

# The Relationship between Diabetes and Intestinal Microbiota

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**Abstract:** *In recent years, the impact of intestinal microbiota on human health has attracted much attention. More and more evidence suggests that Intestinal microbiota are associated with many diseases. Therefore, this review briefly summarizes the current evidence of the relationship between diabetes and intestinal microbiota.*

**Keywords:** intestinal microbiota, diabetes, insulin resistance

## 1. Introduction

Intestinal microbiota is a complex cell population. The intestinal microbiota community includes approximately  $10^{14}$  bacteria in the entire gut of a healthy individual[1]. In humans, the number of Intestinal microbiota cell that from different bacterial species is greatly exceeds the number of human cells of the body by 10-fold[2]. The main bacterial phyla in normal intestinal microbiota are Firmicutes and Bacteroidetes, followed by Actinobacteria and Verrucomicrobia [3-5]. Many studies have shown that intestinal microbiota is involved in body metabolism, fat storage and insulin sensitivity, and thus, is associated with obesity, diabetes and other metabolic diseases.

In recent years, the incidence of metabolic diseases, in particular diabetes increased [6,7]. There are many types of diabetes and type 2 diabetes mellitus (T2DM) accounts for at least 90% of all diabetes cases in the adult population [8]. At present, it is widely accepted that the increased risk of diabetes can not only be attributed to human genes, diet, nutritional status, the average life expectancy, or reduction of normal exercise, and accumulating studies have shown that there is a close relationship between intestinal microbiota and diabetes.

The present review briefly summarizes the current studies of the relationship between diabetes and intestinal microbiota. Backhed et al. found that conventionalization of adult germ-free C57BL/6 mice with a normal microbiota from the distal intestine of conventionally raised animals produces a 60% increase in body fat content and insulin resistance within two weeks despite reduced food intake, which suggest that the intestinal microbiota is an important environmental factor that affects energy harvest from the diet and energy storage in the host[9]. Through modulating intestinal microbiota of mouse by using antibiotics, Chou et al. found that modified intestinal microbiota was linked to the reduced liver triglycerides, increased liver glycogen and improved glucose tolerance [10]. In another study by Rabot et al. they compared the metabolic consequences of high-fat feeding on germ-free and conventional mice and found that germ-free mice consumed fewer calories, excreted more

fecal lipids, and weighed significantly less than conventional mice, indicating the involvement of intestinal microbiota in insulin resistance [11]. A similar study using metagenomic and biochemical analyses also demonstrated that these changes affect the metabolic potential of the mice intestinal microbiota [12]. The results of these animal experiments have shown that intestinal microbiota can the impact insulin resistance, and thus affect the occurrence of diabetes. In addition, obesity is a state of chronic low-grade systemic inflammation, which is a well-known cause of insulin resistance [13]. A recent study suggested that poor diversity of intestinal microbiota is also associated with obesity and insulin resistance [14].

One study from the Ethical Committee of Copenhagen and Frederiksberg Municipalities suggested the number of bacteria in the intestinal microbiota of diabetic patients is different from that of normal subjects[15]. On the basis of deep shotgun sequencing of the intestinal microbiota from 345 individuals, it was demonstrated that patients with type 2 diabetes were characterized by a moderate degree of intestinal microbial dysbiosis, a decrease in the abundance of some universal butyrate-producing bacteria and an increase in various opportunistic pathogens, as well as an enrichment of other microbial functions conferring sulphate reduction and oxidative stress resistance[16].

Although many studies have shown that intestinal microbiota and diabetes are closely related, the mechanisms underlying the relationship are complex and need to be elucidated. At present there are several possible factors to be involved, including bile acid metabolism[17,18], lipopolysaccharides [19-22], short chain fatty acids[23-26]. In recent years, intestinal microbial has been proposed to be a promising target to prevent and treat diabetes. Several studies have shown that probiotics and prebiotics play an important role in the amelioration of T2DM [27,28].

## 2. Conclusion

In conclusion, accumulating evidence supports the relationship between intestinal microbiota and diabetes. Future efforts to fully understand the mechanisms underlying the relationship between intestinal microbiota

and diabetes will provide more useful information for exploring the intestinal microbiota-associated prevention and therapy for diabetes.

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