

Integrative Approaches to the Management of Polycystic Ovary Syndrome Using Probiotics and Healthy Habits

Abordagens Integrativas no Manejo da Síndrome dos Ovários Policísticos com Probióticos e Hábitos Saudáveis
Enfoques Integrativos en el Manejo del Síndrome de Ovarios Poliquísticos con Probióticos y Hábitos Saludables

RESUMO

Objetivo: Avaliar o papel da reeducação alimentar, da atividade física e, em especial, da suplementação com probióticos como estratégias adjuvantes no manejo da síndrome dos ovários policísticos (SOP). **Métodos:** Foi elaborada uma pergunta de pesquisa norteadora utilizando o modelo PICO, e estudos relevantes foram identificados por meio de buscas sistemáticas em bases de dados científicas, com o uso de operadores booleanos. **Resultados:** Os estudos revisados demonstraram, de forma consistente, que essas intervenções, especialmente quando combinadas, promovem melhorias em desfechos clínicos-chave, como peso corporal, sensibilidade à insulina, perfil hormonal e função reprodutiva. Contudo, o potencial terapêutico da suplementação com probióticos ainda necessita de maior elucidação, particularmente no que diz respeito à especificidade das cepas, dosagens ideais e duração do tratamento. **Conclusão:** A integração de intervenções de estilo de vida saudável com a suplementação de probióticos parece oferecer benefícios significativos no manejo da SOP. No entanto, as evidências atuais não sustentam seu uso como modalidade terapêutica isolada.

DESCRIPTORES: Síndrome do Ovário Policístico; Probióticos; Estilo de Vida Saudável; Hiperandrogenismo; Saúde Reprodutiva.

ABSTRACT

Objective: To assess the role of dietary re-education, physical activity, and particularly probiotic supplementation as adjunctive strategies in the management of polycystic ovary syndrome (PCOS). **Methods:** A guiding research question was developed using the PICO framework, and relevant studies were identified through systematic searches of scientific databases employing Boolean operators. **Results:** The reviewed studies consistently demonstrated that these interventions, particularly when implemented in combination, improved key clinical outcomes including body weight, insulin sensitivity, hormonal profiles, and reproductive function. Nevertheless, the therapeutic potential of probiotic supplementation remains to be fully elucidated, particularly regarding strain specificity, optimal dosing, and treatment duration. **Conclusion:** Integrating healthy lifestyle interventions with probiotic supplementation appears to offer significant benefits in the management of PCOS. However, current evidence does not support their use as sole therapeutic modalities.

DESCRIPTORS: Polycystic Ovary Syndrome; Probiotics; Healthy Lifestyle; Hyperandrogenism; Reproductive Health.

RESUMEN

Objetivo: Evaluar el papel de la reeducación alimentaria, la actividad física y, en particular, la suplementación con probióticos como estrategias adjuvantes en el manejo del síndrome de ovario poliquístico (SOP). **Métodos:** Se formuló una pregunta de investigación orientadora utilizando el modelo PICO, y se identificaron estudios relevantes mediante búsquedas sistemáticas en bases de datos científicas, empleando operadores booleanos. **Resultados:** Los estudios revisados demostraron de manera consistente que estas intervenciones, especialmente cuando se aplican de forma combinada, mejoran desenlaces clínicos clave como el peso corporal, la sensibilidad a la insulina, el perfil hormonal y la función reproductiva. Sin embargo, el potencial terapéutico de la suplementación con probióticos aún requiere mayor elucidación, particularmente en relación con la especificidad de las cepas, las dosis óptimas y la duración del tratamiento. **Conclusión:** La integración de intervenciones de estilo de vida saludable con la suplementación con probióticos parece ofrecer beneficios significativos en el manejo del SOP. No obstante, la evidencia actual no respalda su uso como modalidad terapéutica única.

DESCRIPTORES: Síndrome de Ovario Poliquístico; Probióticos; Estilo de Vida Saludable; Hiperandrogenismo; Salud Reprodutiva.

RECEIVED: 05/17/2025 APPROVED: 06/03/2025

How to cite this article: Deretti C, Agostinho J, Neves LG, Delwing-de-Lima D, Pinto LH, Viteritte PL. Integrative Approaches To The Management Of Polycystic Ovary Syndrome Using Probiotics And Healthy Habits. *Saúde Coletiva* (Edição Brasileira) [Internet]. 2025 [acesso ano mês dia];15(97):15998-16013. Disponível em: DOI: 10.36489/saudecoletiva.2025v15i97p15998-16013

**Clara Deretti**Pharmacy Undergraduate
ORCID: <https://orcid.org/0009-0008-8638-2666>**Janine Agostinho**Pharmacy Undergraduate
ORCID: <https://orcid.org/0000-0003-2390-6895>**Laura Gonzatto Neves**Pharmacy Undergraduate
ORCID: <https://orcid.org/0000-0002-5574-1880>**Paulo Luiz Viteritte**Associate Professor, Department of Nutrition
ORCID: <https://orcid.org/0009-0006-2664-6557>**Daniela Delwing de Lima**Associate Professor of Health
ORCID: <https://orcid.org/0000-0001-5335-5102>**Luciano Henrique Pinto**Associate Professor of Health
ORCID: <https://orcid.org/0000-0003-0250-7502>

INTRODUCTION

Polycystic ovary syndrome (PCOS) is characterized as a disease in which endocrine metabolic abnormalities coexist with reproductive system abnormalities.¹ Clinical phenotypes may change over the lifespan with weight gain and may coexist in the same patient.² Therefore, the search for a safe treatment is of utmost importance to prevent future complications resulting from the progression of the disease.

From this perspective, the search for a therapeutic resource that contributes to the health and well-being of the female population that presents complications caused largely by PCOS, in addition to adopting a balanced diet and regular exercise, is of great interest and is highly relevant for further studies on the subject to be carried out. Despite this, due to the variety of problems that this disease can trigger, negatively impacting the quality of life of these women, especially from the point of view of quality of life, this research becomes a great challenge.

It is estimated that approximately 1 in 10 women facing PCOS before menopause struggle with its complications.³ Women with PCOS tend

to be deficient in many common vitamins and minerals.⁴ PCOS has been associated with significant adverse health conditions, including obesity, diabetes, dyslipidemia, cardiovascular disease (CVD), sleep apnea, depression, and nonalcoholic fatty liver disease.⁵ The participation of a multidisciplinary team is essential, which can reflect on the benefit of receiving clinical services and awareness of the importance of a healthy diet.⁴

To control this condition, the most crucial step is to lose at least 5% of your weight, so having a regular exercise plan and fat and sugar free diets are also recommended for all women with PCOS.³ Therefore, adopting adequate nutrition and healthy daily habits are extremely important for managing the condition and improving overall quality of life.

The general principles of a healthy diet should be followed by all women with PCOS throughout their lives. There are several balanced dietary approaches that can be recommended to reduce calorie intake and promote weight loss.⁶ Likewise, early treatment of insulin resistance can improve metabolic dysregulation in women with PCOS and reduce the risk of progression to type 2 diabetes mellitus.⁷ The incurable nature of PCOS reinforces

the importance of developing effective symptomatic relief strategies and component-specific treatment.⁴

In women with PCOS, probiotic therapy results in an improved metabolic profile.⁸ Therefore, it is extremely important to study the incorporation of these microorganisms in the treatment of PCOS to verify their true benefits.

Therefore, this study aims to evaluate the benefits of probiotic supplementation in the treatment of PCOS and to analyze whether, together with the adoption of a balanced diet and regular physical activity, this approach may be sufficient for the complete treatment of the condition. In addition, it aims to provide guidance for health professionals, expanding the understanding of the therapeutic management available for women affected by this syndrome.

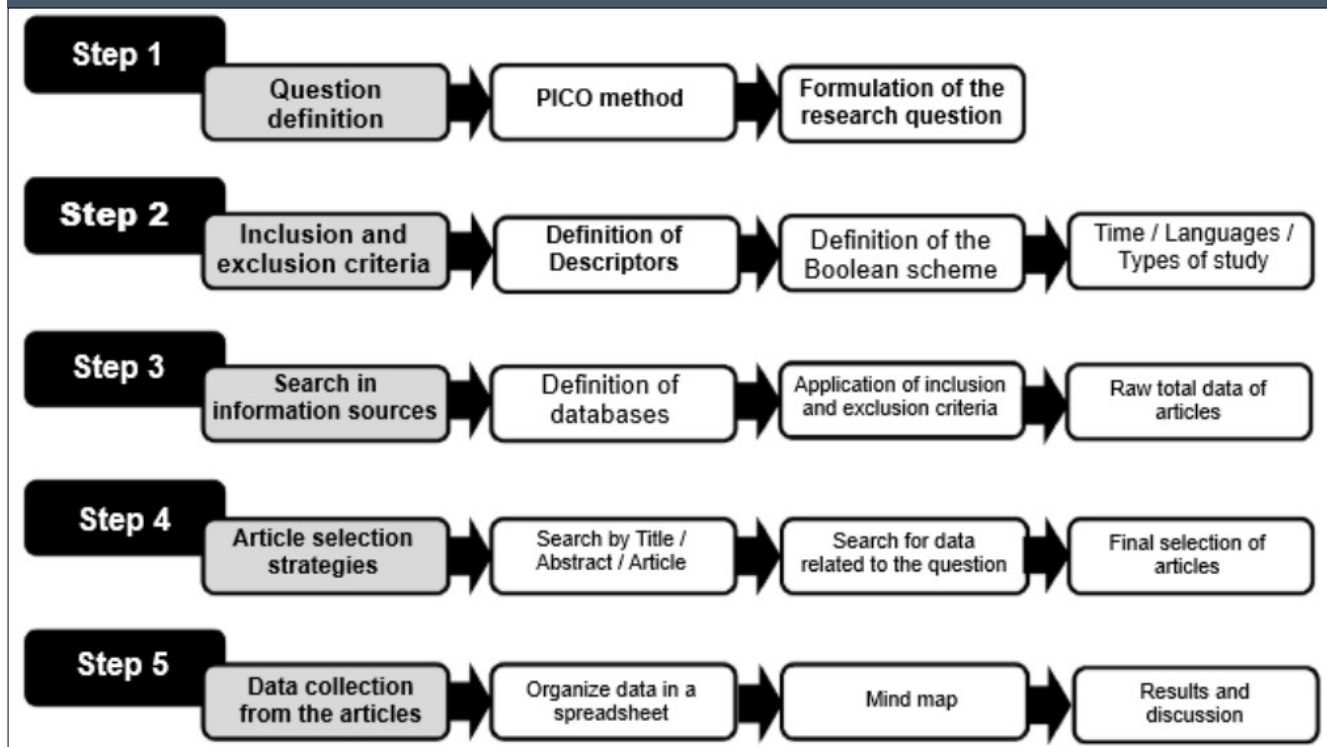
METHOD

The review research was carried out in 5 stages, following the methodological rigor that guaranteed the reproducibility of the information found. The data were collected between December 2024 and April 2025. The stages are listed in Figure 1.

Literature Review

Deretti C, Agostinho J, Neves LG, Delwing-de-Lima D, Pinto LH, Viteritte PL
Integrative Approaches to the Management of Polycystic Ovary Syndrome Using Probiotics and Healthy Habits

Figure 1 - Research method used and its 5 investigation steps based on PRISMA. Source: adapted from SOUZA et al (2010)



The steps of this research are described below:

Step 1, which includes defining the research question, which was obtained using the PICO method. Once the research question was defined, the keywords that would compose the research were then defined.

Step 2 consisted of defining the Boolean scheme that would meet the resolution of the research problem, as well as definitions of eligibility of the articles, such as time [a] Availability in Portuguese, English and Spanish, [b] having been developed from a question obtained using the PICO method, [c] direct relationship with the object of study and its guiding question, [d] not presenting conflicts of interest, [e] having been published no more than 5 years ago.

Step 3 corresponded to the activity of defining search sites, using portals PubMed, Scielo, EBSCO

Step 4 was the selection phase of the

articles found in the portals, in which the analysis was initially by title, abstract, and those of interest were separated for analysis aiming at answering the research problem. The ROBANS (Risk of Bias Assessment Tool for Nonrandomized Studies) and Risk of Bias Tool 2 (RoB 2) methods were used for non-randomized and randomized studies respectively.

Step 5 the results were analyzed using spreadsheets containing information

on the PICO question and the variables chosen for study, aiming to generate the results and discussion of the article.

RESULTS

Considering the terms required in the research question according to GALVÃO et al (2014), the items were established as per table 1.

Table 1 - Development of the research question

	P	I	C	O
Acronym Definitions	Population	Intervention	Comparison	Outcome
Question Components	Women with PCOS and overweight	Use of probiotics and a healthy lifestyle	Other treatments or placebo	Improvement of symptoms and reduction of body weight

Source: the authors

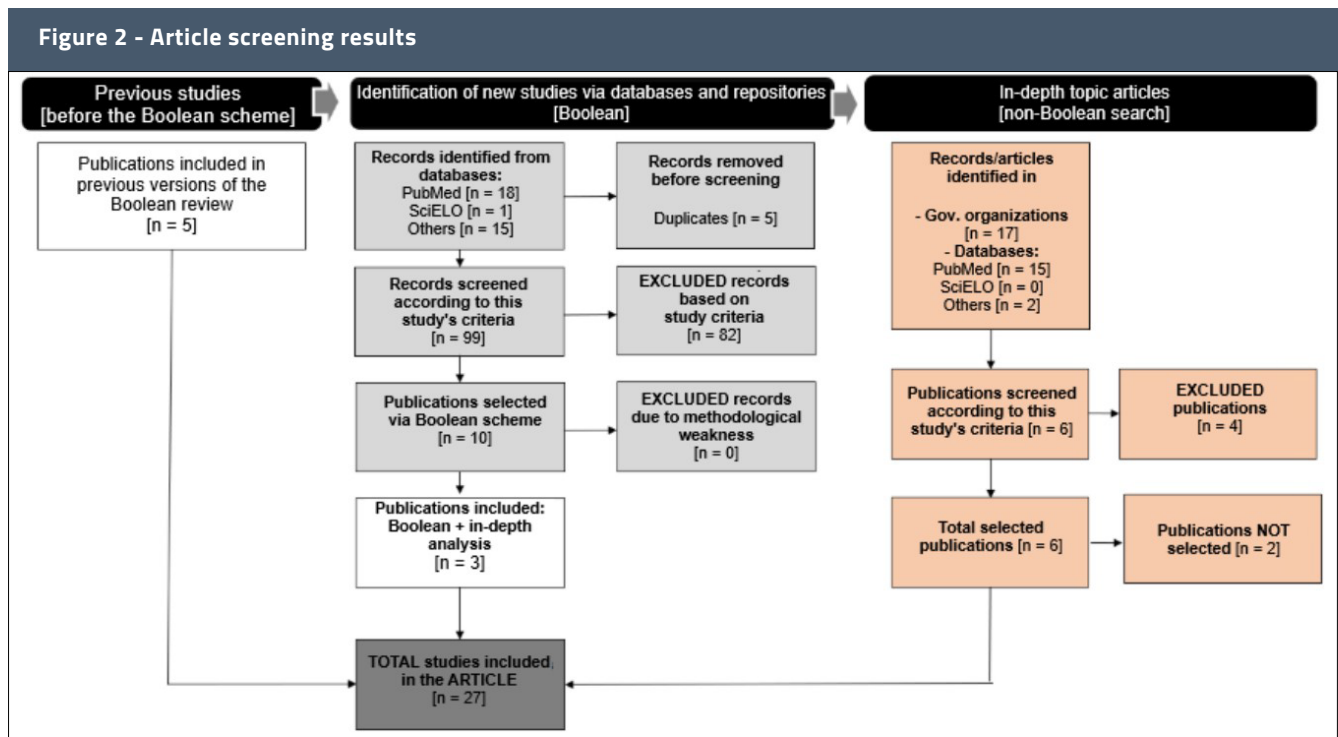
The result of the question was then expressed as follows: *"Is adopting a healthy lifestyle together with probiotic supplementation sufficient to treat the symptoms of women with PCOS and being overweight?"*

From then on, the Boolean scheme was defined for searching for articles

linked to the question, and the scheme used in the databases was as follows: (healthy lifestyle) AND (probiotics) AND (PCOS OR "polycystic ovary syndrome") AND (overweight); in the databases cited in the method.

A total of 99 articles were found in the Boolean scheme, of which 13

met the research selection criteria to find propositions that addressed the research question of the work. There were also 8 previous articles and a total of 6 were added outside the Boolean scheme for theoretical complementation; as shown in Figure 2.



DISCUSSION

PCOS, Obesity and Insulin Resistance: Risks to Women's Health

Polycystic ovary syndrome (PCOS) is an endocrine condition that affects up to 13% of women of reproductive age.⁹ 80% of women with PCOS are overweight or obese and have a higher risk of weight gain compared to women without PCOS, a problem that worsens the clinical picture.^{10,11}

Obesity is an important risk factor for type 2 diabetes, and may be more common in this group than in those with a healthy weight. Based on the results of studies demonstrating a higher frequency of insulin resistance in women with PCOS, it can be con-

cluded that this syndrome is characterized as a risk factor for type 2 diabetes. Therefore, obtaining an early diagnosis and treatment, with weight loss if necessary, can help reduce the risk of long-term complications, such as type 2 diabetes and heart disease.^{12,5}

Studies show that the intestinal microbiota of women with PCOS is less diverse than in women without PCOS; the decrease in intestinal microbiota has been associated with hyperandrogenism, caused by increased levels of systemic inflammation.⁴

There are treatments for altered gut microbiota due to PCOS — these include probiotics, prebiotics, and synbiotics. Probiotics, which are the

focus of this study, occur naturally in fermented foods and are defined by the WHO as live microorganisms that, when consumed in appropriate amounts, can provide beneficial health effects. In women with PCOS, probiotic therapy results in an improved metabolic profile.⁸

Probiotics as an alternative for treating PCOS

Based on the studies analyzed, adopting a healthy lifestyle, combined with probiotic supplementation, presents benefits for women with Polycystic Ovary Syndrome (PCOS) and being overweight, but cannot be considered as the sole and sufficient treatment for the condition (table 2).

Literature Review

Deretti C, Agostinho J, Neves LG, Delwing-de-Lima D, Pinto LH, Viteritte PL

Integrative Approaches to the Management of Polycystic Ovary Syndrome Using Probiotics and Healthy Habits

Table 2 - Summary of studies on the topic addressed

Author/year		Country	Objective	Population and sample	Study design	What was compared	Final Considerations
KARIMI, et al.	2020	Iran	To evaluate the effects of synbiotic supplementation on the lipid profile and anthropometric measurements of women diagnosed with PCOS and infertile	99 women with PCOS	Participants were divided into 2 groups: [1] one group received the intervention with the synbiotic supplement and [2] the other group received a placebo. The participants and researchers were not aware of the intervention to be used (blinding). The follow-up occurred for 12 weeks.	Anthropometric measurements, food intake and biochemical indices	The group that received [1] synbiotic supplementation improved the values of low-density lipoprotein cholesterol (LDL) and high-density lipoprotein cholesterol (HDL). There were no significant differences in the levels of total cholesterol (TC) and triglycerides (TG). Furthermore, there were no significant changes in anthropometric measurements between the groups.
CHUDZICKA et al.	2021	USA	To evaluate the effects of lifestyle changes and synbiotic supplementation in women with PCOS	39 women with PCOS	The participants were divided into 2 groups, [1] synbiotic group and [2] placebo group. Both the participants and the researchers were unaware of the treatment used (blinding). The follow-up was carried out for 3 months.	Changes in BMI and body fat percentage. Changes in testosterone levels.	Weight loss was achieved in both groups, with greater reductions in the [1] synbiotic group. The decrease in testosterone levels was significantly greater in the [1] synbiotic group.
ŁAGOWSKA et al	2022	Poland	To evaluate whether changes in fecal fatty acid content with a calorie-restricted diet and with/without probiotic supplementation interfere with the amount of intestinal bacteria and the lipid profile of women with PCOS and overweight	40 women with PCOS	The participants were divided into 2 groups; group D (low glycemic index weight loss diet) and group DP (low glycemic index weight loss diet + Lactobacillus rhamnosus supplementation). Follow-up was performed for 20 weeks.	Anthropometric parameters, Fecal short-chain fatty acid levels, Gut bacteria abundance Lipid profile (HDL/LDL)	There was a non-significant reduction in body weight and BMI in both groups. In addition, there was a reduction in cholesterol, LDL cholesterol and an increase in HDL cholesterol. There were no differences in the abundance of selected intestinal bacteria. Probiotic supplementation did not provide additional benefits compared to the weight loss diet.
Jl, et al.	2022	China	To verify the effects of probiotic supplementation with metformin intake on the menstrual and metabolic patterns of women diagnosed with PCOS	60 women with PCOS	Participants were divided into 3 groups. [1] group received only probiotic supplementation, [2] group received only metformin, and [3] group received both interventions. Follow-up occurred for 12 weeks.	Regularity of the menstrual cycle Ovulation rate. Changes in anthropometric measurements and Biochemical changes Changes in hormone levels. Androgen-related hirsutism was also evaluated.	Co-supplementation of probiotics and metformin (GROUP 3) showed superior results in improving menstrual patterns. In addition, there was also an improvement in the ovulation rate. There was no significant difference in anthropometric and metabolic factors between the groups.

KAUR, et al.	2022	India	To verify the effects of multistrain probiotic supplementation together with dietary and lifestyle changes on weight, menstrual regularity, metabolic and hormonal profile in women diagnosed with PCOS.	97 women with PCOS	As participantes foram divididas em 2 grupos, [1] grupo que realizou a suplementação com cápsulas probióticas e [2] grupo que realizou a ingestão de placebo. Ambos os grupos receberam planos de dieta e de exercícios. Participantes e pesquisadores não tinham conhecimento da intervenção a ser empregada (cegamento)	Regularity of the menstrual cycle Anthropometric measurements, Hormonal profile. (Testosterone, LH and FSH, TOR) Quality of life	Probiotic supplementation improved menstrual regularity, total testosterone levels, insulin resistance, insulin, LH and FSH levels, and BMI relative to placebo. Quality of life was equal in both groups.
HARIRI, et	2024	Irã	To evaluate the effects of yoga practice and a Mediterranean diet high in probiotics on insulin resistance in women diagnosed with PCOS	52 women with PCOS	Participantes divididas em 2 grupos, [1] um que realizou a prática da Yoga e a ingestão de uma dieta mediterrânea rica em probióticos, e o [2] outro que realizou apenas a prática da Yoga. Acompanhou-se por 12 semanas. Participantes sem conhecimento da intervenção a ser empregada (cegamento).	Fasting blood glucose, Insulin resistance and Serum insulin levels	Both groups obtained positive results. Group [1] Yoga + diet showed significant improvement compared to the other group in weight, BMI, hip circumference, insulin resistance, serum insulin and fasting glucose.

Source: the authors

Polycystic ovary syndrome is one of the most common endocrinopathies affecting women of reproductive age, widely recognized for its clinical complexity and diversity of manifestations.⁹ Thus, lifestyle modifications, such as physical exercise and healthy eating habits, have been shown to improve metabolic status and reduce androgen levels in women with PCOS. Furthermore, it has been suggested that the balance of the intestinal microbiota may play a crucial role in the management of these symptoms, which generates a growing interest in the use of probiotics as therapeutic adjuvants.¹³

In view of the above, we seek to elucidate the effects of probiotic supplementation in women with PCOS, comparing the results with isolated interventions, such as diet and physical exercise.⁴ In this sense, studies indicate that the modulation of the intestinal microbiota, through probiotics, may be related to the improvement in insulin resistance and the reduction

of systemic inflammatory markers.¹⁴ Furthermore, different strains of probiotics may present variations in therapeutic efficacy, which suggests that the choice and duration of treatment become determining factors in clinical outcomes.¹⁵

Ultimately, it is suggested that probiotic supplementation associated with a healthy lifestyle tends to offer better results than the isolated use of diet or physical exercise.¹⁶ However, significant limitations are highlighted in some studies, such as the short follow-up period and the diversity of strains used, which makes it difficult to formulate consolidated clinical guidelines.¹⁷ Therefore, it is important to highlight the need for longer and well-controlled studies in order to determine the most effective strains and dosages, in addition to better understanding the interactions of probiotics with other therapeutic approaches.^{18,19}

Is adopting a healthy lifestyle together with probiotic supplementation sufficient for treating women

with PCOS and overweight?

Based on the studies analyzed in table 2, adopting a healthy lifestyle, combined with probiotic supplementation, presents benefits for women with Polycystic Ovary Syndrome (PCOS) and being overweight, but cannot be considered as the sole and sufficient treatment for the condition.

The findings of Chudzicka-Strugała et al.¹³ demonstrate that lifestyle changes promote weight loss in women with PCOS, and this reduction is even greater when associated with synbiotic supplementation. Similarly, Łagowska and Drzymała-Czyż²⁰ found that calorie-restricted diets lead to weight loss and improve lipid profiles, without probiotic supplementation offering significant additional benefits. This suggests that diet alone plays a key role in improving metabolic parameters.

Probiotic supplementation also showed positive effects on different parameters. Karimi et al.²¹ found improvements in the lipid profile with synbiotics, but without significant

impact on anthropometric measurements. In the study by Hariri et al.²², symbiotic supplementation brought benefits to quality of life, without changes in anthropometric indices.

Finally, Kaur et al.²³ found that probiotic supplementation, associated with diet and lifestyle changes, contributed to improvements in menstrual regularity and insulin resistance, reinforcing the complementary role of probiotics in the treatment of PCOS.

Therefore, despite the evident benefits, probiotic supplementation and a healthy lifestyle are not sufficient as a single treatment for women with PCOS and overweight. The therapeutic approach should be multifactorial, including dietary management, physical exercise and, when necessary, specific pharmacological interventions.

Combined benefits of probiotic supplementation and lifestyle changes on metabolic and hormonal control: what is concrete?

Studies show that women who are overweight or obese account for more than 75% of excess direct spending on health services, which exceeds US\$400 billion.¹⁷ Even with efforts to address this condition, the rate of obesity worldwide continues to rise.¹⁷

Obesity worsens the presentation of PCOS, and ideal weight control is proposed as an initial treatment strategy.²⁴ Given the above, adopting lifestyle changes (diet and exercise) is widely recognized as one of the most important lines of treatment for weight control and, in the case of women diagnosed with PCOS, this would help with the clinical picture of the disease. Excess body weight worsens the underlying hormonal disorders (increased androgen and insulin levels) and the clinical features evident in women with PCOS.²⁴

The vast evidence on the correlation between the intestinal microbiome and the development of metabolic disorders has led to the hypothesis that alterations in the microbiome are

also involved in the genesis of PCOS.¹⁴ Patients with PCOS have lower diversity and an altered phylogenetic profile in their fecal microbiome, which is associated with clinical parameters.²⁵ Probiotic supplements have been shown to improve the metabolic profiles of PCOS patients.²⁶ Therefore, probiotic supplementation has been promoted as a possible solution to this imbalance in the intestinal microbiota, as it may reduce the metabolic disorders characteristic of PCOS, such as insulin resistance and hyperandrogenism. Probiotics and synbiotics can be effectively integrated into existing treatment regimens, offering a viable alternative to conventional pharmacological therapies.²⁷ This assumption was associated by some researchers with the adoption of lifestyle changes by study participants, with the aim of enhancing treatment results and/or verifying the real potential of probiotic supplementation.

Given the above, it is possible to infer that probiotic supplementation together with the proposed lifestyle changes would present more beneficial results in the metabolic and hormonal profiles and in the participants' quality of life compared to the interventions alone. In addition, probiotics were also associated with metformin, a medication already used to treat PCOS, which could also present a positive outcome in different parameters. Despite this, some limitations of the outcomes are the lack of stipulation of a specific dose and strain — which vary between studies — and the great variability of parameters that the syndrome presents, and some could require a longer follow-up period for better verification of the results.

Therefore, despite the evident benefits, probiotic supplementation and a healthy lifestyle are not sufficient as a single treatment for women with PCOS and overweight. The therapeutic approach should be multifactorial, including dietary management, physi-

cal exercise and, when necessary, specific pharmacological interventions.

CONCLUSION

According to studies, it can be stated that performing physical exercises together with following an adequate diet is essential for the treatment of PCOS, especially for improving anthropometric measurements.

Probiotic supplementation has generally shown positive results, although there are some discrepancies between studies, which can be explained by, among other factors, the length of follow-up, the strains chosen and the doses consumed by the participants. Therefore, it is possible to infer that regular physical activity, maintaining a healthy diet and probiotic supplementation have shown beneficial results in the treatment of the syndrome.

Despite this, it cannot be concluded that compliance with these interventions is sufficient for the complete management of all complications, since this is a multifactorial disease and the particularities of each patient.

Therefore, more studies are needed to verify the best way to consume probiotics for the treatment of PCOS, considering appropriate strains and doses, and the effects of ingesting them with traditional medicines already used for this pathology with the aim of obtaining a comprehensive treatment.

ACKNOWLEDGEMENTS

To the Undergraduate Education Support Fund (FAEG) of Univille, which made the ECONUTRI Project possible.

REFERENCES

1. Tong L, Yu H, Yang X, Huang Y, Chen Y. Mechanisms linking gut microbiota and insulin resistance in polycystic ovary syndrome. *Front Endocrinol (Lausanne)*. 2022;13:858855.
2. Szczuk I, Bielska A, Piotrowska A, Szydlowska I, Brodowski J, Szymański W. Phenotype and clinical features in different PCOS phenotypes in a single center. *Int J Environ Res Public Health*. 2021;18(13):6981.
3. Sadeghi N, Mansoori A, Shayesteh AA, Ebrahimi S, Sohrab G. Effects of lifestyle modification on metabolic parameters and oxidative stress in women with polycystic ovary syndrome: a systematic review and meta-analysis. *Diabetol Metab Syndr*. 2022;14(1):5.
4. Alesi S, Venturella R, Rania E, Massaro MG, Di Carlo C, Fazio G, et al. Lifestyle and fertility: the influence of diet, physical activity, and body weight on fertility. *Nutrients*. 2022;14(19):3921.
5. Zhu J, Cui L, Goodarzi MO. Polycystic ovary syndrome and liver disease: a new take on an old question. *Clin Liver Dis (Hoboken)*. 2020;16(6):262–5.
6. Che L, Xu Y, Zhang T, Sun H, Yang X, Wang D. Nutritional interventions improve the ovulatory function and metabolism of overweight and obese women with polycystic ovary syndrome: a systematic review and meta-analysis. *Obes Rev*. 2021;22(4):e13136.
7. Rodrigues A, Fernandes VO, Silva S, Rodrigues F. Probiotic supplementation in women with polycystic ovary syndrome: a systematic review and meta-analysis of randomized controlled trials. *Nutrients*. [s.d.].
8. Di Lorenzo M, Cacciapuoli N, Lonardo MS, Terlizzi F, De Placido G, Fattorusso V, et al. Weight Management Strategies to Reduce Metabolic Morbidity in Women With Polycystic Ovary Syndrome. *Clin Ther*. 2023;45(7):e145–61.
9. Joham AE, Teede HJ, Ranasinha S, Zoungas S, Boyle J. Prevalence and predictors of overweight and obesity in women with polycystic ovary syndrome. *Med J Aust*. 2022;216(4):183–8.
10. Awoke MA, Tekle FF, Ayele BA, Alemayehu W, Alemayehu M. Association between body mass index and polycystic ovary syndrome: a systematic review and meta-analysis. *BMC Endocr Disord*. 2022;22(1):156.
11. Kazemi M, Yousefi H, Hoseinzadeh S, Esmaeili R, Arefi S, Karamali M, et al. The association of obesity with polycystic ovary syndrome: a systematic review and meta-analysis. *Obes Med*. 2022;28:100438.
12. Ahn CH, Lee SH, Cho YM. Relationship between insulin resistance and polycystic ovary syndrome. *J Korean Med Sci*. 2020;35(4):e32.
13. Chudzicka-Strugała I, Marczak M, Adamczak M, Wilk M. Gut microbiota, probiotics and prebiotics in polycystic ovary syndrome—review. *Int J Mol Sci*. 2021;22(23):12933.
14. Giampaolino P, Foreste V, Della Corte L, Vitale SG, Fusco F, Della Corte R, et al. Role of probiotics in the treatment of polycystic ovary syndrome. *Minerva Obstet Gynecol*. 2021;73(2):218–32.
15. Xie Y, Guo Y, Huang J, Zhu J, Chen Z, Liu Y, et al. Effects of different probiotic strains on metabolic profiles in PCOS: A systematic review and meta-analysis. *Nutrients*. 2023;15(3):675.
16. Diakosavvas M, Oyeboode O, Bhide A. The role of probiotics in the management of PCOS: a narrative review. *Arch Gynecol Obstet*. 2025;311(1):1–8.
17. Marinelli L, Tenore GC, Stiuso P, Nazzaro F, Maisto M, Novellino E. Challenges in assessing probiotic efficacy in PCOS: a call for standardized trials. *Nutrients*. 2022;14(9):1885.
18. Galvão TF, Pereira MG. Revisões sistemáticas da literatura: passos para sua elaboração. *Epidemiol Serv Saude*. 2014;23(1):183–4.
19. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2022;372:n71.
20. Łagowska K, Drzymala-Czyż S. Effects of calorie-restricted diet with or without probiotic supplementation in women with polycystic ovary syndrome. *Nutrients*. 2022;14(5):953.
21. Karimi M, Rezaei M, Fallahzadeh H, Mirzaei K. Effects of synbiotic supplementation on anthropometric indices and lipid profile in women with polycystic ovary syndrome: a randomized controlled trial. *J Res Med Sci*. 2020;25:20.
22. Hariri M, Salehpour S, Seifati SM, Ghaemi S, Mirtaheri E, Yari Z. Effect of synbiotic supplementation on quality of life and anthropometric indices in women with polycystic ovary syndrome: a randomized clinical trial. *BMC Endocr Disord*. 2024;24(1):17.
23. Kaur H, Kumar A, Jindal A, Gupta P. Role of lifestyle modification and probiotics in improving menstrual regularity and insulin resistance in PCOS: a prospective trial. *J Obstet Gynaecol Res*. 2022;48(7):1595–602.
24. Lim SS, Davies MJ, Norman RJ, Moran LJ. Overweight, obesity and central obesity in women with polycystic ovary syndrome: a systematic review and meta-analysis. *Hum Reprod Update*. 2019;25(3):312–24.
25. Lindheim L, Bashir M, Münzker J, Trummer C, Zachhuber V, Pieber TR, et al. Alterations in gut microbiome composition and barrier function are associated with reproductive and metabolic defects in women with PCOS: A pilot study. *PLoS One*. 2017;12(1):e0168390.
26. Ramzan H, Bukhari DA, Bibi Z, Arifullah, Isha, Nawaz A, Rehman A. Probiotic supplement for the treatment of polycystic ovarian syndrome. *Pharmacol Ther*. 2025;266:108785. doi: 10.1016/j.pharmthera.2024.108785.
27. Guevara DM, Vidal Cañas S, Palacios I, Gómez A, Estrada M, Gallego J, Liscano Y. Effectiveness of probiotics, prebiotics, and synbiotics in managing insulin resistance and hormonal imbalance in women with polycystic ovary syndrome (PCOS): A systematic review of randomized clinical trials. *Nutrients*. 2024;16(23):3916. doi: 10.3390/nu16223916.