Plant Biotechnology Persa
Online ISSN: 2676-7414
Homepage: https://pbp.medilam.ac.ir

Probiotics and Their Role in Obesity Management as a Major Cardiovascular Risk Factor: A Comprehensive Review

Pouneh Pashapour [1]

[1]Cardiovascular Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

Article Info

Article type:
Review Article

Article History:
Received: Jan 02, 2026
Revised: Apr 03, 2026
Accepted: Apr 06, 2026
Published Online: Apr 20, 2026

Correspondence to:
Pouneh Pashapour

Email:
pashapour.md@gmail.com

A B S T R A C T

Objective: Obesity is a major global public health concern, closely linked to an increased risk of metabolic, cardiovascular, and inflammatory disorders. Growing evidence indicates that dysbiosis of the gut microbiota plays a central role in regulating energy metabolism, fat storage, and the pathogenesis of obesity. Probiotics, by modulating gut microbiota composition, represent a potential therapeutic strategy for obesity management.

Methods: A comprehensive literature search was conducted across major databases, including PubMed, Scopus, and Web of Science, to identify peer-reviewed studies examining the effects of probiotics on obesity. Selected studies were analyzed with a focus on anthropometric outcomes, lipid and glucose metabolism, and mechanisms underlying gut microbiota regulation.

Results: Evidence suggests that specific probiotic strains, particularly those belonging to the genera *Lactobacillus* and *Bifidobacterium*, may promote reductions in body weight, body mass index (BMI), and body fat. These effects are primarily mediated through modulation of energy metabolism, attenuation of inflammation, and enhancement of insulin sensitivity. While these two genera are the most extensively studied in obesity research, emerging strains, such as *Akkermansia muciniphila*, are gaining attention as promising candidates for further investigation.

Conclusion: Current findings support the potential of probiotics as a safe and promising adjunctive strategy in obesity management. However, well-designed clinical trials are needed to determine the most effective strains, optimal dosing, and treatment duration.

Keywords: Probiotics, Obesity, Gut Microbiota, Energy Metabolism, Body Mass Index

➢ **How to cite this paper**
Pashapour P. Probiotics and Their Role in Obesity Management as a Major Cardiovascular Risk Factor: A Comprehensive Review. Plant Biotechnology Persa. 2026; 8(2): 82-93.

DOI: 10.61882

Publisher: Ilam University of Medical Sciences

Introduction

Obesity a complex metabolic disorder characterized by excessive or abnormal fat accumulation and is widely recognized as a global health crisis [1]. Its profound impact on both physical and mental health has established obesity as a major public health challenge worldwide [2]. The significance of this condition is underscored by its rapidly increasing prevalence and its association with elevated risks of cardiovascular diseases, type 2 diabetes, metabolic disorders, certain cancers, and reduced quality of life [3]. Furthermore, the economic burden of managing obesity and its complications places substantial pressure on healthcare systems [4].

The etiology of obesity is multifactorial, involving genetic predisposition, environmental influences, lifestyle factors, high-calorie diets, physical inactivity, and psychological determinants [5]. Emerging evidence highlights the critical role of gut microbiota dysbiosis in the onset and progression of obesity [6]. Pathophysiologically, obesity is characterized by energy imbalance, chronic systemic inflammation, insulin resistance, and alterations in the gut–brain axis [7]. The gut microbiota influences fat metabolism, energy absorption, and inflammatory responses, thereby contributing to either the development or mitigation of obesity [8].

Obesity is associated with a wide range of complications, including cardiovascular disorders, type 2 diabetes, metabolic dysfunction, musculoskeletal and respiratory issues, as well as psychological conditions such as anxiety and depression [9]. These complications can significantly reduce both lifespan and quality of life [9]. Clinical diagnosis typically relies on anthropometric measurements, including body mass index (BMI), waist-to-hip ratio, body fat percentage, and comprehensive clinical evaluation [10]. Early and accurate diagnosis is crucial for identifying at-risk individuals and implementing appropriate therapeutic strategies [10].

Management of obesity encompasses both pharmacological and non-pharmacological approaches. Non-pharmacological interventions emphasize dietary modification, increased physical activity, and lifestyle changes, whereas pharmacological treatments involve anti-obesity and metabolic agents [11,12]. Commonly prescribed medications, such as orlistat, fluoxetine, sertraline, and appetite-regulating drugs, although effective in weight reduction, may be accompanied by adverse effects and practical limitations [12].

The role of traditional and complementary therapies in obesity management has gained increasing attention. These approaches, which focus on metabolic regulation, gut microbiota modulation, and reduction of chronic inflammation, may serve as effective adjunctive treatments [13]. Among these, probiotics exhibit anti-inflammatory and metabolic regulatory properties, with evidence supporting their potential to promote weight loss and improve metabolic health [14]. Probiotics are live microorganisms that, when administered appropriately, restore gut microbial balance and enhance gastrointestinal and immune function [15]. Commonly studied genera, including *Lactobacillus* and *Bifidobacterium*, are involved in metabolism, inflammation attenuation, and overall health maintenance [16]. By modulating gut microbiota, regulating energy metabolism, and reducing chronic inflammation, probiotics can contribute to effective weight management [17]. Clinical studies have demonstrated that probiotic supplementation may reduce body fat, improve insulin sensitivity, and favorably modulate inflammatory markers in individuals with obesity [18].

This review aims to synthesize current evidence on the role of probiotics in obesity management, focusing on their effects on gut microbiota composition, energy metabolism, inflammation, and weight reduction. The goal is to provide a comprehensive understanding of probiotics as a safe and effective adjunctive strategy for addressing obesity and related metabolic disorders.

Methods

This study is a systematic and narrative review of existing evidence on the effects of probiotics in the prevention and management of obesity and related metabolic disorders.

Data Sources

Relevant studies were identified from internationally recognized databases, including PubMed, Scopus, Web of Science, and Library, as well as Persian-language databases such as SID and Magiran.

Search Period

The literature search was restricted to publications from 2010 to 2025 to capture the most recent and robust evidence regarding the effects of probiotics on body weight, obesity, and metabolic parameters.

Search Strategy and Keywords

A combination of primary keywords and Medical Subject Headings (MeSH) terms was used to identify relevant studies. Key search terms included:

Probiotics, Obesity OR Overweight OR "Metabolic syndrome", Gut microbiota OR "Gut–brain axis", Lactobacillus, Bifidobacterium and Weight management OR Body mass index (BMI)

Boolean operators (AND, OR) were applied to structure the search as follows: (Probiotics OR Lactobacillus OR Bifidobacterium) AND (Obesity OR Overweight OR "Metabolic syndrome") AND ("Gut microbiota" OR "Gut–brain axis")

Inclusion Criteria

Original research articles, reviews, clinical trials, and experimental studies examining the effects of probiotics on weight reduction or obesity management.

Publications in English or Persian.

Studies with full-text availability.

Articles reporting clinical outcomes, underlying biological mechanisms, or changes in metabolic indicators resulting from probiotic intervention.

Exclusion Criteria

Studies unrelated to obesity, body weight, or probiotics.

Abstracts, conference proceedings, letters, and articles without full text. Studies with poor methodological quality or insufficient data. Animal studies whose findings could not be directly extrapolated to humans, except when used to support preclinical evidence in the discussion.

Study Selection Process

All articles identified through the search strategy were initially compiled.

Titles and abstracts were screened to remove irrelevant studies.

Full texts of remaining articles were reviewed, and studies meeting the inclusion and exclusion criteria were selected for final analysis.

Key data extracted included study design, population, probiotic type, dosage, treatment duration, and outcomes related to clinical and metabolic effects.

Results

Evidence from the reviewed studies indicates that probiotics can exert beneficial effects in the management of obesity and related metabolic disorders. Specific strains, particularly those belonging to the genera *Lactobacillus* and *Bifidobacterium*, have been shown to reduce body weight, body mass index (BMI), and fat mass. These effects are primarily mediated through modulation of energy metabolism, attenuation of systemic inflammation, and enhancement of insulin sensitivity.

Animal studies generally report more pronounced and significant effects compared to human trials; however, the direct translation of these findings to clinical practice remains limited. Emerging strains, including *Akkermansia muciniphila* and *Hafnia alvei*, have been identified as promising candidates for further investigation.

A detailed summary of the studies, including study design, probiotic strains, dosage, duration, and observed effects on weight and metabolic parameters, is presented in Table 1.

Table 1: Overview of studies investigating the effects of probiotics on weight management and metabolic outcomes

Study Type	Population / Model	Intervention	Dose / Duration	Primary Outcomes	Key Findings	Limitations	Author (Year)	Reference
Review	Preclinical + Human	NGPs (*Akkermansia*, *Hafnia*)	Variable	Weight, metabolism, inflammation	Improved metabolism and weight reduction	Need for larger studies	Vallianou (2023)	[19]
Review	Animal + Human	Pro/Prebiotics	Variable	Weight, inflammation	Metabolic improvement	Heterogeneity	Abenavoli (2019)	[20]
Review	Animal + limited Human	*Lactobacillus*, *Bifidobacterium*	Variable	Fat, glucose	Reduced fat mass	Limited human data	Nova (2016)	[21]
RCT	50 humans	Probiotics	12 weeks	Visceral fat	Reduced waist circumference	Dependent on enterotype	Song (2020)	[22]
Meta-analysis	Obese adults	Probiotics	8–12 weeks	Weight, BMI	Weight reduction (~0.55 kg)	Small effect	Wang (2019)	[23]
Review	Conceptual	*Lactobacillus*	-	F/B ratio	Dysbiosis correction	Strain-dependent	Stojanov (2020)	[24]
RCT	50 adolescents	*L. salivarius*	12 weeks	Inflammation	No effect	Low baseline inflammation	Gøbel (2012)	[25]
Systematic review	27 studies	Pro/Synbiotics	~12 weeks	Weight	Positive effect in most studies	Heterogeneity	Álvarez (2021)	[26]
Meta-analysis	957 participants	Probiotics	3–12 weeks	Weight, BMI	Modest reduction	Small effect	Borgeraas (2018)	[27]

Review	Humans	Pro/Pre/Synbiotics	Variable	Appetite	Hormone regulation	Need for more evidence	Aoun (2020)	[28]
Animal	MSG mice	Probiotics + Omega-3	-	Weight, insulin	Weight reduction	Animal study	Kobyliak (2018)	[29]
RCT	Humans	Probiotics + Herbal	-	Weight	Weight reduction without group difference	Combination effect	Lee (2014)	[30]
Animal	HFD mice	Multi-strain	-	Fat, insulin	↑ *Akkermansia*	Animal study	Alard (2016)	[31]
Review	Animal + Human	*Lactobacillus*, *Bifidobacterium*	Variable	Weight	Mostly positive	Contradictory results	Ejtahed (2019)	[32]
Review	RCTs	Pro/Prebiotics	-	Weight, glucose	<3% effect	Diet-dependent	Barengolts (2016)	[33]
Review	Obese children	Pro/Pre/Synbiotics	-	BMI, lipids	Improvement in some strains	Strain-dependent	Balas (2023)	[34]
Animal	MSG mice	Probiotic mix	3 months	Weight, lipids	Obesity prevention	Animal study	Savcheniuk (2014)	[35]
Animal	HFCD mice	*L. plantarum* + *L. curvatus*	9 weeks	Fat	Fat reduction	Animal study	Yoo (2013)	[36]
Observational	31,190 children	Early-life probiotics	-	Obesity	Reduced risk	Observational	Zhang (2025)	[37]
RCT	411 pregnant women	*L. rhamnosus* + *B. animalis*	-	GDM, weight	Reduced gestational weight gain	No effect on GDM	Callaway (2019)	[38]

Longitudinal RCT	159 mother–child pairs	*L. rhamnosus* GG	Prenatal to 6 months	Child growth	Reduced early weight gain	Requires confirmation	Luoto (2010)	[39]
Meta-analysis	412 participants	Probiotics	Variable	Weight, visceral fat	Significant reduction	Heterogeneity	Guo (2025)	[40]
Meta-analysis	RCT + Animal	*Lactobacillus*, *Bifidobacterium*	5–11 weeks	BMI, CRP	Metabolic improvement	Non-standardized	López-Moreno (2020)	[41]
RCT	87 adults	*L. gasseri*	12 weeks	Abdominal fat	Significant reduction	Limited population	Kadooka (2010)	[42]
Animal	HFD/HCD mice	Multi-strain	4 weeks	Weight	Dysbiosis improvement	Animal study	Kong (2019)	[43]
RCT	64 children with NAFLD	Multi-strain	12 weeks	Liver, lipids	Improved fatty liver	No weight change	Famouri (2017)	[44]
Animal	Mice	Pro/Pre/Synbiotics	12 weeks	Cognition	Cognitive improvement	Animal study	Chunchai (2018)	[45]
Animal	Dog model	*E. faecium*, *B. lactis*	Variable	Weight	Weight reduction	Animal study	Kang (2024)	[46]
Meta-analysis	1,720 participants	Multi-strain	≥8 weeks	Weight, inflammation	Dose-dependent effect	Heterogeneity	da Silva Pontes (2021)	[47]
RCT	19 adolescents	VSL#3	16 weeks	Body fat	Increased fat	Small sample	Jones (2018)	[48]
RCT	62 women	Multi-strain	12 weeks	Weight, hormones	Weight reduction	Small sample	Narmaki (2022)	[49]

Meta-analysis	19 RCTs	Pro/Synbiotics	Variable	Waist circumference	Reduction	Low quality	Suzumura (2019)	[50]
Animal	Mice	*L. gasseri* BNR17	Variable	Weight	Weight reduction	Animal study	Kang (2013)	[51]
RCT	Humans	*L. sakei*	Variable	Fat	Fat reduction	No weight change	Lim (2020)	[52]
RCT	Postmenopausal women	Ecologic Barrier	12 weeks	HOMA-IR	Metabolic improvement	Limited population	Szulińska (2018)	[53]
Pilot	Children	*L. casei*	6 months	Weight, HDL	Metabolic improvement	Small sample	Nagata (2017)	[54]
Animal	Mice	Probiotics	Variable	Bone	↑ Bone formation	Animal study	Behera (2021)	[55]

Discussion

Current evidence indicates that probiotics, prebiotics, and synbiotics can exert meaningful effects on weight management, body composition, and energy metabolism. Systematic reviews and meta-analyses have shown that commonly studied strains of *Lactobacillus* and *Bifidobacterium* are associated with reductions in body mass index (BMI) and fat mass, as well as improvements in insulin sensitivity [21, 27, 32, 41]. These effects are primarily mediated through modulation of gut microbiota, attenuation of systemic inflammation, and correction of dysbiosis [24, 31, 47].

Animal studies, particularly in high-fat/high-carbohydrate (HFD/HCD) and monosodium glutamate (MSG) mouse models, demonstrate more pronounced effects of probiotics on weight reduction and visceral fat accumulation [29, 36, 43, 51], whereas human studies often report smaller or inconsistent outcomes [22, 27, 30]. Such discrepancies may reflect differences in probiotic strain, dosage, intervention duration, dietary background, or individual participant characteristics [33, 34, 40].

Emerging strains, including *Akkermansia muciniphila* and *Hafnia alvei*, have shown promise in preclinical and select human studies, indicating potential benefits for metabolic regulation and weight reduction [19, 31]. These findings underscore the potential of Next-Generation Probiotics (NGPs) in the development of future therapies for metabolic disorders.

Longitudinal and observational studies suggest that early-life or combined probiotic supplementation in children and pregnant women may confer preventive effects, potentially lowering the risk of excessive weight gain or obesity later in life [37, 38, 39]. Nonetheless, some small-scale clinical trials, particularly in adolescents or postmenopausal women, report minimal or no significant effects [25, 49, 53].

Despite promising results, several limitations persist, including study heterogeneity, small sample sizes, variability in probiotic strains and dosages, short intervention durations, and differences in metabolic outcome assessments [20, 27, 50]. These factors constrain the generalizability of findings. Therefore, large-scale, multicenter, and standardized clinical trials are warranted to accurately determine the efficacy of probiotics, particularly emerging NGP strains.

In summary, current evidence supports the use of probiotics especially *Lactobacillus* and *Bifidobacterium* strains as adjunctive interventions for obesity and associated metabolic disorders. The clinical development and evaluation of NGPs may provide new opportunities for personalized and preventive therapeutic strategies [19, 32, 41].

Conclusion

Probiotics, particularly strains of *Lactobacillus* and *Bifidobacterium*, may serve as effective adjuncts for weight reduction, BMI improvement, and regulation of energy metabolism. Their beneficial effects are largely mediated through modulation of gut microbiota, attenuation of systemic inflammation, and enhancement of insulin sensitivity. Emerging strains, such as *Akkermansia muciniphila* and *Hafnia alvei*, show potential for future interventions targeting metabolic disorders. However, heterogeneity among studies and limitations in clinical trial design highlight the need for large, multicenter, and standardized investigations. Overall, probiotics represent a safe, promising, and potentially personalized approach for the prevention and management of obesity.

Declarations

Conflict of Interest

The author declares no conflict of interest related to the publication of this article.

Acknowledgements

The authors would like to express their gratitude to the Tabriz University of Medical Sciences, for finantial support.

Consent for Publication

The author confirms that the final version of the manuscript has been reviewed and approved for publication.

Funding/Support

None.

Authors' Contributions

PP: Conceptualization, the original draft writing, investigation, writing including reviewing and editing and investigation and formal analysis; PP: Conceptualization, supervision, and project administration; PP Conceptualization, the original draft writing, investigation, writing including reviewing and editing.

Ethical Approval

As this study is a review article, it does not involve human or animal subjects and therefore does not require ethical approval or informed consent.

References

1. Kopelman PG. Obesity as a medical problem. Nature. 2000 Apr;404(6778):635-43.
2. Chooi YC, Ding C, Magkos F. The epidemiology of obesity. Metabolism. 2019 Mar 1;92:6-10.
3. Wright SM, Aronne LJ. Causes of obesity. Abdominal Radiology. 2012 Oct;37(5):730-2.
4. Racette SB, Deusinger SS, Deusinger RH. Obesity: overview of prevalence, etiology, and treatment. Physical therapy. 2003 Mar 1;83(3):276-88.
5. Bray GA. Etiology and pathogenesis of obesity. Clinical Cornerstone. 1999 Jan 1;2(3):1-5.
6. Garaulet MO, Ordovás JM, Madrid JA. The chronobiology, etiology and pathophysiology of obesity. International journal of Obesity. 2010 Dec;34(12):1667-83.
7. Kinlen D, Cody D, O'Shea D. Complications of obesity. QJM: An International Journal of Medicine. 2018 Jul 1;111(7):437-43.
8. Malnick SD, Knobler H. The medical complications of obesity. Journal of the Association of Physicians. 2006 Sep 1;99(9):565-79.
9. Gray DS. Diagnosis and prevalence of obesity. Medical Clinics of North America. 1989 Jan 1;73(1):1-3.
10. Bardia A, Holtan SG, Slezak JM, Thompson WG. Diagnosis of obesity by primary care physicians and impact on obesity management. InMayo Clinic Proceedings 2007 Aug 1 (Vol. 82, No. 8, pp. 927-932). Elsevier.
11. Halpern A, Mancini MC. Treatment of obesity: an update on anti-obesity medications. Obesity reviews. 2003 Feb;4(1):25-42.
12. Gudzune KA, Kushner RF. Medications for obesity: a review. Jama. 2024 Aug 20;332(7):571-84.
13. Kazemipoor M, Radzi CW, Cordell GA, Yaze I. Potential of traditional medicinal plants for treating obesity: a review. arXiv preprint arXiv:1208.1923. 2012 Aug 8.
14. Zendeboodi F, Khorshidian N, Mortazavian AM, da Cruz AG. Probiotic: conceptualization from a new approach. Current Opinion in Food Science. 2020 Apr 1;32:103-23.
15. Boyle RJ, Robins-Browne RM, Tang ML. Probiotic use in clinical practice: what are the risks?. The American journal of clinical nutrition. 2006 Jun 1;83(6):1256-64.
16. Czajeczny D, Kabzińska K, Wójciak RW. Does probiotic supplementation aid weight loss? A randomized, single-blind, placebo-controlled study with Bifidobacterium lactis BS01 and Lactobacillus acidophilus LA02 supplementation. Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity. 2021 Aug;26(6):1719-27.
17. Park S, Bae JH. Probiotics for weight loss: a systematic review and meta-analysis. Nutrition research. 2015 Jul 1;35(7):566-75.
18. 18.
19. Vallianou NG, Kounatidis D, Tsilingiris D, Panagopoulos F, Christodoulatos GS, Evangelopoulos A, Karampela I, Dalamaga M. The role of next-generation probiotics in obesity and obesity-associated disorders: current knowledge and future perspectives. International journal of molecular sciences. 2023 Apr 4;24(7):6755.
20. Abenavoli L, Scarpellini E, Colica C, Boccuto L, Salehi B, Sharifi-Rad J, Aiello V, Romano B, De Lorenzo A, Izzo AA, Capasso R. Gut microbiota and obesity: a role for probiotics. Nutrients. 2019 Nov 7;11(11):2690.
21. Nova E, Pérez de Heredia F, Gómez-Martínez S, Marcos A. The role of probiotics on the microbiota: effect on obesity. Nutrition in clinical practice. 2016 Jun;31(3):387-400.
22. Song EJ, Han K, Lim TJ, Lim S, Chung MJ, Nam MH, Kim H, Nam YD. Effect of probiotics on obesity-related markers per enterotype: a double-blind, placebo-controlled, randomized clinical trial. EPMA Journal. 2020 Mar;11(1):31-51.
23. Wang ZB, Xin SS, Ding LN, Ding WY, Hou YL, Liu CQ, Zhang XD. The potential role of probiotics in controlling overweight/obesity and associated metabolic parameters in adults: a systematic review and meta-analysis. Evidence-Based Complementary and Alternative Medicine. 2019;2019(1):3862971.
24. Stojanov S, Berlec A, Štrukelj B. The influence of probiotics on the firmicutes/bacteroidetes ratio in the treatment of obesity and inflammatory bowel disease. Microorganisms. 2020 Nov 1;8(11):1715.
25. Gøbel RJ, Larsen N, Jakobsen M, Mølgaard C, Michaelsen KF. Probiotics to adolescents with obesity: effects on inflammation and metabolic syndrome. Journal of pediatric gastroenterology and nutrition. 2012 Dec;55(6):673-8.
26. Álvarez-Arraño V, Martín-Peláez S. Effects of probiotics and synbiotics on weight loss in subjects with overweight or obesity: A systematic review. Nutrients. 2021 Oct;13(10):3627.
27. Borgeraas H, Johnson LK, Skattebu J, Hertel JK, Hjelmesaeth J. Effects of probiotics on body weight, body mass index, fat mass and fat percentage in subjects with overweight or obesity: a systematic review and meta-analysis of randomized controlled trials. Obesity Reviews. 2018 Feb;19(2):219-32.
28. Aoun A, Darwish F, Hamod N. The influence of the gut microbiome on obesity in adults and the role of probiotics, prebiotics, and synbiotics for weight loss. Preventive nutrition and food science. 2020 Jun 30;25(2):113.
29. Kobyliak N, Falalyeyeva T, Boyko N, Tsyryuk O, Beregova T, Ostapchenko L. Probiotics and nutraceuticals as a new frontier in obesity prevention and management. diabetes research and clinical practice. 2018 Jul 1;141:190-9.
30. Lee SJ, Bose S, Seo JG, Chung WS, Lim CY, Kim H. The effects of co-administration of probiotics with herbal medicine on obesity, metabolic endotoxemia and dysbiosis: a randomized double-blind controlled clinical trial. Clinical nutrition. 2014 Dec 1;33(6):973-81.
31. Alard J, Lehrter V, Rhimi M, Mangin I, Peucelle V, Abraham AL, Mariadassou M, Maguin E, Waligora-Dupriet AJ, Pot B, Wolowczuk I. Beneficial metabolic effects of selected probiotics on diet-induced obesity and insulin resistance in mice are associated with

improvement of dysbiotic gut microbiota. Environmental microbiology. 2016 May;18(5):1484-97.
32. Ejtahed HS, Angoorani P, Soroush AR, Atlasi R, Hasani-Ranjbar S, Mortazavian AM, Larijani B. Probiotics supplementation for the obesity management; A systematic review of animal studies and clinical trials. Journal of Functional Foods. 2019 Jan 1;52:228-42.
33. Barengolts E. Gut microbiota, prebiotics, probiotics, and synbiotics in management of obesity and prediabetes: review of randomized controlled trials. Endocrine Practice. 2016 Oct 1;22(10):1224-34.
34. Borka Balas R, Meliț LE, Lupu A, Lupu VV, Mărginean CO. Prebiotics, probiotics, and synbiotics—a research hotspot for pediatric obesity. Microorganisms. 2023 Oct 28;11(11):2651.
35. Savcheniuk OA, Virchenko OV, Falalyeyeva TM, Beregova TV, Babenko LP, Lazarenko LM, Demchenko OM, Bubnov RV, Spivak MY. The efficacy of probiotics for monosodium glutamate-induced obesity: dietology concerns and opportunities for prevention. EPMA Journal. 2014 Dec;5(1):2.
36. Yoo SR, Kim YJ, Park DY, Jung UJ, Jeon SM, Ahn YT, Huh CS, McGregor R, Choi MS. Probiotics L. plantarum and L. curvatus in combination alter hepatic lipid metabolism and suppress diet-induced obesity. Obesity. 2013 Dec;21(12):2571-8.
37. Zhang M, Ding L, Strodl E, Yin X, Wen G, Sun D, Xian D, Zhao Y, Zheng Y, Liu F, Hu R. Early supplement of probiotics reduces the risk of obesity among preschool children: a real-world observational study. Frontiers in Nutrition. 2025 May 15;12:1597894.
38. Callaway LK, McIntyre HD, Barrett HL, Foxcroft K, Tremellen A, Lingwood BE, Tobin JM, Wilkinson S, Kothari A, Morrison M, O'Rourke P. Probiotics for the prevention of gestational diabetes mellitus in overweight and obese women: findings from the SPRING double-blind randomized controlled trial. Diabetes care. 2019 Mar 1;42(3):364-71.
39. Luoto R, Kalliomäki M, Laitinen K, Isolauri E. The impact of perinatal probiotic intervention on the development of overweight and obesity: follow-up study from birth to 10 years. International journal of obesity. 2010 Oct;34(10):1531-7.
40. Guo M, Li J, Zhang L, Chen C, Wei Y, Shen ZA. Effects of oral supplementation of probiotics on body weight and visceral fat in obese patients: a meta-analysis and systematic review. Scientific reports. 2025 Feb 21;15(1):6355.
41. López-Moreno A, Suárez A, Avanzi C, Monteoliva-Sánchez M, Aguilera M. Probiotic strains and intervention total doses for modulating obesity-related microbiota dysbiosis: a systematic review and meta-analysis. Nutrients. 2020 Jun 29;12(7):1921.
42. Kadooka Y, Sato M, Imaizumi K, Ogawa A, Ikuyama K, Akai Y, Okano M, Kagoshima M, Tsuchida T. Regulation of abdominal adiposity by probiotics (Lactobacillus gasseri SBT2055) in adults with obese tendencies in a randomized controlled trial. European journal of clinical nutrition. 2010 Jun;64(6):636-43.
43. Kong C, Gao R, Yan X, Huang L, Qin H. Probiotics improve gut microbiota dysbiosis in obese mice fed a high-fat or high-sucrose diet. Nutrition. 2019 Apr 1;60:175-84.
44. Famouri F, Shariat Z, Hashemipour M, Keikha M, Kelishadi R. Effects of probiotics on nonalcoholic fatty liver disease in obese children and adolescents. Journal of pediatric gastroenterology and nutrition. 2017 Mar;64(3):413-7.
45. Chunchai T, Thunapong W, Yasom S, Wanchai K, Eaimworawuthikul S, Metzler G, Lungkaphin A, Pongchaidecha A, Sirilun S, Chaiyasut C, Pratchayasakul W. Decreased microglial activation through gut-brain axis by prebiotics, probiotics, or synbiotics effectively restored cognitive function in obese-insulin resistant rats. Journal of neuroinflammation. 2018 Jan 9;15(1):11.
46. Nitert MD, Barrett HL, Foxcroft K, Tremellen A, Wilkinson S, Lingwood B, Tobin JM, McSweeney C, O'Rourke P, McIntyre HD, Callaway LK. SPRING: an RCT study of probiotics in the prevention of gestational diabetes mellitus in overweight and obese women. BMC pregnancy and childbirth. 2013 Feb 25;13(1):50.
47. da Silva Pontes KS, Guedes MR, da Cunha MR, de Souza Mattos S, Silva MI, Neves MF, Marques BC, Klein MR. Effects of probiotics on body adiposity and cardiovascular risk markers in individuals with overweight and obesity: A systematic review and meta-analysis of randomized controlled trials. Clinical Nutrition. 2021 Aug 1;40(8):4915-31.
48. Jones RB, Alderete TL, Martin AA, Geary BA, Hwang DH, Palmer SL, Goran MI. Probiotic supplementation increases obesity with no detectable effects on liver fat or gut microbiota in obese Hispanic adolescents: a 16-week, randomized, placebo-controlled trial. Pediatric obesity. 2018 Nov;13(11):705-14.
49. Narmaki E, Borazjani M, Ataie-Jafari A, Hariri N, Doost AH, Qorbani M, Saidpour A. The combined effects of probiotics and restricted calorie diet on the anthropometric indices, eating behavior, and hormone levels of obese women with food addiction: a randomized clinical trial. Nutritional Neuroscience. 2022 May 4;25(5):963-75.
50. Suzumura EA, Bersch-Ferreira AC, Torreglosa CR, da Silva JT, Coqueiro AY, Kuntz MG, Chrispim PP, Weber B, Cavalcanti AB. Effects of oral supplementation with probiotics or synbiotics in overweight and obese adults: a systematic review and meta-analyses of randomized trials. Nutrition reviews. 2019 Jun 1;77(6):430-50.
51. Kang JH, Yun SI, Park MH, Park JH, Jeong SY, Park HO. Anti-obesity effect of Lactobacillus gasseri BNR17 in high-sucrose diet-induced obese mice. PloS one. 2013 Jan 30;8(1):e54617.
52. Lim S, Moon JH, Shin CM, Jeong D, Kim B. Effect of Lactobacillus sakei, a probiotic derived from kimchi, on body fat in Koreans with obesity: a randomized controlled study. Endocrinology and Metabolism. 2020 Jun 30;35(2):425-34.
53. Szulińska M, Łoniewski I, Van Hemert S, Sobieska M, Bogdański P. Dose-dependent effects of multispecies probiotic supplementation on the lipopolysaccharide

(LPS) level and cardiometabolic profile in obese postmenopausal women: A 12-week randomized clinical trial. Nutrients. 2018 Jun 15;10(6):773.

54. Nagata S, Chiba Y, Wang C, Yamashiro Y. The effects of the Lactobacillus casei strain on obesity in children: a pilot study. Beneficial microbes. 2017 Aug 24;8(4):535-44.
55. Behera J, Ison J, Voor MJ, Tyagi N. Probiotics stimulate bone formation in obese mice via histone methylations. Theranostics. 2021 Jul 25;11(17):8605.