

NUTRITION IN PREGNANCY WITH DIABETES MELLITUS

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Abstract: The nutritional needs of diabetic pregnancies are different from normal pregnancies. Differences in nutritional recommendations can also be seen between pregnant women who are using and who are not using insulin therapy. In this literature review, recommendations for different meal proportions of carbohydrates, proteins, and fats in the diets of pregnant women with diabetes mellitus are listed. Different meal plans were also addressed in this group of patients. The role of exercise in the management of diabetes in pregnancy is undeniable and different approaches found in the literature are presented.

Keywords: diabetes mellitus, pregnancy, nutrition.

INTRODUCTION

The main goal of therapy and dietary regime in pregnant women with pregestational and gestational diabetes is to ensure the food needs of the mother and the fetus are in a state of optimal health and euglycemia (1). Educating and encouraging patients in this direction is crucial.

The diet of a pregnant woman with diabetes does not differ significantly compared to the condition before pregnancy. The total daily caloric intake is 7140 - 7560 KJ (1700 - 1800 kcal), assuming that she is not at work, which is a sufficient amount for the good condition of the organism of the mother and the child. Pregnancy should not be a time for losing weight or excessive weight gain (up to 12 kg). Food is divided into 5 - 6 smaller meals according to the principle of proper nutrition in diabetes. Pregnant women who receive insulin according to the scheme of intensive therapy will take meals, as usual, three times a day (2).

If insulin therapy was started during pregnancy, the meals are adapted to the type of insulin and its action. This is a group of pregnant women who need extensive nutrition education because it is a new experience for them (3).

According to the National Academy of Sciences 1990 (4) recommendation on nutrition during pregnancy, the caloric intake should be based on the pregnant woman's pre-pregnancy body weight and rate of progress during pregnancy to determine optimal body weight. For a regular-weight woman, caloric needs are estimated at 36 kcal/kg/day (2200 kcal/day) during the first trimester of pregnancy, with an increase of 40 kcal/kg/day (2500 kcal/day) during the second and third trimesters. Jovanovic - Peterson and Peterson (5), as well as the American Diabetes Association (6) later on, recommend an intake of 30 kcal/kg/day for a woman with normal nutrition (80% to 120% of regular weight), 40 kcal/kg/day for an undernourished woman (< 80% of ideal body weight) and 24 kcal/kg/day for an obese woman (> 120% of ideal body weight), based on the concept of keeping the woman above the threshold for ketonuria while preventing postprandial hyperglycemia.

The caloric needs of obese women with and without diabetes are controversial (7). Although there is caution regarding the potentially harmful effects of maternal ketonemia that occurs with insufficient caloric intake on the fetus, studies in obese pregnant women with diabetes have shown improved pregnancy outcomes with moderate caloric restriction (25 kcal/kg/day or 1800 to 2000 kcal/day). Severe ketosis disrupts the mother's acid-base balance, which is undoubtedly dangerous for both the mother and the fetus. With a

strict restriction of calorie intake (< 1200 kcal/day), ketonemia can occur, and prolonged exposure of the fetus in utero is associated with problems in the neurological development of the newborn. Ketosis can be avoided by feeding smaller and more frequent meals containing slowly absorbing carbohydrates, thereby improving insulin response and delaying lipolysis and ketogenesis between meals.

Carbohydrates, Proteins, and Fats

An intake of 40% to 50% is more appropriate for maintaining glycemia in pregnancy. By using carbohydrates with a lower glycemic index, more than 60% of the total energy needs can be met with them, without a harmful effect on glucose tolerance. Diets with low glycemic indexes are associated with reduced insulin sensitivity. A euglycemic diet designed to alleviate postprandial hyperglycemia is effective. In a pregnancy complicated by diabetes, postprandial hyperglycemia is a major promoter of fetal macrosomia. Women who are insulin resistant may require a reduction in carbohydrate content to 40% of all calories. The diabetic diet is based on the concept that there are two main classes of carbohydrates: simple or refined (glucose, sucrose, and fructose), which are quickly absorbed and cause a relatively large increase in glycemia, and complex or starchy (such as rice, potatoes, vegetables) which are absorbed and digested more slowly and slightly increase glycemia. Complex carbohydrates that contain fiber should replace simple or refined carbohydrates whenever possible (8, 9).

Simple carbohydrates are not recommended in the diet of people suffering from diabetes, except in limited amounts in treating hypoglycemia, acute diseases, and kidney complications, when they serve as energy compensation due to reduced protein intake. Complex carbohydrates are slowly broken down, so blood glucose gradually rises. This is a characteristic of carbohydrates attached to dietary fibers (cellulose, pectin, gum). For people who have enough insulin and eat large amounts of food rich in carbohydrates, the excess energy is converted into fat, which leads to an increase in body weight (10).

In the diet of patients with diabetes, carbohydrates must represent 50 to 60% of the daily energy intake. These must be complex unrefined carbohydrates of vegetable origin.

Fiber is defined as all food components that are resistant to hydrolysis during digestion. They are primarily found in plant foods, including cereals, fruits, and vegetables. There are two types of fiber: water-soluble and water-insoluble. Soluble fibers such as pectin, resin, and polysaccharides affect glycemia and insulin

levels through delayed intestinal absorption and gradually increase glycemia. Foods rich in soluble fiber include fruits, oats, barley, and vegetables. Insoluble fibers such as cellulose, lignin, and most hemicelluloses have a greater effect on gastrointestinal emptying and fecal volume than on plasma glucose and insulin levels. A daily intake of 20 to 35 g of soluble and insoluble fiber is recommended (11).

The recommended protein intake is 65g/day. The optimal amount of protein in the diet has not been determined, although in most diets it ranges from 12% to 20%. This amount must be adapted to the physiological needs of the pregnant woman and the growth and development of the fetus and placenta (12). Since most amino acids are gluconeogenic, a high-protein diet in diabetics is believed to help stabilize glycemia by providing a substrate for glucose production.

To achieve normoglycemia fats can make up more than 40% of daily calorie intake. A diet with a lot of fats is not recommended, considering that they can increase insulin resistance and have a toxic effect on β - cells. Saturated fats, found primarily in animal fats, meat, hydrogenated fats, palm oil, coconut oil, coconut butter, whole milk products, and commercial baked goods, should be reduced to a third of calories or less. Mono-unsaturated fatty acids in grape seed, olive, and peanut oil, should make up a third or more of the calories. The rest of the fat should be made up of polyunsaturated fats found in vegetables and fish oil. Supplementation of fish oil and polyunsaturated fatty acids reduces hypertension and serum triglycerides while slightly increasing LDL cholesterol in patients with diabetes (13). The increase in plasma insulin after the ingestion of a mixed meal accelerates the uptake of ingested triglycerides (TG) by tissues and serves to increase fat synthesis and storage in the liver and adipose tissue.

The influence of glucose intake on the metabolism of free fatty acids (FFA) is different compared to normal pregnancy. Normally in pregnancy, the rise in plasma insulin after glucose intake inhibits lipolysis which reduces the amount of FFA available for lipolysis in skeletal muscle. In patients with type II diabetes, despite the availability of insulin, there is much less suppression of lipolysis during glucose intake due to insulin resistance, and FFA accumulation occurs. Similar metabolic changes have been observed in patients with type I diabetes, mainly due to insulin deficiency, although insulin resistance may contribute in these patients.

The concentration of FFA in the blood is often elevated in patients with diabetes. This phenomenon appears to be due to the accelerated mobilization of fat reserves in the body and may be attributed to re-

duced insulin action. In patients with type II diabetes, an increase in FFA occurs in the presence of normal or elevated insulin levels, indicating resistance to the inhibitory effect of insulin on lipolysis. Increased availability of FFA leads to oxidation in skeletal muscles. Although FFAs cannot be directly converted to glucose, they promote hyperglycemia in diabetic patients by providing the liver with energy fuel and cofactors for gluconeogenesis. FFAs affect glucose disposal in skeletal muscle by activating cellular processes that interfere with insulin signaling (14). In patients with diabetes, the postprandial rise in plasma triglycerides may be elevated and/or prolonged, mainly due to defective storage of triglycerides. Fat intake may contribute to further worsening of glycemic control.

Salt and Liquids

Salt is necessary in the daily diet. It is known that taking a large amount of salt (more than 3g) is a risk for high blood pressure. People with high blood pressure, heart disease, and diabetes who have impaired kidney function should reduce their salt intake to 2.4g to 1.4g per day (15). Adequate fluid intake is a health condition for both healthy people and people with diabetes. This is even more important for people with elevated body temperature, increased sweating, and physical exertion. People with heart disease and those with reduced urine output due to kidney disease must be careful and regulate their fluid balance under the supervision of a doctor.

Meal planning

Although the nutritional needs of women with gestational and pregestational diabetes are the same, there are some differences in the approach to meal planning (2). Individual adjustments in meal planning according to lifestyle, physical activity, cultural habits, and preferences are the cornerstone of successful diabetes nutritional therapy. The recommended caloric intake schedule is similar for gestational and pregestational diabetes (16). However, the number of snacks in women with gestational diabetes is controversial. Some recommend three meals, with only an evening snack, in obese women. Others advise smaller meals with adequate snacks between meals.

The composition of calories in a meal is important for maintaining postprandial glycemia in gestational diabetes. Peterson and Jovanovic - Peterson (5) showed that reducing carbohydrates by 33%, 45% and 40% in breakfast, lunch, and dinner is necessary to maintain glycemic control. With the carbohydrates in the snack, total carbohydrates account for 40% to 50% of calories. No study has shown the effect of a

particular type of carbohydrate or fat on glycemia and pregnancy outcomes.

Three meals and three snacks are therefore considered optimal. Snacks serve to avoid a rapid drop in glycemia as a result of insulin action.

Implementing a proper diet is the basis of treatment for all people with diabetes, regardless of the type of disease. We use the ADA (American Dietetic Association) system for calculating the needs for macronutrients and energy intake. Food is divided into six groups. Each group contains foods with the same characteristics of composition and energy value. The only differences are in the weight of the foods in the same group. The schedule of meals is important so that the smallest time gap between meals is four hours. The portion of carbohydrates in meals should be balanced. It is important to eat less fat, especially cholesterol. It is recommended to avoid frying, baking, and frying food. Food should be prepared by stewing, boiling, baking in foil, on the grill, and using as little fat as possible (16).

Daily food intake is divided into six meals. In patients who are treated only by changing their diet, i.e. in those in whom it is useful to correct weight, the daily food intake should be divided into three meals of low energy value. Three meals are also recommended for patients who are treated with multiple doses of insulin, even though they are fed a standard or increased food intake. The number of insulin doses necessary during the day depends on the number of meals. An exception can be made if the patient is not allowed to take a large daily meal. Patients treated with two doses of mixed insulin per day should take five to six meals, depending on the combination of insulin they receive. If short-acting insulin is taken in the evening in combination with an intermediate-acting one, the sixth meal should be consumed before going to bed to prevent nocturnal hypoglycemia (16).

Foods that should be avoided except in the treatment of hypoglycemia are sugar, honey, chocolate, sweets, drinks with sugar, and all foods with simple carbohydrates (monosaccharides and disaccharides). These foods are easily resorbed and cause an increase in glycemia after a meal. Other foods to avoid are alcohol and animal fats. Foods that can be taken in smaller quantities are fats of plant origin. Foods that can be taken without restriction if there are no other reasons for restriction are herbal spices, pepper, vinegar, lemon juice, and spices without energy value, drinks without added sugar are coffee, tea, mineral water, tonic, and lemonade (17).

In the Diabetes Control and Complications Study (18), several specific dietary regimens were associated with reductions in hemoglobin A1c levels. Adher-

ing to a prescribed meal schedule and adjusting food and insulin to increase blood sugar levels helps reduce HbA1c. In those who did not regularly take a snack in the evening while following specific guidelines in the treatment of hypoglycemia, lower levels of HbA1c were recorded compared to patients who took an additional snack. More frequent glycemic measurement was associated with statistically significantly better control. All patients, especially women with gestational diabetes who are on insulin therapy, should have meal strategies in case of illness, holidays, celebrations, and dinners away from home. Regardless of the meal planning strategy used, all patients must learn to adjust their insulin dose to their carbohydrate intake. These methods allow active control of blood sugar.

Exercise and diet

Excessive treatment of hypoglycemia can cause hyperglycemia and contribute to poor glycemic control. Glucose tablets or gels work much faster than milk and fruit juice and have a similar and consistent glycemic response without causing rebound hyperglycemia. Food diaries or records that patients make periodically are useful in identifying foods or situations that affect glycemia. Patients and nutritionists can develop a strategy to prevent hyperglycemia and hypoglycemia by choosing more adequate food, portions, or meals during the day (19).

Women should be encouraged to continue physical activity with the consent of a perinatologist. The optimal time for exercise is 60 to 90 minutes after a meal for a patient with gestational diabetes and those with pregestational diabetes. A regular schedule of physical activity can be an integral part of the overall treatment and does not require changes, but additional and occasional exercise may require a higher food intake. As with fasting, during exercise, there is a need to create endogenous fuels to meet the increased needs of the tissues. During exercise, energy primarily comes from the liver, which can increase glucose production by 300 to 500%. Hepatic glucose production is precisely regulated to maintain normal levels of circulating glucose despite increased consumption by skeletal muscle. During exercise, FFAs are also mobilized from adipose tissue to reduce the depletion of limited hepatic glycogen stores. The body stores these glycogen reserves for the needs of the CNS. As physical activity continues, FFA consumption assumes an increasingly important role in meeting the needs of skeletal muscle. This spares the liver further demands for glucose production, which, after prolonged exercise, occurs to a greater extent from gluconeogenic precursors, such as protein-derived amino acids (20).

During exercise, insulin secretion is decreased, the sympathetic nervous system is activated, and several counterregulatory hormones are increased, including glucagon, cortisol, growth hormone, and catecholamines (epinephrine, norepinephrine). These hormones have their highest values during intense physical exertion. This hormonal milieu promotes the mobilization of glucose and FFA from the liver and adipose tissue, providing the necessary fuel for muscle tissue. Non-hormonal mechanisms are also important: increased fuel consumption by the muscle is mediated by local non-hormonal mechanisms, including increased mobilization of glucose transport proteins (eg. GLUT 4) to cell surfaces (21, 22).

Studies using radio-labeled glucose have helped to clarify the mechanism of the effect of physical activity on lowering glycemia in patients with diabetes. Normally, physical activity leads to a significant increase in glucose uptake by skeletal muscle. Glycemia remains unchanged because hepatic glucose production increases to compensate for increased peripheral glucose consumption. This process is mediated by a drop in insulin levels and activation of the sympathetic nervous system, as well as the release of counter-regulatory hormones. In diabetic patients receiving exogenous insulin, circulating insulin levels may remain inappropriately high during exercise. Exercise can enhance the absorption of insulin from subcutaneous injection sites. Relative hyperinsulinemia prevents compensatory increases in hepatic glucose production and may enhance glucose uptake by exercising muscles. The net effect is potentially dangerous hypoglycemia (23).

The clinical benefit of the acute glycemic-lowering effects of exercise in patients with type I diabetes is limited. Unless exercise is regular and of appropriate intensity and duration, few long-term effects in improving glycemic control can be expected. Hypoglycemia is a common complication of strenuous exercise in patients with type I diabetes. The rapid rise in counterregulatory hormones, together with the diabetic patient's increased response to these hormones and the tendency to overeat when symptoms occur, can lead to hyperglycemia. In clinical practice, intermittent exercise may cause large glycemic fluctuations instead of the desired effects of improving glycemic control (24).

The main difference in gluconeogenesis between subjects without diabetes and patients with type I diabetes is quantitative. During short-term exercise in subjects without diabetes, increased hepatic glucose production is mediated by accelerated glycogenolysis while the rate of gluconeogenesis remains unchanged. Patients with diabetes show a rapid increase in gluconeogenesis during exercise. In healthy people, these changes can only be induced by prolonged periods of

exercise (2 to 4 hours). The effect of exercise in insulin-deficient diabetic patients is to increase the gluconeogenesis that characterizes diabetes. In patients with type II diabetes, there is a more favorable risk-benefit ratio of planned physical activity compared to insulin-dependent patients. In patients with type II diabetes, regular aerobic exercise improves insulin sensitivity and may have beneficial effects on both long-term glycemic control and microangiopathy. Because patients with type II diabetes retain some degree of endogenous insulin regulation, there is a reduced tendency for sudden and extensive changes in glycoregulation during exercise. An aerobic exercise program is routinely recommended for most patients with type II diabetes, and exercise is advised for patients with type I diabetes, mainly to delay cardiovascular complications (25).

CONCLUSION

Food should be divided into 5 - 6 smaller meals according to the principle of proper nutrition in diabetes. If insulin therapy was started during pregnancy, the meals are adapted to the type of insulin and its

action. By using carbohydrates with a lower glycemic index, more than 60% of the total energy needs can be met with them, without a harmful effect on glucose tolerance. Diets with low glycemic indices are associated with reduced insulin sensitivity. A euglycemic diet, designed to alleviate postprandial hyperglycemia is effective. A high-protein diet in diabetics helps to stabilize glycemia by providing a substrate for glucose production. A diet with lots of fats is not recommended, considering that they can increase insulin resistance and have a toxic effect on β - cells. Salt intake must be strictly controlled, and alcohol intake must be stopped. Exercise is of great importance in diabetes prevention and management during pregnancy.

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Sažetak

ISHRANA TRUDNICA SA DIJABETESOM

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Nutritivne potrebe kod trudnoća opterećenih dijabetesom razlikuju se od fizioloških trudnoća. Razlike u nutritivnim preporukama se mogu videti i između trudnoća koje koriste i koje ne koriste insulinsku terapiju. U ovom pregledu literature navedene su preporuke za različitu zastupljenost ugljenih hidrata, proteina

i masti kod trudnoća sa dijabetes melitusom. Obradeni su i različiti planovi obroka u ovoj grupi pacijenata. Uloga vežbanja u kontroli dijabetesa u trudnoći je neosporna i predočeni su različiti pristupi pronađeni u literaturi.

Ključne reči: diabetes melitus, trudnoća, ishrana.

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