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Physical activity is an important element in the prevention and treatment of diabetes. Part I

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Abstract
Objective: Review about current knowledge in the role of physical activity in diabetes management.
State of the Art: Recent years have brought a very rapid development of methods of monitoring and controlling glucose homeostasis. It is associated with a significant tightening of the metabolic control criteria in patients with diabetes. In assessing the factors influencing this alignment, attention is drawn to the importance of physical activity. This applies to all groups of patients with impaired glucose metabolism, but especially attention is paid to adolescent diabetic patients and pregnant women. In these groups of patients, maximum metabolic control is of particular importance.
Clinical Implications: This review points out the important role of physical activity in the prevention of diabetes and the management of patients with diabetes
Conclusions: Physical activity plays an important role in maintaining glucose homeostasis. It is a very important element in the treatment of disorders of this homeostasis. In addition to diet, an increase in physical activity should be implemented as early as possible.
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I. Introduction

The mechanisms for maintaining glucose homeostasis in the organism are varied. One of them is, of course, an adequate supply of glucose or products from which it can be obtained. A very important factor in maintaining glucose homeostasis is insulin. The influence of insulin on glucose metabolism is associated with both insulin deficiency and insulin malfunction. Insulin deficiency results either from damage to the pancreas by mechanical or pathological factors. [1,2]
Another cause may be dysfunction of insulin-producing β-cells, which is most often the result of autoimmunity. [3]

The cause of impaired glucose homeostasis, in states where insulin production is preserved or even increased, is insulin resistance. [4,5,6]
A prerequisite for the biological activity of insulin is its ability to bind to a specific insulin receptor on the surface of the effector cell.Such impairment of insulin action leads in consequence to the development of diabetes mellitus. Currently, several types of diabetes are distinguished. [7,8,9].
The most common is autoimmune diabetes mellitus, in which we deal with insulin deficiency. We highlight 'classic' type 1 diabetes, occurring in children and adolescents, and LADA, i.e. late-onset autoimmune diabetes. [10]

II. Objective:

Review about current knowledge in the role of physical activity in diabetes management

The role of muscle in maintaining glucose homeostasis.

Muscle tissue is thought to be a major regulator of systemic glucose homeostasis. The initial step of glucose utilization requires glucose transport into cells. The insulin-receptor complex stimulates glucose uptake by cells.

In the well-nourished state, muscle contains approximately 1% of its mass as glycogen. Because of its mass, muscle contains almost four times more glycogen than liver. Muscle glycogen is not directly available as a source of blood glucose because muscle does not have glucose-6-phosphatase. During muscle activity, glycogen is converted in the liver to lactate and then to glucose in the blood. Insulin in muscle promotes the oxidation, storage, and disposal of glucose and is involved in maintaining glucose homeostasis. Patients with diabetes are characterized by insulin deficiency (type 1 diabetes) or peripheral insulin resistance (type 2 diabetes) manifested by reduced insulin action on glucose utilization in muscle. Muscle tissue is thought to be a major regulator of systemic glucose homeostasis.[11]Many factors influence the metabolic processes in muscle tissue, among them are genetic factors. Substrate concentration also has an important role in regulating these processes. Hormonal regulation has a very important role in muscle metabolism, one of the most important hormones is insulin. An important role in metabolic processes in muscles is their participation in protein metabolism. Muscle also performs an important role in fat metabolism. Among the most common conditions associated with abnormal insulin secretion or action is diabetes. As mentioned earlier, the type of these abnormalities varies depending on the substrate of diabetes development. [7]

In autoimmune diabetes, i.e. classical type 1 diabetes and LADA (Latent Autoimmunological Diabetes in Adults), endogenous insulin secretion is reduced due to cell destruction. Other forms of diabetes have a different basis for insulin dysfunction. These forms primarily include type 2 diabetes. In this type, insulin resistance is usually present initially. In response, there is an increase in insulin secretion and hyperinsulinemia. This condition changes over time and insulin secretion is reduced. The course of these processes varies widely. [9]In the process of treatment of disorders of glucose homeostasis, in addition to dietary treatment and pharmacotherapy, due to the very important role that skeletal muscles play in metabolic processes, activation of their function plays a significant role in the treatment of these disorders. [12.13]

The importance of physical exercise in the treatment of disorders of glucose homeostasis.

The importance of physical exercise in the treatment of diabetes has been known for a very long time. The encyclopaedia of Aulus Cornelius Celsius, dating back to 25 BC-50 AD, already recommends patients with diabetes to exercise.

Physical activity not only increases the body's glucose consumption making it easier to maintain normoglycemia, but also improves fat metabolism. Physical activity also increases the sensitivity of tissues, especially muscles, to insulin.

An extensive discussion of methods of physical activity in adolescent patients with type 1 diabetes was recently presented by Polish authors, who presented recommendations for physical activity and reviewed contemporary methods of its assessment.[14]

The most common determinant used to measure training intensity is MET - metabolic equivalent of task. This concept is defined as the amount of oxygen consumed during rest and is equal to 3.5 ml of O2 per kilogram of body weight for one minute.

Guidelines have recommended using metabolic equivalent oftask (METs) as reference thresholds of absolute intensities (light, <3.0 METs; moderate, 3.0 - 5.9 METs; vigorous 6.0 METs) [3], however, its validity parameters are not available in theliterature.[15]

Studies have shown that all physical activities that consume more than 3 MET units have been shown in studies to reduce the risk of complications of many chronic diseases.

The physical activity recommended program depends on the type of glucose metabolism disorder.

Among patients with impaired glucose homeostasis there are three main groups with different needs and abilities.

- One of them is patients with diagnosed and treated type 1 diabetes. These patients are usually young. They are treated with insulin and now usually with continuous infusion (CSII) using insulin pumps. These patients usually have continuous glycemic measurement (CGM). [16,17]

This greatly facilitates glycemic control during exercise.The primary impediment to glucose homeostasis in these patients is usually hypoglycemia; therefore, it is important to adequately protect the patient prior to exercise, as well as to control blood glucose after exercise and, in the case of prolonged physical activity, during exercise.A comprehensive discussion of the influence of physical activity on glucose homeostasis in adolescent diabetic patients is presented in the ISPAD guidelines.[18]

- Patients with type 2 diabetes are usually elderly, overweight or obese. These patients most often have variously advanced chronic complications of diabetes or associated conditions. Physical activity reduces the risk of developing second type diabetes due to weight reduction and improved insulin sensitivity.
- The third group of patients with impaired glucose homeostasis are patients who have gestational diabetes. In these patients it is very important to diagnose them as early as possible and to implement treatment together with systematic physical activity. We should also not forget about the prevention of overweight and obesity before pregnancy.

III. Conclusion

Physical activity plays an important role in maintaining glucose homeostasis. It is a very important element in the treatment of disorders of this homeostasis. In addition to diet, an increase in physical activity should be implemented as early as possible in patients with glycemic disturbances regardless of their underlying cause. The program of physical activity should be adjusted to the degree of glycemic disturbances, the patient's age, and the general state of health. The activity program should be established under the supervision of a rehabilitation facility.

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