve visualization in obese patients [47]. A full bladder and the use of the so-called tissue windows, *i.e.* areas of lower cumulation of adipose tissue such as the umbilical region, the area above mons pubis, or the iliac fossa, offer another possibility to improve the quality of imaging in pregnant women with obesity [47].

First trimester ultrasound

The aim of the first screening test is to determine the gestational age, evaluate fetal anatomy, and assess the risk for the most common chromosomal aberrations and preeclampsia. So far, no relationship between maternal obesity and increased risk for fetal aneuploidy has been found. However, it has been confirmed that obesity significantly increases the rate of failed attempts to assess nuchal translucency and of inadequate imaging of the nasal bone in the first trimester. Also, maternal obesity significantly prolongs the duration of the test [48–50]. The recommended path for the prenatal diagnostics in the first trimester of pregnancy in obese women is presented in Figure 2 [51–55].

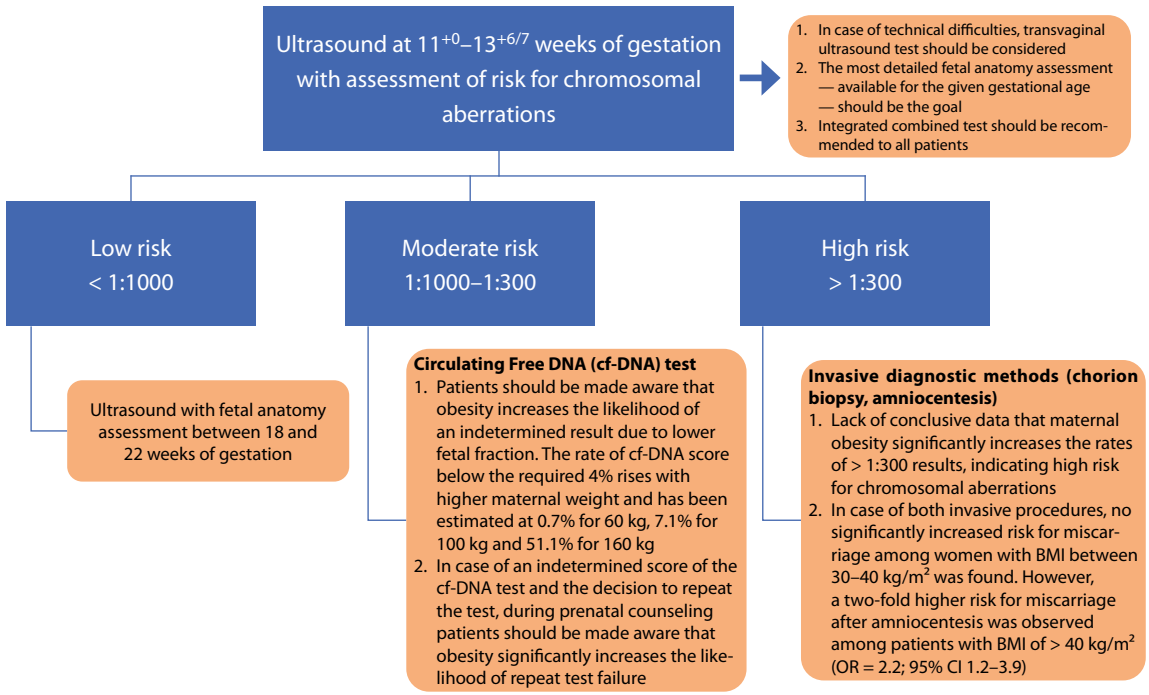

Figure 2. The recommended path for prenatal diagnostics in the first trimester of pregnancy in women with obesity [51–55]; BMI — body mass index; OR — odds ratio; CI — confidence interval

Table 5. The risk for structural defects in the fetuses born to mothers with obesity [56, 57]

Structural defect in the fetus	Odds ratio (OR) and confidence interval (CI)
Neural tube defects	OR = 1.87; 95% CI 1.62–2.15
Spina bifida	OR = 2.24; 95% CI 1.86–2.69
Cardiovascular defects	OR = 1.30; 95% CI 1.12–1.51
Split palate	OR = 1.23; 95% CI 1.03–1.47
Split lip and palate	OR = 1.20; 95% CI 1.03–1.40
Anorectal atresia	OR = 1.48; 95% CI 1.12–1.97
Hydrocephalus	OR = 1.68; 95% CI 1.19–2.36
Hemimelia	OR = 1.34; 95% CI 1.03–1.73
Umbilical hernia	OR = 1.63; 95% CI 1.07–2.47

Second trimester ultrasound

The aim of the ultrasound test performed between 18 and 22 weeks of gestation is a detailed evaluation of fetal anatomy. A link has been found between maternal obesity and an elevated risk for NTD, including spina bifida, cardiovascular defects, split palate, split lip and palate, anorectal atresia, hydrocephalus, hemimelia, and fetal hernia (Tab. 5). In contrast, pregnancy in obese women is significantly less often associated with gastroschisis [odds ratio (OR) = 0.17; 95% confidence interval (CI) 0.10–0.30] [56, 57].

According to the literature, maternal obesity significantly lowers the detection rate for fetal structural defects on second trimester ultrasound [50, 58]. In a retrospective cohort study, conducted among 11,135 singleton pregnancies, the detection rate for fetal malformations was 66% among patients with BMI of < 25 kg/m^2, but only 48% and 25%, respectively in women with Class I (BMI 30–34.9 kg/m^2) and Class III (BMI > 40 kg/m^2) obesity [58]. Another study found that complete evaluation of fetal anatomy in the second trimester of pregnancy was successfully performed in only 30% of patients with BMI of > 40 kg/m^2 [59].

Third trimester ultrasound

The main goal of fetal ultrasound at 28–32 weeks of gestation is reevaluation of fetal anatomy, combined with fetal growth assessment. **It is especially important in mothers with obesity due to a correlation between maternal excess weight and fetal macrosomia, as well as higher incidence of small for gestational age (SAGA) neonates (< 10 percentile) born to mothers after bariatric surgery [60, 61]**. As far as the additional late-third trimester ultrasound test (*i.e.*, between 34^{+0} and 36$^{+6/7}$weeks of gestation) is concerned, the findings of studies published so far have not validated the need for such a test [62–64]. When it comes to low birthweight fetuses, the sensitivity and the positive predictive values of ultrasound evaluation of the fetal weight at that stage of pregnancy are 8.1–32% and 58.5–100%, respectively, while for fetuses with birthweight of > 90 percentile the values are 38.6–87.1% and 30.2–77.1%, respectively [62–64]. The abovementioned percentile values are the reason why, in a group of mothers with obesity, a significant number of fetuses with birthweight of <10 percentile remain undiagnosed, whereas in case of excess fetal growth, approximately half of the readings are false positive. In light of the above, it is not recommended to perform an additional ultrasound test, with the evaluation of fetal weight, between 34^{+0} and 36$^{+6/7}$weeks of gestation, in women with isolated obesity. However, such a test should be considered in obese women with concomitant diabetes or hypertension, after bariatric surgery, and in cases when the 28–32 weeks ultrasound revealed fetal growth abnormality. **A relationship between maternal obesity and fetal growth abnormalities as well as shoulder dystocia is the reason why an ultrasound should be performed before elective labor induction and at term.**

HYPERTENSION IN PREGNANT WOMEN WITH OBESITY

Cardiovascular changes during pregnancy include, among others, volume overload. Also, obesity is additionally associated with increased circulating blood volume, stroke volume, systemic and pulmonary blood pressure, which may predispose the affected individual to hypertrophic cardiomyopathy and left ventricular hypertrophy. As far as function is concerned, left ventricular systolic as well as diastolic functions may be impaired, and in severe cases obesity may even lead to right ventricular heart failure [65].

Left ventricular hypertrophy, with signs of diastolic dysfunction and abnormal deformation indices, was observed in women with class II and III obesity as compared to normal weight pregnant women [66]. These changes constitute a cardiac response to excessive strain and may explain higher incidence of unfavorable pregnancy results associated with dysfunctions of the uteroplacental circulation, which is observed among pregnant women with obesity.

Abnormal maternal BMI constitutes an independent risk factor both, for preeclampsia and pregnancy-induced hypertension [5–7, 67]. In a review of 13 cohort studies, including almost 1.4 million pregnant women, the risk for preeclampsia doubled each time BMI increased by 5–7 kg/m^2, and that correlation persisted after individuals with chronic hypertension, diabetes or multiple pregnancy had been excluded [68]. Studies of patients after bariatric surgery indicate that loss of weight significantly lowers the risk for preeclampsia [69].

Obesity-related pathophysiological changes such as insulin resistance, hyperlipidemia, or elevated concentrations of pro-inflammatory and oxidative stress factors may

be responsible for higher incidence of preeclampsia, as these factors affect placental development and function. Adipose tissue is an important source of proinflammatory cytokines, which may promote the expansion of maternal anti-angiogenic factors engaged in the pathogenesis of preeclampsia [70, 71]. In patients with obesity, the course and the progression of hypertension and preeclampsia may be more dynamic and more severe. Therefore, the number and frequency of follow-up visits as well as laboratory tests should be adjusted accordingly. Regular blood pressure measurement, Blood Pressure Diary, and monitoring for symptoms of preeclampsia are essential. The rules for proper blood pressure measurement need to be followed. **In obese women, it is necessary to select adequate size of the cuff to fit the patient arm (the bladder length inside the cuff should be 80% and the width 40% of the patient's arm circumference) [72]**.

Obesity is a known risk factor for preeclampsia and prophylaxis is vital in case of such patients. Meta-analyses of numerous randomized studies demonstrated that administration of acetylsalicylic acid (ASA), initiated late in the first trimester, significantly lowers the risk for preeclampsia [73, 74]. The use of aspirin was associated with an 80% decrease in preeclampsia rates at < 34 weeks and a 63% reduction at < 37 weeks of gestation [75]. Due to a high number (even up to 30%) of pregnant women who are resistant to acetylsalicylic acid at a dose of < 100 mg, **ASA at the dose of 150 mg is advised in the evening** [72]. Preventive measures should be implemented in patients with at least one high-risk factor or two moderate-risk factors (Tab. 6). The use of the Fetal Medicine Foundation (FMF) algorithm, used to calculate individual risk for developing preeclampsia, might be considered, especially in patients with obesity. The screening tests combine medical history, biophysical methods, and maternal serum markers. In case of high risk for PE (preeclampsia), (cut-off > 1:150), prophylaxis using acetylsalicylic acid is recommended.

As the rates of unintended pregnancies remain high, every menstruating woman needs to be treated as potentially pregnant. It is advised to select adequate pharmacotherapy and **avoid using angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, and mineralocorticoid receptor antagonists in reproductive-age women.** Due to limited availability of labetalol and nifedipine (special-request import), methyldopa remains the main medication for hypertensive pregnant women in Poland. It needs to be mentioned that a multi-drug combination therapy is often used to achieve satisfactory control of patient blood pressure (calcium channel blockers, alpha- and beta-blockers). The criteria for pharmacotherapy and target blood pressure values should be tailored to individual patients.

Table 6. Risk factors for preeclampsia

Risk factors for preeclampsia	
Moderate risk	**High risk**
Primipara	HT in previous pregnancy
Age > 40 years	Chronic renal diseases
Interpregnancy interval > 10 years	Systemic lupus erythematosus
Pre-pregnancy BMI > 35 kg/m^2	Antiphospholipid syndrome
History of PE in patient's mother	Type 1 or 2 diabetes
Multiple pregnancy	Chronic HT

HT —Hypertension, BMI — body mass index; PE — Preeclampsia

Thromboprophylaxis

Due to elevated risk for thrombotic complications, **pregnant women with Class III or lower obesity with concomitant risk factors (one high- or two low-risk), should receive thromboprophylaxis with the use of low-molecular-weight heparins, since the beginning of pregnancy and throughout the entire puerperium period, at a pre-pregnancy weight-dependent dose.** The risk should be individually assessed, documented, and discussed during the first antenatal visit, and also during the perinatal period. The risk factors for venous thromboembolism (VTE) in pregnancy are presented in Table 7.

Patients who present with more than two additional risk factors are advised to wear compression stockings. Also, the beneficial role of physical activity should not be overlooked. Early postpartum mobility is recommended in patients with obesity [76, 77].

Recommendations: care during pregnancy

1. Low gestational weight gain is advised in pregnant women with obesity in order to lower the risk for complications during pregnancy and delivery (category B).
2. Obese women should receive reliable information about balanced and diversified diet and the benefits of engaging in moderate-intensity physical activity during pregnancy (category B).
3. Pharmacotherapy with metformin for insulin resistance should not be continued beyond the first trimester of pregnancy (category A).
4. Women with more than one moderate risk factor (BMI ≥ 35 kg/m^2, primipara, maternal age > 40 years, family history of preeclampsia, multiple pregnancy) might benefit from receiving 150 mg/day of aspirin from week 12 to week 36 of gestation (category B).
5. Pregnant women with at least Class II or Class I obesity and additional risk factors should receive thromboprophylaxis since the very beginning of pregnancy, up until day 7 postpartum, with small-molecular-weight heparins, using pre-pregnancy weight-based dosing (category B).

Table 7. Risk factors for venous thromboembolism in pregnancy

High risk factors
Personal history of VTE
Concomitant diseases: malignancy in pregnancy, circulatory failure (NYHA III/IV), active SLE, exacerbation of inflammatory bowel diseases, active inflammatory polyarthritis (*e.g.*, rheumatoid arthritis), nephrotic syndrome > 3.5 g/day, type 1 diabetes with nephropathy, sickle cell anemia, intravenous drug use
High-risk thrombophilia: AT III deficiency, double heterozygous prothrombin gene mutation and factor V Leiden, homozygous factor V Leiden and prothrombin gene mutation, antiphospholipid syndrome
Surgical intervention during pregnancy
Hyperemesis gravidarum with the need of hospitalization
Ovarian hyperstimulation syndrome (only in the 1st trimester)
Morbid obesity
Low risk factors
Low-risk thrombophilia without personal history of VTE: heterozygous factor V Leiden, heterozygous prothrombin gene mutation, protein C deficiency, protein S deficiency.
First-line family history of VTE
Obesity
Large varicose veins (lower extremities, vagina, vulva)
Parity ≥ 3
Smoking
Age > 35 years
Preeclampsia in current pregnancy
Multiple pregnancy
Surgical delivery (cesarean section, VE, forceps, manual extraction of the placenta)
Postpartum hemorrhage (> 1000 mL), or blood transfusion, or Hb drop to 4 g/dL
Graviditas obsoleta in current pregnancy
In vitro fertilization (peri-conception)
Systemic infection with clinical symptoms and elevated inflammatory indices
Immobilization, dehydration
Postpartum proteinuria > 1.0 g/24 h

VTE — venous thromboembolism; NYHA —New York Heart Association, SLE —Systemic Lupus Erythromatosus; AT —Antithrombin, VE — Vacuum extractor

6. Obese women should be tested for carbohydrate intolerance as early as the first antenatal visit (category B).
7. At least four ultrasound tests at 11^{+0}–$13^{+6/7}$, 18–22, 28–3 weeks of gestation and at term are recommended in women with obesity (category A).
8. During each of the above-recommended ultrasound tests, obese pregnant women should be informed about the technical limitations associated with maternal excess weight and the resulting lower effectiveness of detecting fetal structural defects on ultrasound. An annotation about informing the patient, together with pre-pregnancy BMI values, should be included in the test report. A record of all elements whose imaging was either incomplete or impossible, together with recommendations for further management, should be included in the patient ultrasound report. In such cases, and if fetal structural defect is suspected, it is prudent to consider referring the patient to higher-level of care center (category C).

CARE DURING DELIVERY

The center which provides care to pregnant women with obesity should be equipped with proper size and load capacity transport chairs and trolleys, as well as operating tables. Pregnant women with BMI of ≥ 30 kg/m^2 should be informed about elevated risk for perinatal and postpartum complications, including perinatal injury, shoulder dystocia, perinatal hemorrhage, venous thromboembolism, problems with wound healing, and postoperative wound infection. Active management of the third stage of labor is advised in obese women due to higher risk for postpartum hemorrhage [78]. The mode of delivery should be selected to meet the individual needs of the woman, after consulting with the patient and presenting the benefits and risks associated with every mode of delivery.

Labor induction

Recent years have witnessed a notably higher rates of pregnant patients with obesity. Obesity has been demonstrated to be correlated with higher odds for post-term pregnancy [79]. Moreover, it also increases the duration of labor, especially in primiparas [80, 81]. It is believed that myometrial dysfunction might be the cause of higher risk for post-term pregnancy and prolonged labor in that population of patients [82]. As a result, weaker uterine reaction to oxytocin is found in obese women as compared to patients with normal BMI.

As far as induction of labor is concerned, there is no consensus which method — the Foley catheter vs vaginal administration of prostaglandins E2 (PGE2) — is more effective in patients with obesity. In one of the randomized studies, the Foley catheter was found to significantly shorten the duration of labor, but it did not lower the risk for cesarean section delivery [83]. However, Beckwith et al. [84], compared obese women with their normal weight peers and found that the effectiveness of labor induction using the Foley catheter was not significantly different between the groups, whereas prostaglandins were statistically significantly less effective in patients with obesity. However, the amount of data is insufficient to determine which method of labor induction might be more beneficial for women with obesity [85].

In a retrospective cohort study among patients from California (n = 74 725), labor induction in obese women at

term significantly decreased the risk for cesarean section delivery, without increasing the risk for perinatal complications as compared to conservative management [86]. In 2021, the results of the largest retrospective cohort study, which investigated whether labor induction in patients with isolated obesity at 39 weeks of gestation increased the risk for a cesarean section, were published [87]. A total of 1 184 058 pregnant patients with BMI ≥ 30 kg/m^2 were included in that study, which demonstrated that labor induction at 39 weeks of gestation in those patients significantly lowered the risk for cesarean section delivery, without increasing the risk for perinatal complications (OR: 95% CI 0.58–0.60), especially among multiparous women. In light of the abovementioned findings, labor induction at 39 weeks of gestation may be recommended to pregnant women with obesity.

Additionally, it needs to be emphasized that in cases with suspected fetal macrosomia, labor induction does not decrease the risk for a cesarean section, as was demonstrated in the 2016 systematic review of the Cochrane database. In such case, the patient should be informed about the risk associated with fetal macrosomia [88].

Anesthesia during delivery

The patients should receive information about the possibility of technical difficulties with regional anesthesia, and a higher risk for general anesthesia for cesarean delivery if regional anesthesia proves unsuccessful. The anesthesia care team should be informed in advance about hospitalization of obese pregnant patients.

Fetal monitoring during labor

Fetal monitoring during labor may present a challenge in obese patients due to excess adipose tissue within the abdominal cavity. The patients should be informed about potential difficulties with fetal monitoring using CTG. If external cardiotocography proves ineffective, internal CTG (if available) needs to be considered. It is also possible to use ultrasound imaging directly in the delivery room in order to monitor fetal well-being.

Cesarean section

Obesity is not an indication for cesarean section delivery. Subramaniam et al. [89], demonstrated that elective cesarean section in women with Class III obesity does not lower the risk for perinatal complications as compared to women with induced labor. The literature offers no consensus about the preferred technique for cesarean section incision (midline vs. transverse); the technique should be individually adjusted to the patient. However, some authors emphasize the advantage of a longitudinal midline incision, below the umbilicus, over the Pfannenstiel incision, claiming better visualization of the operative field and, in consequence, decreased operative time and blood loss [90]. Obesity constitutes a risk factor for poor postoperative wound healing. The available sources unequivocally recommend suture closure of the subcutaneous tissue if the thickness is > 2 cm to significantly lower the risk for impaired wound healing [91]. **Higher dose antibiotic prophylaxis should be considered in obese patients with BMI of ≥ 30 kg/m^2 and weight of ≥ 120 kg [92]**. Data on the effectiveness of using wound retractor or negative pressure wound therapy in obese patients remain limited [93, 94].

Vaginal birth after previous cesarean section (VBAC)

Pregnant women with obesity are at an elevated risk for failed vaginal birth after earlier cesarean delivery. In a retrospective cohort study, Durnwald et al., demonstrated that only 54.6% of obese women with history of cesarean section managed to deliver vaginally, as compared to 70.5% of women with normal BMI (p = 0.003) [95]. **Class III obesity is associated with higher risk for inter-delivery uterine rupture.** Additionally, emergency cesarean section in obese women is associated with higher risk for perioperative complications as compared to women with normal BMI. Therefore, obese patients with history of caesarean delivery should be informed about all benefits and complications before making the decision to deliver vaginally.

Recommendations: care during delivery

1. Active management of the third stage of labor is advised in obese women due to higher risk for postpartum hemorrhage (category A).
2. Pregnant women with obesity should receive antibiotic prophylaxis during the cesarean section due to higher risk for wound infection (category A).
3. In obese women, subcutaneous tissue layer should be sutured in order to lower the risk for wound infection and dehiscence (category A).

CARE DURING PUERPERIUM

During the puerperium, the risk for complications in obese women increases with BMI values. Obesity-related health problems may require careful patient monitoring during the short postnatal period, as well as support from the medical personnel throughout the entire puerperium. The most common complications result from patient immobility, poor wound healing after cesarean section incision and episiotomy, venous thromboembolism, and problems with breastfeeding. Higher-quality postnatal care may result in improved health outcomes in that group of patients.

Postnatal clinical surveillance

Morbid obesity is a well-known risk factor for respiratory failure [96]. Obesity constitutes a risk factor for hypoventilation and respiratory tract blockage while the patient emerges from anesthesia and during the postoperative time [97]. Due to elevated risk for obstructive sleep apnea and aspiration syndrome, based on patient health, it is prudent to monitor oxygen saturation and breath frequency, especially when narcotic medicines or tranquilizers have been administered [98]. Positioning the headrest at a 45-degree angle may also be beneficial. Temperature monitoring, to detect early signs of infection, and estimation of blood loss volume, to prevent postpartum hemorrhage, constitute essential elements of clinical surveillance.

Early mobility

Early mobility is vital to lower the risk for deep vein thrombosis, pulmonary embolism, respiratory complications, or bed sores, and adequate and effective postnatal analgesia may help to achieve that. Women after cesarean section should be mobilized early and encouraged to use physiotherapy. In that group of patients, it is important to monitor areas of the body where bed sores might develop and, if possible, encourage the woman to change position frequently [76].

Wound care

Regardless of the delivery mode and antibiotic prophylaxis, obese mothers are at a higher risk for infection and wound dehiscence. Infection may affect the following areas: vagina, endometrium, episiotomy, and the cesarean section wound [99, 100]. One in ten obese women present with poor wound healing after a cesarean section. The risk for that complication is approximately 1.5 higher as compared to normal weight women, and increases with BMI values [101, 102]. Extra caution is advised during the interval between day 6 and 12 after a cesarean section in women with BMI of ≥ 50 kg/m^2 [9, 103]. Episiotomy and the abdominal wound should be carefully monitored for signs of infection, hematomas, and wound dehiscence during hospitalization and after the patient is discharged.

Anti-Rh(D) prophylaxis

A few reports have suggested that intramuscular administration of the anti-D immunoglobulin at a standard dose may not be optimal and effective in Rh-D-negative mothers with BMI over 30 kg/m^2. At present, the available data are not sufficient to change immunoglobulin dosing. Immunoglobulin is administered by deep intramuscular injection, so appropriate injection site and length of the needle need to be selected for women with obesity [104].

Thromboprophylaxis

Obesity, pregnancy, puerperium, and cesarean section constitute independent risk factors for developing venous thromboembolism, especially in women with obesity. The risk for VTE increases 5-fold during pregnancy and 60-fold during the puerperium, especially during the first six weeks postpartum [105]. Other factors which increase the risk for VTE include surgical delivery (especially emergency delivery), and other demographic and medical factors (maternal age, smoking, infections, varicose veins, thrombophilia, and postpartum hemorrhage) [106].

Venous thromboembolism is one of the leading causes of maternal morbidity and mortality, especially during the postpartum period [107]. The risk for venous thromboembolism increases with BMI values [108]. Compression stockings and antithrombotic prophylaxis should be considered for all obese women with risk factors for VTE. Pharmacological thromboprophylaxis, dosing and duration of therapy should be individually adjusted.

Antithrombotic prophylaxis should be implemented in all women with Class III obesity (BMI > 40 kg/m^2), regardless of the mode of delivery [109]. Routine antithrombotic prophylaxis is not indicated in patients with Class I and II obesity after vaginal delivery [110]. Proper hydration is necessary and early mobility should be encouraged. While making the decision to start antithrombotic prophylaxis, it is necessary to take into account individual risk factors other than BMI. Low-molecular-weight or unfractionated heparins should be used and the dose should be adjusted to patient weight, not BMI [111]. Early mobility is advised in patients after cesarean section delivery. Patients who experience problems with mobility should be offered a chance to work with a physiotherapist.

Antithrombotic prophylaxis should be considered in all patients with Class I and II obesity after a cesarean section delivery, especially those with additional (one high or two low) risk factors (Tab. 7) [102]. The literature offers no conclusive evidence to support routine dosing and duration of antithrombotic prophylaxis in that population of women. Dosing and duration of the treatment should be individually adjusted, based on the calculated risk. It is advised to continue the antithrombotic prophylaxis at least until the patient has regained full mobility [110].

In patients with BMI of ≥ 30 kg/m^2 and at least two other risk factors, compression stockings for 7 days are advised, apart from low-molecular-weight heparins. Heparin therapy needs to be continued throughout the entire duration of the puerperium, *i.e.* 6 weeks, in women who received antithrombotic prophylaxis during pregnancy [109].

Lactation and breastfeeding

Problems with breastfeeding, delayed and shortened breastfeeding are observed among women with

obesity [112–114]. A Danish cohort study found a link between a BMI index and early cessation of breastfeeding - higher BMI correlated with higher incidence of breastfeeding cessation [115]. Patient constitution may affect breastfeeding in case of obese women. Larger breasts may make it challenging to position the infant comfortably for breastfeeding. Postpartum shifts of fluids may cause breast edema, flat nipples, and difficulty latching [116, 117]. Delayed lactogenesis may be responsible for failure to attempt breastfeeding [118].

Complications during pregnancy and delivery are more often reported among pregnant women with high BMI as compared to normal weight women. Diabetes and caesarean sections are statistically significantly more often observed in that group of women, while their neonates are more often hospitalized at an intensive care unit. In such circumstances, the child is separated from the mother, which is yet another reason why breastfeeding is delayed and stopped [7, 119–121].

Other puerperium-related complications

Women with BMI of > 30 kg/m^2 are more likely to experience postpartum depression, which may also result in maternal unwillingness to breastfeed the child [122]. In accordance with the Ministry of Health directive of 16 August, 2018, about the standards of perinatal care, postnatal assessment of maternal emotional condition, including the risk for postpartum depression, should be performed up to 8 weeks after delivery [123]. The assessment should be performed by a Primary Health Care midwife during the postnatal home visits.

Higher risk for postpartum anemia may also affect the care of a newborn and breastfeeding [124]. Therefore, routine screening for postpartum anemia seems justified in that group of patients.

Lactation support during hospitalization and after the patient is discharged should be considered in order for the obese mothers to start and continue breastfeeding. Women with obesity should be encouraged to breastfeed. It is necessary to emphasize the benefits of breastfeeding both, for the mother and the child, especially since lack of neonatal breastfeeding is yet another, apart from maternal obesity, risk factor for obesity in the offspring.

Recommendations: care during puerperium

1. Early postpartum mobility should be encouraged among obese women to lower the risk for venous thromboembolism (category B).
2. Thromboprophylaxis needs to be implemented in all women with BMI of ≥ 40 kg/m^2 postpartum, regardless of the delivery mode (category D).
3. Preoperative thromboprophylaxis (the dose needs to be adjusted to patient BMI) is advised in all obese women after cesarean section delivery due to higher risk for venous thromboembolism (category C).
4. Screening for postpartum depression and anxiety is recommended as obesity constitutes a risk factor for both these conditions (category B).
5. Women with obesity should have access to a lactation consultant and receive lactation support after delivery (category D).

LONG-TERM RECOMMENDATIONS

Excess weight gain in pregnancy constitutes a significant risk factor for maintaining excessive weight after delivery, which elevates the risk for metabolic disorders and overweight or obesity in the subsequent pregnancies. All women should be made aware that weight reduction between pregnancies is associated with significantly lowered risk for intrauterine fetal demise, hypertension-related complications, and fetal macrosomia. Weight reduction increases the chances for a successful vaginal delivery after cesarean section (VBAC) [125–127]. It has been demonstrated that interpregnancy weight loss in obese women lowers the risk for LGA infant. The literature presents no evidence for elevated risk of SGA infant as long as maternal weight loss did not exceed 8 BMI units [128]. **All obese women should receive advice about dietary approaches to weight management and be encouraged to engage in regular physical activity in order to decrease their weight, and as prophylaxis for diseases associated with the metabolic syndrome [129].** Women who were diagnosed with gestational diabetes should undergo OGTT testing at 6–12 weeks postpartum [130].

Children born to obese mothers present with more fatty tissue as compared to infants born to normal weight mothers. Also, the metabolic syndrome [131] and childhood obesity [132, 133] are more often observed in children born to obese mothers. In a study from Scandinavia, a relationship between higher maternal BMI and elevated risk for asthma in the children was demonstrated [134]. Maternal obesity in pregnancy may be associated with behavioral disorders, attention deficits, hyperactivity, and symptoms related to autism in the offspring [8].

Birth control

Contraceptive counselling is especially important among women with obesity. Safe and effective contraception is vital, as it prevents unintended pregnancy and the risk for pregnancy-related complications is significantly elevated in that group of women, especially in patients with concomitant diseases [135–137].

Obstetric care of obese women — summary
Guidelines of the Polish Society of Gynecologists and Obstetricians on the obstetric care of women with obesity
In light of a steadily growing number of reproductive-age women with obesity, all healthcare centers should be prepared, both in terms of knowledge and equipment, for providing care to obese mothers during pregnancy and labor. Only obese mothers with comorbidities and/or Class III — morbid obesity (BMI ≥ 40 kg/m^2) should be referred to a high level of care center (category D)
Recommendations — pre-conception care
1. Management of obese women with reproductive plans should include body mass reduction to improve fertility and lower the risk for pregnancy-related complications in the mother and the child (category B)
2. Pharmacotherapy for management of obesity should be discontinued during pregnancy (category D)
3. Pregnancy in women after bariatric surgeries should be delayed for 12–24 months after the optimal weight was achieved and stabilized (category B)
4. Folic acid supplementation at a daily dose of 800 ug, including 400 ug of active folates, is advised in obese women with reproductive plans. It is recommended to measure serum folic acid concentration after 4–6 weeks of supplementation and, if the level is < 28 nmol/L, to increase the dose to 5 mg/day, max. up to 12 weeks of gestation (category B)
5. Myo-inositol preparations should also be considered for pre-conception supplementation in women with obesity to lower insulin resistance and to prevent neural tube defects (category C)
Recommendations — care during pregnancy
1. Low gestational weight gain is advised in pregnant women with obesity in order to lower the risk for complications during pregnancy and delivery (category B)
2. Obese women should receive reliable information about balanced and diversified diet and the benefits of engaging in moderate-intensity physical activity during pregnancy (category B)
3. Pharmacotherapy with metformin for insulin resistance should not be continued beyond the first trimester of pregnancy (category A)
4. Women with more than one moderate risk factor (BMI ≥ 35 kg/m^2, primipara, maternal age > 40 years, family history of preeclampsia, multiple pregnancy) might benefit from receiving 150 mg/day of aspirin from week 12 to week 36 of gestation (category B)
5. Pregnant women with at least Class II or Class I obesity and additional risk factors should receive thromboprophylaxis since the very beginning of pregnancy, up until day 7 postpartum, with small-molecular-weight heparins, using pre-pregnancy weight-based dosing (category B)
6. Obese women should be tested for carbohydrate intolerance as early as the first antenatal visit (category B)
7. At least four ultrasound tests at 11^{+0}–$13^{+6/7}$, 18–22, 28–3 weeks of gestation and at term are recommended in women with obesity (category A)
8. During each of the recommended ultrasound tests, obese pregnant women should be informed about the technical limitations associated with maternal excess weight and the resulting lower effectiveness of detecting fetal structural defects on ultrasound. An annotation about informing the patient, together with pre-pregnancy BMI values, should be included in the test report. A record of all elements whose imaging was either incomplete or impossible, together with recommendations for further management, should be included in the patient ultrasound report. In such cases, and if fetal structural defect is suspected, it is prudent to consider referring the patient to higher-level of care center (category C)
Recommendations — care during delivery
1. Active management of the third stage of labor is advised in obese women due to higher risk for postpartum hemorrhage (category A)
2. Pregnant women with obesity should receive antibiotic prophylaxis during cesarean section due to higher risk for wound infection (category A)
3. In obese women, subcutaneous tissue layer should be sutured in order to lower the risk for wound infection and dehiscence (category A)
Recommendations — care during puerperium
1. Early postpartum mobility should be encouraged among obese women to lower the risk for venous thromboembolism (category B)
2. Thromboprophylaxis needs to be implemented in all women with BMI of ≥ 40 kg/m^2 postpartum, regardless of the delivery mode (category D)
3. Preoperative thromboprophylaxis, at a dose adjusted to patient BMI, is advised in all obese women after cesarean section delivery due to higher risk for venous thromboembolism (category C)
4. Screening for postpartum depression and anxiety is recommended as obesity constitutes a risk factor for both these conditions (category B)
5. Women with obesity should have access to a lactation consultant and receive lactation support after delivery (category D)
Long-term recommendations
1. After the delivery, women with obesity should receive nutrition advice and be encouraged to engage in regular physical activity; they should also consider pharmacotherapy or surgical therapy, to reduce their weight and lower the number of complications in the subsequent pregnancy, and prophylaxis for metabolic syndrome-related diseases (category B)
2. Women with obesity should be informed about potentially lower effectiveness of contraceptives in their weight group (category D)

BMI — body mass index

Obesity may alter both, the pharmacokinetics and the pharmacodynamics of oral contraceptives. Peak levels of the contraceptive hormones are lower in women with obesity as compared to their normal weight peers. The effectiveness of oral contraceptives and transdermal patches may be limited due to lower serum concentrations of a given preparation, which results in insufficient levels of hormones to maintain the contraceptive effect. These women should be informed about potentially lower effectiveness of the abovementioned methods [138–140].

Intrauterine devices (IUDS), which contain copper and levonorgestrel (LNG), proved to be highly effective in obese women, and are the method of choice for those patients as far as hormonal contraception is concerned. The half-life of levonorgestrel is prolonged in obese women, and levonorgestrel levels plateau later in normal weight women. Contraceptives have been demonstrated to inhibit ovulation and to effectively prevent pregnancy in most women with obesity. However, they may be associated with a higher failure rate as obesity significantly affects pharmacokinetics [140]. Due to a 2- or 3-fold higher risk for venous thromboembolism, it is always advised to choose a preparation with the lowest available ethinylestradiol content (20–30 µg of ethinylestradiol) when considering hormonal contraceptives for women with obesity [136, 137].

A limited number of reports have indicated that the use of combined contraceptives in women with obesity is not associated with an elevated risk for acute myocardial infarction or stroke, as compared to obese women who do not use such preparations.

Contraceptives containing estrogens should be considered after a thorough analysis of the additional risk factors for VTE, and should not be administered earlier than 4–6 weeks postpartum [141–143]. An etonogestrel implant seems to be effective, irrespective of body weight, although some sources suggest that its pharmacokinetics may be altered in obese individuals.

The use of oral contraceptives, progestogen implants, and intrauterine devices is not correlated with weight gain. Medroxyprogesterone acetate (MPA) is believed to be safe for women with obesity, but caution is advised since MPA has the highest pro-thrombotic activity among the available progestogens [138, 139, 144]. Nevertheless, a link between weight gain and the possibility of menstruation disorders has been reported.

Long-term recommendations

1. After delivery, women with obesity should receive nutrition advice and be encouraged to engage in regular physical activity. Also, they should consider pharmacotherapy or surgical therapy, to reduce their weight and lower the number of complications in the subsequent pregnancy, and prophylaxis for metabolic syndrome-related diseases (category B).
2. Women with obesity should be informed about potentially lower effectiveness of contraceptives in their weight group (category D).

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Data availability statement

All data are available in supplemented literature.

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Conflict of interest

All authors declare no conflict of interest.

Supplementary material

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