

THE INFLUENCE OF INTESTINAL MICROBIOTA ON GLUCOSE METABOLISM

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Annotation

The article examines the relationship between the state of the intestinal microbiota and the regulation of glucose metabolism. It highlights the mechanisms by which intestinal microbes affect insulin sensitivity, inflammation, and energy homeostasis. It describes the factors that change the composition of the microbiota and their consequences for the risk of developing type 2 diabetes. It presents modern methods for correcting the intestinal microflora and the possibilities of using probiotics and prebiotics in the prevention of carbohydrate metabolism disorders. It emphasizes the potential of the microbiota as a therapeutic target in the future.

Keywords

gut microbiota, glucose metabolism, insulin resistance, probiotics, prebiotics , type 2 diabetes, SCFA, dysbiosis , inflammation, gut barrier, glucose, lipopolysaccharides , microbiome , metformin , metabolic syndrome

Gut microbiota is a collection of microorganisms that inhabit the human gastrointestinal tract. In recent years, it has become clear that microbiota plays a critical role not only in digestion, but also in metabolic regulation, including glucose metabolism.

The relevance of the topic is due to the global increase in the number of patients with metabolic diseases, primarily type 2 diabetes, as well as the insufficient effectiveness of traditional therapy without taking into account the state of the microbiota. **The purpose of the study** is to analyze the mechanisms of the influence of intestinal microbiota on glucose metabolism and consider the prospects for using microbiome technologies in the prevention and treatment of carbohydrate metabolism disorders.

Content

The intestinal microbiota consists of trillions of microorganisms - bacteria, viruses, archaea and fungi, which outnumber the cells of the human body. The most represented bacteria are Firmicutes , Bacteroidetes , Actinobacteria and Proteobacteria . In a healthy adult, the microbiota is highly diverse, stable and capable of regulating various

functions: fermentation of dietary fiber, synthesis of vitamins, modulation of immunity, protection from pathogens.

The role of microbiota in glucose homeostasis.

Research shows that gut bacteria influence carbohydrate metabolism not only indirectly, through the modulation of inflammation or body weight, but also directly through the synthesis of metabolites that act on receptors and hormonal systems in the body. SCFA and glucose metabolism. SCFA (short-chain fatty acids), especially butyrate, propionate and acetate, are products of the fermentation of dietary fiber by bacteria. Butyrate activates AMPK (5' AMP-activated protein kinase) in the liver and muscles, increasing insulin sensitivity. Propionate stimulates the production of incretins (GLP-1 and PYY) by enteroendocrine cells, which helps reduce appetite and improve insulin secretion. Acetate regulates glucose levels in the liver and affects fat metabolism. Incretin system and microbiota. GLP-1 and PYY are hormones secreted by intestinal L-cells and are important regulators of glycemia. Their secretion is enhanced by exposure to certain microbes and SCFA, improving the postprandial insulin response. Inflammation and insulin resistance.

Microbiota imbalance can lead to dysbiosis, which increases the permeability of the intestinal barrier. Lipopolysaccharides (LPS), entering the bloodstream, cause chronic systemic inflammation and insulin resistance. This process is called metabolic endotoxemia. Bile acids and microbiota. Bile acids metabolized by bacteria activate FXR and TGR5 receptors, which regulate glucose and lipid levels. Disturbance of the balance of these acids in dysbiosis worsens glycemic control.

Experimental and clinical studies

Numerous studies confirm the influence of microbiota on carbohydrate metabolism: In the study Qin et al. (2022) in patients with type 2 diabetes, a decrease in *Akkermansia* was observed, *Muciniphila* and *Roseburia*, which was associated with high glycemia and inflammation. In an experiment with a transplant of fecal microbiota from a healthy donor to patients with metabolic syndrome, an improvement in insulin sensitivity was recorded after just 6 weeks. In volunteers taking probiotics with *Lactobacillus casei*, after 12 weeks, statistically significant reductions in fasting glucose and HOMA-IR (insulin resistance index) were observed.

Drug intervention: metformin and microbiota

Metformin, in addition to its direct glucose-lowering effects, actively modulates the microbiota. It increases the amount of *Akkermansia muciniphila*, a bacterium that strengthens the intestinal mucus barrier. This interaction improves insulin sensitivity, reduces inflammation, and enhances GLP-1 production.

Prospects for therapy through microbiota

New approaches to correct glucose metabolism through microbiota include:

Use of prebiotics and probiotics that restore microbial balance and reduce insulin resistance. Symbiotics (combination of probiotics and prebiotics) show promise in combination therapy. Fecal microbiota transplant (FMT) is being investigated as a treatment for refractory metabolic syndrome. Diet therapy: consumption of plant fiber, polyphenols and avoidance of excess fat promote the growth of butyrate-producing bacteria. Limitations and problems

Despite promising data, challenges remain: individual differences in microbiota make a universal approach difficult; insufficient duration of clinical studies; limited knowledge of microbes with unknown functions (about 40% of the microbiome is not cultured); the need to develop safe and standardized microbiome-targeted drugs.

Microbiota and glucose metabolism: biological mechanisms

Gut microbiota influences glucose metabolism through several key mechanisms:

Production of short-chain fatty acids (SCFA) such as butyrate, acetate and propionate, which regulate the secretion of incretins (GLP-1), improve insulin sensitivity and modulate inflammation. Modulation of intestinal barrier permeability. Dysbiosis increases the penetration of bacterial products (eg, lipopolysaccharides), which causes systemic inflammation and insulin resistance. Effects on gene and receptor expression. Some microbes activate receptors that regulate energy metabolism (eg, GPR41, GPR43), affecting hepatic glucose synthesis. Bile acid metabolism, which affects glucose homeostasis via FXR and TGR5 receptors.

Factors Affecting Microbiota

The composition of the microbiota changes under the influence of: diet (excess fat and sugar reduces diversity); antibiotics (disrupt the balance of microbes); lifestyle (stress, sedentary lifestyle); chronic inflammation and gastrointestinal diseases.

Microbiota and type 2 diabetes. Patients with type 2 diabetes show characteristic changes in the microbiota: a decrease in the number of “butyrate-producing” bacteria

(*Faecalibacterium prausnitzii* , *Akkermansia muciniphila*) and an increase in opportunistic strains. Studies show that fecal microbiota transplants from a healthy donor can improve insulin sensitivity in recipients with metabolic syndrome.

Drugs and microbiota
Metformin , the standard drug for type 2 diabetes, not only lowers glucose levels but also modifies the microbiota, increasing the number of beneficial bacteria. This is part of its hypoglycemic action.

Probiotics, prebiotics and nutrition The following are used for prevention and therapy: probiotics (*Lactobacillus* , *Bifidobacterium*); prebiotics (inulin, resistant starch); symbiotics (a combination of the first two); a high- fiber diet (promotes the growth of beneficial microflora). The results of clinical studies show a moderate but statistically significant improvement in glycemic control with long-term use of probiotics.

Conclusions

Gut microbiota is an important regulator of glucose metabolism, and its imbalance can contribute to the development of insulin resistance and diabetes. Early diagnosis of dysbiosis and correction of microbiota using nutrition, probiotics, and drugs can be an effective strategy for preventing carbohydrate metabolism disorders.

Integration of microbiome technologies into clinical practice opens up new horizons in the treatment of metabolic diseases. Prevention of metabolic disorders should begin with an assessment of the state of the microbiota as a key link in pathogenesis.

Literature

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