PERSPECTIVE

The impact of gut microbes on diabetes

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ABSTRACT

Diabetes Mellitus (DM) is a metabolic condition with a startlingly high occurrence rate that places a significant burden on both the patient's life and the lives of those who offer medical treatment. It is characterised by an increase in blood glucose levels and insulin resistance. Urbanisation, obesity, and genetic mutations are examples of internal and environmental variables that may raise the chance of developing DM. Microbes in the stomach have an impact on nutrition and immunity, which affects general health. More research has been done recently to assess and estimate the part played by the gut microbiome in the onset, progression, and management of diabetes. This article provides an overview of the present understanding of three major bacterial species. Diabetes Mellitus (DM) is a metabolic disorder that has an astonishingly high prevalence rate and has a substantial negative impact on both the lives of the patient and those who provide medical care. Insulin resistance and a rise in blood glucose levels are its defining characteristics. Examples of internal and environmental factors that may increase the risk of having DM include urbanisation, obesity, and genetic mutations. Stomach microbes have an effect on immunity and nutrition, which has an effect on overall health. More studies have recently been conducted to evaluate and estimate the role that the gut microbiome played in the development, progression, and management of diabetes. An overview of the current knowledge of three significant bacterial species is provided in this article.

Key Words: *Bifidobacterium adolescentis*; *Bifidobacterium bifidum*; *Diabetes*; *Gut, Health*

INTRODUCTION

Diabetes Mellitus : one of the biggest causes of morbidity and mortality worldwide is diabetes mellitus. Hyperglycemia, an increase in blood glucose levels brought on by a problem with insulin secretion and/or action, is one of its primary symptoms. It is a chronic metabolic disorder Type 1, type 2, and gestational diabetes are the three primary forms of diabetes, according to their genetics, aetiology, and diagnostic criteria . The patient's quality of life is severely impacted by their difficulties in a number of organs, including the heart, eyes, and kidneys. The signs of diabetes can include polyuria, polyphagia, polydipsia, and weight loss, depending on the kind and length of the disease. One of the biggest causes of morbidity and mortality worldwide is diabetes mellitus. Hyperglycemia, an increase in blood glucose levels brought on by a problem with insulin secretion and/or action, is one of its primary symptoms. It is a chronic metabolic disorder. Type 1, type 2, and gestational diabetes are the three primary forms of diabetes, according to their genetics, aetiology, and diagnostic criteria. The patient's quality of life is severely impacted by their difficulties in a number of organs, including the heart, eyes, and kidneys. The signs of diabetes can include polyuria, polyphagia, polydipsia, and weight loss, depending on the kind and length of the disease.

Gut microbiome and diabetes

There are 100 trillion different bacterial species in the digestive system that make up the human gut microbiome. Both internal and environmental factors, including genetics, nutrition, and drugs, affect it . Through nutrition, physiology, and immunity, the gut microbiome affects an individual's general state of health . Diabetes is one of many clinical disorders connected to disruption in the diversity of the gut microbiome. Lipopolysaccharide is transported as a result of gut dysbiosis and increased gut permeability, which can activate the innate immune system .

Gut microbial profile in diabetes

The gut contains 60%–80% of the species from two important phyla, *Firmicutes* and *Bacteroides*. Numerous pathological changes have been connected to variations in their abundance. The amount of Firmicutes was substantially greater in the control group compared to the diabetic group in a study involving 36 male participants, 18 of whom had diabetes (p-value = 0.03). This raises the possibility of a link between the composition of the gut microbiota and diabetes. Additionally, the diminished levels of butyrate-producing bacteria, such as *Clostridiales sp.*, affect diabetic

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patients' low-grade inflammatory response, insulin sensitivity, and glucose and fat metabolism. Some bacterial species, such as *Lactobacillus*, have been linked to diabetes not only at the phylum level but also because they positively correlate with fasting blood glucose and glycosylated haemoglobin. More work is needed overall because the results of various cohort studies were inconsistent. Recently, the gut-brain axis in the treatment of diabetes has drawn increased interest because it may hold promise. Through communication with brain regions that regulate energy, the gut microbiome has a significant impact on the glucose homeostasis pathway. This demonstrates how significant the metabolites created by the gut microbiota are.

Diabetes management using microbial species

Significant gut dysbiosis is linked to the onset of diabetes. Diabetes has been shown to be improved by reestablishing the equilibrium of the gut microbiome composition by giving probiotics (live nonpathogenic microorganisms) in an adequate dosage. The effects of taking probiotics for diabetes have been described in a number of human and non-human research. For instance, probiotic yoghurt containing L. acidophilus La5 and B. lactis Bb12 was administered to diabetic individuals who showed a reduction in fasting blood glucose, insulin, insulin resistance, and glycosylated haemoglobin levels. The onset of diabetes is associated with significant gut dysbiosis. It has been demonstrated that treating diabetes with probiotics (live, nonpathogenic microorganisms) in a sufficient dosage can restore the gut microbiome's composition to balance. Numerous human and non-human research studies have described the effects of taking probiotics for diabetes. For instance, diabetic people who consumed probiotic yoghurt containing L. acidophilus La5 and B. lactis Bb12 demonstrated lower levels of fasting blood sugar, insulin, insulin resistance, and glycosylated haemoglobin. However, similar outcomes were seen when the probiotic was administered to animal models.

In a mouse model of type 2 diabetes, the treatment of Bifidobacterium for one month and Lactobacillus for three months was found to normalise glucose metabolism and insulin sensitivity. Safety and tolerability are two issues with probiotic medication. The use of probiotics was safe, according to all the research mentioned, which found no negative effects. Despite this, additional work is needed to standardise the process and determine the appropriate dosage.

The influence of specific microbial species on diabetes

The impact of three bacterial species—*Bifidobacterium adolescentis*, *Bifidobacterium bifidum*, and *Lactobacillus rhamnosus*—on diabetes mellitus is covered in numerous studies throughout our research. Here, we go into great detail about each one and explain how they work to treat diabetes.

1. *Bifidobacterium adolescentis:* The earliest bacteria to colonise the baby gut are known to be *bifidobacteria*, which are Gram-positive, non-spore-forming, and non-motile. They inhibit intestinal inflammation, colonic inflammation, and other favourable effects on the host due to their existence in the gut. The earliest bacteria to colonise the baby gut are known to be bifidobacteria, which are Gram-positive, non-spore-forming, and non-motile. They inhibit intestinal inflammation, colonic inflammation, and other favourable effects on the host due to their existence in the gut.
2. *Bifidobacterium bifidum:* One naturally occurring microbiota species found in breastfed newborns is *Bifidobacterium bifidum*. It is regarded as the gut population's dominant resident Glycosyl Transferases (GTs), Glycosyl Hydrolases (GHs), and Carbohydrate Esterases (CEs) are only a few of the 3000 carbohydrate enzymes that are encoded by the *B. bifidum* genome . This demonstrated *B. bifidum's* capacity to metabolise glycans produced from the host, including mucus and oligosaccharides found in human milk . Recently, the use of *B. bifidum* in the treatment of diabetes has begun to receive more scientific attention. In Wistar rats, fasting blood glucose, glycosylated haemoglobin, Triglycerides (TG), and total cholesterol were all decreased by a single injection dose of 1107 cfu/mL every day for 28 days .
3. *Lactobacillus rhamnosus:* The 1983 discovery of *Lactobacillus rhamnosus* led to its widespread recognition for both its potent affinity for intestinal cells and its resistance to stomach acid. As a powerful probiotic, it has been widely utilised to treat a variety of pathological illnesses, including cancer For four weeks, daily administration of *L. rhamnosus* (1108 cfu/mL) to rodents improved glucose tolerance by lowering endoplasmic reticulum stress Additionally, treating mice with 109 cfu/mL of *L. rhamnosus* daily significantly decreased fasting blood glucose and insulin levels in animals fed a high-fat diet. Pro-inflammatory cytokines including IL-6 and TNF-a were also decreased.

DISCUSSION

A metabolic disorder with a high prevalence rate worldwide is diabetes. It is essential to create novel and enhanced therapeutic strategies to combat the illness and its complications. Recently, the gut microbiome and diabetes have been connected. Here, we reviewed the literature and discussed how the three most frequently discussed *Bifidobacterium adolescentis, Bifidobacterium bifidum, and Lactobacillus rhamnosus* are three microbial species that affect diabetes. Studies on both animals and people found that *Bifidobacterium adolescentis* supplementation had a dose-dependent effect on blood glucose level, the quantity of short-chain fatty acids, and inflammatory response, ranging from 1 108 to 5 108 CFU/mL. Additionally, giving *Bifidobacterium bifidum* (1107 CFU/mL–2109 CFU/mL) decreased fasting blood sugar. We found a lack of standardisation in the literature with regard to the protocol utilised, the model employed, the diet used to cause diabetes in animal models, and the manner of administration, with the majority of research using oral or intraperitoneal delivery. To progress the field, standardised protocols that outline precise instructions should be established. The literature also reveals that many research focus on a particular microbial species. A population of microorganisms interacting with each other and the human body is known as gut microbiome.