International Journal of Research in Medical Sciences
Neela CK et al. Int J Res Med Sci. 2025 Jun;13(6):2719-2724
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20251675

Review Article

Balancing the gut, shedding the weight: probiotics for adolescent obesity - a narrative review

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Received: 02 April 2025
Accepted: 06 May 2025

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ABSTRACT

Adolescent obesity, a rising global health concern, increases the risk of metabolic disorders, psychological problems, and cardiovascular disease. Alternative approaches to weight management are becoming more popular as a result of the limited long-term effectiveness of conventional strategies like diet and exercise. By altering gut microbiota, enhancing insulin sensitivity, controlling hunger, and lowering systemic inflammation, probiotics-live microorganisms with health benefits offer a potential strategy. Some probiotic strains, such as Lactobacillus and Bifidobacterium, have demonstrated promise in improving the function of the gut barrier, restoring microbial balance, and influencing the metabolic pathways linked to obesity. By altering the ratio of Firmicutes to Bacteroidetes, boosting the synthesis of short-chain fatty acids, and altering hunger-related hormones like ghrelin and leptin, probiotics help regulate energy homeostasis and fat metabolism. Additionally, they improve glucose metabolism, reduce inflammation, and decrease endotoxin absorption. Despite their variable effectiveness based on dosage, strain specificity, and individual gut microbiota composition, probiotics have been demonstrated to aid in the management of obesity. Probiotics may be a non-invasive, complementary option to traditional weight-management methods for improving the metabolic health and overall well-being of adolescents. A comprehensive and long-term strategy for managing and preventing adolescent obesity may be possible by combining probiotics with dietary changes and lifestyle interventions, which would ultimately enhance metabolic health and general well-being.

Keywords: Adolescent obesity, Probiotics, Dysbiosis, Gut microbiome, Metabolic disorder

INTRODUCTION

Probiotics, which are live microorganisms with health benefits, have attracted attention for their potential role in addressing adolescent obesity. As the prevalence of obesity among adolescents continues to raise posing increased risks of metabolic disorders and long-term health challenges exploring alternative or supplementary treatments has become essential.[1] The gut microbiota is pivotal in regulating metabolism, digestion, and energy balance, and disruptions in this microbial ecosystem have been linked to obesity.[2] Probiotics work to restore microbial balance by encouraging the growth of beneficial bacteria, reducing inflammation, strengthening gut barrier function, and influencing both fat storage and appetite.[3] Certain probiotic strains, such as Lactobacillus and Bifidobacterium, may aid in weight management by modifying gut microbiota composition, enhancing insulin sensitivity, and minimizing fat accumulation. Incorporating probiotics into dietary strategies for adolescents presents a promising, non-invasive approach to obesity management, complementing traditional methods like balanced nutrition and physical activity.[4]

Obesity is a chronic complex disease defined by excessive fat deposits that can impair health. Obesity can lead to increased risk of type 2 diabetes and heart disease, it can affect bone health and reproduction, and it increases the risk of certain cancers.[5] The rise in weight gain among individuals, leading to overweight, adiposity, and obesity, is a significant factor behind the escalating prevalence of non-communicable diseases (NCDs). Around the world,

health systems are grappling with the increasing economic strain of detecting and addressing this NCD epidemic and its associated complications. Although obesity was officially recognized as a disease in the International Classification of Disease-6 back in 1948, many global health systems still categorize it as a risk factor rather than a disease.[6] In 2022, 1 in 8 people in the world were living with obesity. Worldwide adult obesity has more than doubled since 1990, and adolescent obesity has quadrupled.[5]

Adolescent obesity has become a critical global health issue, with its rising prevalence leading to severe metabolic, cardiovascular, and psychological repercussions. It stems from a complex interaction of factors, including genetic predisposition, unhealthy eating habits, physical inactivity, and alterations in gut microbiota.[7] Obesity raises the risk of early puberty in children, irregular menstruation in teenage girls, sleep disorders like obstructive sleep apnea (OSA), and cardiovascular risk factors like type 2 diabetes, prediabetes, high cholesterol, hypertension, non-alcoholic fatty liver disease (NAFLD), and metabolic syndrome. Furthermore, psychological problems like eating disorders, anxiety, sadness, low self-esteem, body image, and peer interactions can affect obese kids and teenagers.[8]

As conventional weight management strategies have shown limited success, there is growing interest in innovative approaches like modulating gut microbiota through probiotics. Addressing the multifaceted causes of obesity and identifying effective interventions are essential for ensuring long-term health and well-being in adolescents.[9]

This review aims to determine the effectiveness and mechanisms by which probiotics influence obesity-related parameters, providing valuable insights for healthcare practitioners and policymakers in combating adolescent obesity.

METHODS

Search strategy and database

Databases like PubMed and Google Scholar were explored from 2005 to March 2024. Using the keywords, "probiotics", "obesity", "adolescence", "gut microbiome," "dysbiosis" and "metabolic disorder" an electronic search was conducted to find possible publications.

Selection criteria

Only articles that satisfy the following selection criteria were included: review papers and observational studies involving human participants demonstrating the association between obesity and probiotics; patients with obesity; and both genders.

The articles were excluded if they were: animal/*in-vitro* studies; case series or reports; and abstracts from conferences.

Literature search

A total of 59300 articles were identified from Google Scholar and 711 articles from PubMed using keywords and Boolean operators. Duplicate records were removed based on similar author names, publication years, journal names, and article title. After screening 2,026 articles, 25 articles satisfy the criteria were taken in this review (Figure 1).

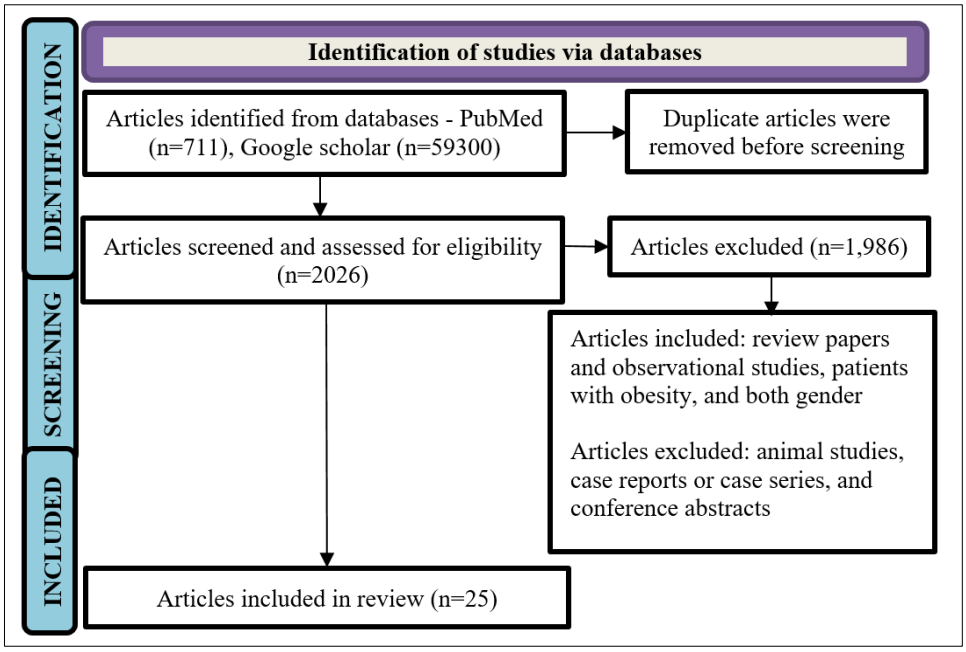

Figure 1: PRISMA flow diagram.

PROBIOTICS AND GUT MICRIBIOME

A varied population of trillions of microorganisms, including bacteria, viruses, fungus, and archaea, make up the human gut microbiome. These microorganisms are essential to preserving general health. Immune system performance, digestion, metabolism, and even mental health are all impacted by the balance of these microbes. Probiotics, which are live bacteria that are beneficial to health when taken in sufficient quantities, work closely with the gut microbiota to support a number of physiological processes.[10] Probiotics and the gut microbiota have a complicated interaction that encompasses a number of mechanisms, such as immunological modulation, metabolic regulation, and the restoration of microbial equilibrium.[11]

The gut microbiome includes bacteria that are beneficial, neutral, and potentially dangerous. A state of dysbiosis, in which harmful bacteria outnumber helpful ones, can result from factors like nutrition, antibiotics, lifestyle, and diseases that upset this equilibrium. Numerous health problems, such as immunological dysfunction, obesity, diabetes, and gastrointestinal illnesses, have been connected to dysbiosis.[12] By boosting the number of good bacteria like Lactobacillus and Bifidobacterium, which compete with harmful pathogens, improve nutrient absorption, and maintain the integrity of the gut barrier, probiotics aid in the restoration of microbial equilibrium.[13]

Mechanisms by which probiotics enhance gut microbiome health

Microbial competition and colonization

By competing for resources and binding sites in the gut lining, probiotics prevent pathogenic bacteria from overgrowing. Certain probiotic strains produce antimicrobial peptides, organic acids (such as lactic acid and acetic acid), and bacteriocins, all of which prevent the growth of dangerous bacteria. Probiotics improve gut barrier function by encouraging the creation of mucus and tight junction proteins, which prevent dangerous bacteria and toxins from entering the circulation.[14]

Immune system modulation

Probiotics work with gut-associated lymphoid tissue (GALT) to control immune responses by increasing anti-inflammatory cytokine production and decreasing inflammation associated with autoimmune and allergy disorders.

Fermentation and metabolite production

Probiotics help to produce short-chain fatty acids (SCFAs) such butyrate, propionate, and acetate. SCFAs supply energy to gastrointestinal cells, reduce inflammation, and regulate glucose and lipid metabolism.[15] Probiotics are a promising way to manage a variety of health disorders because they restore microbial balance, repair the intestinal barrier, and modulate immune responses. However, their efficacy is dependent on strain specificity, dosage, and individual microbiome composition.[13]

PROBIOTICS AND OBESITY

Chronic low-grade inflammation linked to obesity is partially caused by endotoxins generated from the gut, such as LPS (Lipopolysaccharides). Probiotics increase insulin sensitivity and metabolic function by fortifying the intestinal barrier and lowering systemic inflammation and LPS absorption.[16] Genetic, environmental, and behavioral variables all play a role in the complex metabolic disease known as obesity. Probiotics, which are live microorganisms that provide health advantages when taken in sufficient quantities, have drawn interest due to their possible role in managing obesity.[2] Probiotics may affect metabolism by modifying the gut flora, reducing fat storage, and improving insulin sensitivity. The human gut microbiome contains trillions of microbes that play important roles in digestion, energy management, and overall metabolic health.[17]

Dysbiosis, or an imbalance in gut microbiota, is frequently seen in obese people and is characterized by the following.

Increased firmicutes-to-bacteroidetes ratio

Research indicates that in obese people, the ratio of firmicutes to bacteroidetes bacteria is higher.[18] This is linked to increased fat accumulation and calorie absorption.

Diminished microbial diversity

Inflammation and metabolic diseases are associated with a reduced diversity of gut microorganisms.

Modified production of short-chain fatty acids

Short-chain fatty acids (SCFAs), including butyrate and propionate, are involved in the regulation of insulin sensitivity, hunger, and fat metabolism.[19]

Imbalanced SCFA production might result from dysbiosis. Increased inflammation and gut permeability may be weakened by dysbiosis, which increases the absorption of inflammatory chemicals such lipopolysaccharides (LPS), which encourage insulin resistance and fat storage. Probiotics have been investigated as a means of re-establishing the equilibrium of the gut microbiota and reversing these changes brought on by obesity.[17] Probiotics work in a number of ways to control metabolism and body weight. The quantity of energy derived from food is influenced by specific gut bacteria. Fat storage is encouraged by an elevated firmicutes-to-bacteroidetes ratio, which improves calorie absorption and promotes fat accumulation.[12]

Probiotics like strains of Lactobacillus and Bifidobacterium may assist this change of equilibrium by lowering the extraction and storage of energy. A change in gut hormones and regulation of appetite involves the synthesis of important hormones related to appetite and fullness is influenced by the gut bacteria.[19] Probiotics can lower the levels of the hunger hormone ghrelin, which in turn reduces appetite and also increases leptin sensitivity, which improves appetite regulation.[20] Some probiotic strains increase the synthesis of GLP-1, which encourages insulin secretion and satiety. Probiotics raise peptide YY (PYY) secretion, which lowers food consumption.[21]

Probiotics influence fat metabolism by decreasing fat absorption and increasing fat excretion, altering the genes that control the oxidation and storage of fat, enhancing the metabolism of bile acids, which is involved in the regulation of cholesterol and the digestion of fat.[22] Probiotics increase glucose absorption, decrease inflammation, and alter gut-derived SCFAs to increase insulin sensitivity. Clinical studies have demonstrated the ability of Lactobacillus and Bifidobacterium strains to improve insulin resistance and lower fasting blood glucose results.[23]

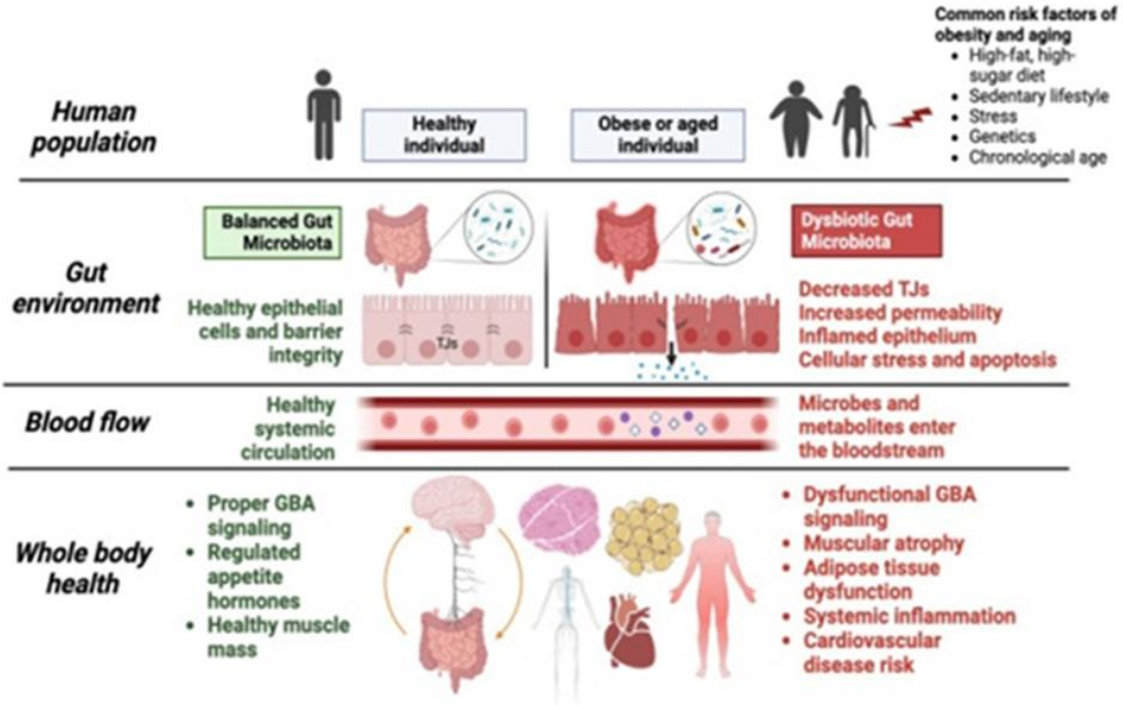

Figure 2: A comparison of gut microbiota, intestinal epithelium, and systemic health in healthy versus obese individuals.[13]

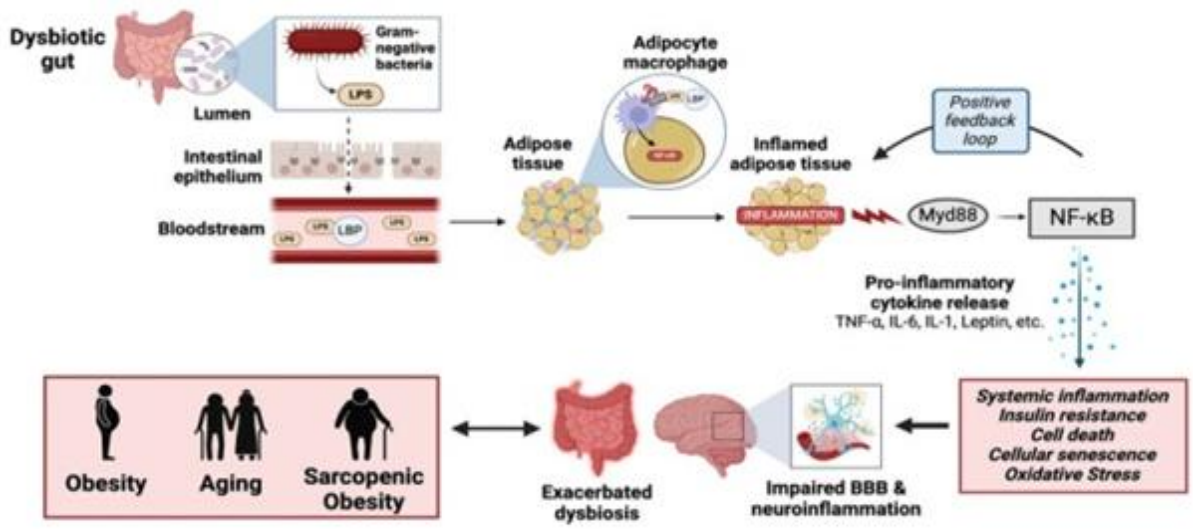

Figure 3: Schematic representation of the inflammatory pathway from the gut to adipose tissue and the resulting consequences on human health.[13]

CONCLUSION

Adolescent obesity is becoming more common, which calls for creative and practical management approaches in addition to traditional diet and exercise regimens. Probiotics provide a promising non-invasive approach to managing obesity by enhancing the integrity of the intestinal barrier, controlling immunological responses, altering metabolic pathways, and restoring microbial balance. Certain strains of Bifidobacterium and Lactobacillus have shown promise in lowering body fat, enhancing insulin sensitivity, controlling hunger, and altering lipid metabolism. Probiotics are a useful supplement in the fight against obesity, but how well they work depends on the strain, dosage, length of the intervention, and makeup of each person's gut microbiota. In order to determine the best probiotic formulations and their long-term effects on adolescent obesity, more investigation through extensive clinical trials is required. A comprehensive and long-term strategy for managing and preventing adolescent obesity may be possible by combining probiotics with dietary changes and lifestyle interventions, which would ultimately enhance metabolic health and general well-being.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Neela CK, Srinivas G, Sundar JS, Kalpana S, Valarmathi S, Poornema U. Balancing the gut, shedding the weight: probiotics for adolescent obesity - a narrative review. Int J Res Med Sci 2025;13:2719-24.