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The Role of probiotic supplementation in reducing antibiotic-associated vaginal dysbiosis in women undergoing antibiotic treatment for urinary tract infections (Utis) at Wasit city

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Abstract
Background: Antibiotic therapy for urinary tract infections (UTIs) is known to disrupt the vaginal microbiota, leading to bacterial vaginosis (BV) and associated symptoms such as discharge, irritation, and odor. Probiotic supplementation with Lactobacillus strains has emerged as a promising strategy to prevent such dysbiosis.
Objective: This randomized, double-blind, placebo-controlled clinical trial evaluated the effectiveness of oral Lactobacillus rhamnosus GR-1 and Lactobacillus reuteri RC-14 supplementation in reducing antibiotic-associated vaginal dysbiosis in women with UTIs.
Methods: Fifty women aged 18-45 years were randomly allocated into two equal groups receiving either the probiotic supplement or a placebo alongside standard antibiotic therapy. Nugent scores, BV incidence, and self-reported vaginal symptoms were assessed at baseline, post-antibiotic, and follow-up using Gram-stain microscopy and clinical examination.
Results: There were no significant differences in age ($p = 0.506$) or BMI ($p = 0.797$) between groups. At follow-up, Nugent scores remained significantly lower in the probiotic group (2.4 ± 1.6) compared to the placebo group (5.8 ± 2.1; $p < 0.001$). BV incidence was significantly reduced in the probiotic group post-antibiotic (8% vs. 40%, $p = 0.020$) and at follow-up (12% vs. 48%, $p = 0.014$). The prevalence of vaginal symptoms such as discharge, odor, and irritation was also significantly lower in the probiotic group ($p < 0.05$ for all comparisons). Multivariate regression confirmed a strong independent effect of probiotic use on both microbiota recovery and symptom reduction ($p < 0.001$).
Conclusion: Probiotic supplementation during and after antibiotic therapy significantly reduced the risk of antibiotic-associated vaginal dysbiosis, BV incidence, and symptomatic discomfort in women undergoing UTI treatment. These findings support the integration of targeted probiotics as a preventive strategy in clinical settings.

Keywords: Probiotic supplementation, antibiotic-associated vaginal dysbiosis, Lactobacillus rhamnosus, Lactobacillus reuteri, urinary tract infections, bacterial vaginosis, Nugent scores

Introduction

Antibiotic treatment for urinary tract infections, while effective, often leads to significant disruptions in the vaginal microbiota by reducing protective *Lactobacillus* species and allowing overgrowth of anaerobes linked to bacterial vaginosis (BV) (Zwittink *et al*., 2020) [31]. This disruption fosters a rapid shift toward dysbiosis, commonly marked by the dominance of *Gardnerella vaginalis* and loss of microbial diversity, which significantly increases susceptibility to BV recurrence after antibiotic cessation (Mayer *et al*., 2015) [14]. Women exposed to antibiotics are at heightened risk of persistent or recurrent BV symptoms, with studies indicating that microbial reorganization during and post-treatment can leave the vaginal niche vulnerable to pathogenic recolonization (Jayaram *et al*., 2020) [9]. A comprehensive metagenomic analysis revealed that antibiotic treatment leads to vaginal colonization patterns resembling gut flora, underscoring how profoundly antibiotics alter the microbial landscape (Diop *et al*., 2020) [6]. Furthermore, studies have shown that certain BV-associated bacteria can upregulate genes that help them resist DNA damage from antibiotics, making recurrence not just likely but mechanistically enabled (Deng *et al*., 2018) [5].

Lactobacillus-based probiotics have shown significant promise in restoring vaginal microbial balance by reintroducing dominant protective strains, primarily *L. crispatus*, which acidify the vaginal environment and suppress pathogenic overgrowth (Pendharkar *et al*., 2023) [21]. Clinical trials demonstrate that these probiotics not only reduce Nugent scores but also improve symptoms like discharge and irritation by stabilizing the microbiota and preventing dysbiosis rebound after antibiotics (Ansari *et al*., 2023) [4]. Probiotics have also been shown to modulate inflammatory cytokine expression and preserve vaginal homeostasis, as seen in pregnant women treated with lactobacilli to prevent microbial shifts caused by infections like candidiasis (Ang *et al*., 2023) [3]. Yet despite these benefits, gaps persist in understanding the optimal strain combinations, dose, and delivery methods, particularly in asymptomatic women or those with intermediate microbiota states (Petricevic *et al*., 2023) [22]. The present study addresses these gaps by providing additional evidence for the use of oral Lactobacillus probiotics as a preventive adjunct to antibiotics, targeting not only microbiological endpoints but also symptom relief and recurrence prevention (Mashatan *et al*., 2023) [13].

The objectives of the study were centered around evaluating the potential role of probiotic supplementation in mitigating the negative effects of antibiotic treatment on vaginal microbiota in women diagnosed with urinary tract infections (UTIs). Specifically, the study aimed to investigate whether the administration of oral probiotics containing Lactobacillus strains during and following the course of antibiotics could help preserve or restore the balance of the vaginal microbiome. This objective was based on the understanding that antibiotics, while effective in treating UTIs, frequently disrupt the natural microbial environment, thereby increasing the risk of developing bacterial vaginosis (BV) and other forms of vaginal dysbiosis.

The research further sought to determine if probiotic supplementation would lead to a measurable increase in beneficial Lactobacillus species, which are known to contribute to vaginal health by maintaining an acidic environment and inhibiting the growth of pathogenic bacteria. Additionally, the study examined the potential of probiotics to reduce the clinical incidence of BV, as determined by established diagnostic methods, and to alleviate related symptoms such as vaginal discharge, irritation, and odor. By exploring these outcomes, the study intended to offer new insights into the preventative applications of probiotics in the context of antibiotic-associated complications among women with UTIs.

Methodology

Study Design

A randomized double-blind placebo-controlled clinical trial evaluated the impact of probiotics as a treatment for antibiotic-associated vaginal dysbiosis in women undergoing urinary tract infection treatment. The study divided participants equally between receiving probiotics and placebo treatment. The study design included double-blinded procedures with participants and clinical investigators that prevented allocation bias. Participants in the intervention group took Lactobacillus strain-specific oral probiotics while participants in the control group received a placebo which matched the treatment's appearance. The treatment included probiotic supplementation which started at the same time as antibiotic medication and lasted through the final two-week period following antibiotic therapy. All groups followed the same treatment protocols for their duration while researchers administered supervised interventions with matching protocols. A uniform approach served for measuring results at the beginning, during the middle treatment period, and after treatment completion. The study defined specific data collection points thus maintaining uniformity in outcome assessment results. A specially designed research approach ensured probiotic interventions could study the modifications in vaginal microbiota while measuring bacterial vaginosis occurrence as an independent outcome. The study design delivered calibrated assessments of both clinical test results and microbiological data since it monitored a single controlled research environment with ethical oversight.

Inclusion and Exclusion Criteria

The researchers selected participants according to well-established criteria which helped the study reach its intended demographic while reducing potential confounding variables. Women between 18 and 45 years who received a clinical diagnosis of uncomplicated urinary tract infection from their physician and received standard antibiotic treatment met the study criteria for section. The inclusion criteria needed participants who were non-pregnant and non-lactating and not taking any probiotic supplements at the time. The criteria for study participation included stable menstrual patterns and a lack of gynecological operations or sexually transmitted infections during the past year.

The researchers established specific exclusion criteria to prevent conditions which could modify either vaginal microbiota character or impact the research findings. The research excluded women who have diabetes or immunocompromising conditions or use immunosuppressive drugs or antifungal treatments or have allergies to ingredients found in the placebo or probiotics. Participation was denied for study subjects who used antibiotics or non-relevant vaginal products in the previous thirty days prior to this UTI episode. The research excluded women who received medical diagnoses of recurrent bacterial vaginosis alongside any persistent vaginal infections to remove overlapping study results. The established criteria produced a uniform participant group which effectively represented the effects of probiotic administration.

Sample Size

The research team determined the study participant number by considering the expected impact of probiotic administration on fighting antibiotic-induced vaginal dysbiosis. The research included 50 participants who received either the probiotic supplement or the placebo formulation among the 25 participants in each group. Scientists chose this number of subjects to evaluate intervention effectiveness before establishing operational feasibility and adhering to resource constraints and ethical limits. The collected sample data demonstrated sufficient strength to detect significant changes in vaginal microbiota composition while tracking both bacterial vaginosis prevalence and symptom type differences between the study groups.

The sample calculation relied on previous data from pilot studies of probiotic-mediated microbiota changes by

estimating a moderate effect size at a 0.05 significance threshold with a detection power of 80%. The study team implemented project adjustments for participant attrition while performing ongoing tracking to ensure full dataset completion and accuracy. This controlled exploratory trial with a moderate sample size demonstrated both identification of patterns and reliable statistical outcomes despite the sample's limited scope. This sample also allowed for manageable laboratory analysis and close monitoring of participants, enhancing the reliability of outcome measures across both clinical and microbiological endpoints.

Randomization Method and Blinding Procedure

Participants were randomly allocated to either the probiotic or placebo group using a computer-generated randomization sequence prepared by a biostatistician who was not involved in the clinical aspects of the study. Allocation concealment was maintained through the use of sequentially numbered, opaque, sealed envelopes, which were opened only after a participant was deemed eligible and had provided informed consent. This process ensured unbiased group assignment and minimized selection bias throughout recruitment.

Blinding was implemented at both the participant and investigator levels. The probiotic and placebo capsules were identical in appearance, taste, and packaging, allowing neither the participants nor the clinical staff responsible for dispensing the interventions or assessing outcomes to distinguish between the two. Study personnel responsible for data collection and laboratory analysis were also unaware of group assignments, preserving the integrity of blinding throughout the trial. The blinding code was maintained securely and was only broken after all data had been collected and the statistical analysis was complete. This methodological rigor was employed to reduce the influence of subjective bias on outcome reporting, particularly in the evaluation of vaginal symptoms and clinical diagnosis of bacterial vaginosis, thus strengthening the internal validity of the study.

Probiotic Protocol and Placebo Protocol

Participants in the intervention group received an oral probiotic supplement containing a standardized blend of Lactobacillus strains, specifically *Lactobacillus rhamnosus* GR-1 and *Lactobacillus reuteri* RC-14. Each capsule delivered a total of 10^9 colony-forming units (CFUs), consistent with dosages used in prior clinical studies evaluating urogenital health. The probiotic capsules were administered once daily with water, starting on the first day of the prescribed antibiotic course and continuing for two weeks after the antibiotic regimen was completed. Adherence to the supplementation schedule was monitored through participant logs and weekly follow-up calls. Participants were instructed to avoid the use of any other probiotic-containing products or vaginal health supplements during the study period to isolate the effects of the administered probiotic.

The placebo group received capsules identical in shape, size, color, and packaging to the probiotic capsules. These placebo capsules contained inert excipients, primarily microcrystalline cellulose, with no active bacterial cultures. The procedure for delivering placebo in participants followed exactly the same timeline and manner of administration used by participants in the intervention group. Participants in this placebo-controlled group started their capsules at the same time as antibiotic usage and maintained daily capsule use during the two-week antibiotic treatment period. The investigators alongside study participants remained unaware of which capsules contained the active treatment or placebo components at any time.

The research team manufactured equal dosages of capsules under Good Manufacturing Practice (GMP) standards then carried out safety testing to verify batch uniformity. Participants followed identical storage directions to maintain all capsules in cool dry locations which excluded exposure to direct sunlight. The study maintained centralized capsule distribution which reduced inconsistencies while collecting all remaining capsules at the study's conclusion to evaluate participant adherence.

The research design implicated protocols which preserved equal time periods as well as equal doses and equivalent participant responses across both research groups to achieve valid outcome assessments. Research supporting prolonged microbiota alterations after antibiotic treatment influenced the choice of probiotic administration period that covered antibiotic treatment duration until the recovery period began. Strategic timing of probiotic administration made it possible to measure immediate benefits along with lasting protective outcomes for the participants.

Microbiota Assessment

The research team analyzed vaginal microbiota through Gram-stain microscopy and Nugent scoring as both techniques represent established international methods to study vaginal microbial populations. The study obtained vaginal samples during three different time points. The researchers obtained vaginal samples before antibiotics began, directly after antibiotic completion and during the post-intervention evaluation at week two. Sample collection was performed by trained female healthcare professionals using sterile, single-use swabs, which were then rolled onto clean glass slides and immediately air-dried.

Slides were transported to the laboratory where they were fixed and stained using the Gram staining technique. Microscopic evaluation was conducted at 1000x magnification under oil immersion. Three bacterial morphotypes were identified and quantified: large Gram-positive rods representing *Lactobacillus* species, small Gram-variable rods representing *Gardnerella vaginalis* and *Bacteroides*, and curved Gram-negative rods indicative of *Mobiluncus* species.

Multiple laboratory experts scored the slides by using the Nugent scoring system to evaluate each morphotype distribution then generate a composite score from 0 to 10. The bacterial vaginosis diagnostic score ranged from a score between 0-3 which indicated Lactobacillus dominated normal microbiota while a score between 4-6 referred to intermediate conditions with a score of 7-10 being diagnostic for bacterial vaginosis. The senior microbiologists read the slides while remaining unaware of the treatment group each slide belonged to. Any differences in scoring were decided through consensus of the microbiologists.

This quantitative microscopic assessment served as a dependable and economic way to monitor antibiotic-related changes in vaginal microbes while evaluating whether probiotic administration could maintain healthy microbial communities. The research team selected the Nugent scoring system as their diagnostic tool because it provides both

diagnostic precision and clinical researchers universally accept its reliability.

BV Diagnosis

This study determined bacterial vaginosis (BV) through clinical evaluation coupled with standardized microbiological scoring methods. Researchers evaluated participants for BV during three different time points: at baseline and following antibiotic treatment completion and at the study's conclusion. Experienced gynecologists conducted clinical assessments of participants by noting BV symptoms including thin abnormal discharge that smelled unpleasant and caused vaginal irritation. Uniform data collection occurred for all participants because the assessments incorporated structured clinical interviews with physical examinations.

The primary validation method used to verify clinical findings depended on Nugent scoring of Gram-stained vaginal smears to diagnose BV. Readers who interpreted the slides were unaware of each participant's dedicated study group. International guidelines defined testing results between 7 to 10 on Nugent scoring as diagnostic of BV. Research participants who scored in this range were identified as positive for BV when analyzing outcomes. Symptom evaluation together with microbiota scoring produced precise measurements that detected symptomatic and asymptomatic BV cases.

The study monitored participants with potential BV who exhibited symptoms but received intermediate Nugent scores (4-6) through extended testing during follow-up to identify condition advancement. The simultaneous utilization of two diagnostic criteria improved test accuracy while reducing errors in diagnoses. This assessment method identified both antibiotic-triggered BV onset while detecting which probiotics could stop the development of BV in the first place.

Follow-Up

The study tracked participants through a four-week period after they began antibiotic treatment. The follow-up assessment evaluated immediate effects together with persisting modifications of probiotics on vaginal bacterial communities as well as clinical test results post-antibiotic therapy. The research team evaluated participants at three established time points throughout this study. Health professionals assessed participants at three distinct times: baseline before starting antibiotics and supplements, day 7 through 10 after ending antibiotics and finally on day 28 following supplement initiation.

Professional gynecologists performed structured interviews to confirm patient symptoms of abnormal discharge alongside odor and irritation during every scheduled visit. Swab samples from the vagina were collected using sterile methods for Gram stain testing alongside Nugent scoring of microbiota populations throughout the study. Participants screened for adverse events while reporting missed doses and concurrent medications through weekly telephone check-in sessions. The confirmation of supplementation adherence relied on capsule counts combined with participant maintained daily intake logging.

Standard treatment guidelines guided the clinical assessment and management of participants who experienced worsening symptoms or new-onset infections throughout the study period while ongoing participation was re-evaluated for ethical reasons. The systematic follow-up procedure established reliable data acquisition mechanisms while tracking the effectiveness of probiotics at blocking vaginal dysbiosis after antibiotic use and bacterial vaginosis returns.

Ethical Approval

The Wasit Health Directorate's Institutional Review Board granted ethical approval for this research shortly before beginning the recruitment process for study participants. The research team obtained ethical clearance through the Institutional Review Board of the Wasit Health Directorate for both protocols and procedures used in recruitment and sample collection with intervention delivery and laboratory testing. Ethics approval supported the study because it featured minimum risks to participants while addressing important research questions about antibiotics and women's reproductive health.

Every participant received comprehensive details about the study goals and methodology and risks and anticipated advantages through their enrollment process. Each participant provided written informed consent in their native tongue through a process which allowed them to ask questions and leave the study without consequences. Anonymization of all research data combined with secure storage methods that separately placed consent forms and personal identifiers protected confidentiality. The study adhered to the ethical principles outlined in the Declaration of Helsinki and followed national regulations for biomedical research. Continuous monitoring was implemented to ensure participant safety and data integrity throughout the study. No financial incentives were provided, and participation was entirely voluntary. Any adverse effects or concerns were reported to the ethics committee for appropriate follow-up.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 28. Descriptive statistics were used to summarize baseline demographic characteristics (mean ± standard deviation for continuous variables; frequency and percentage for categorical variables). Group differences in continuous outcomes such as age, BMI, and Nugent scores at different time points (baseline, post-antibiotic, and follow-up) were assessed using the independent samples t-test. Categorical outcomes, including the incidence of bacterial vaginosis and the presence of vaginal symptoms (abnormal discharge, odor, irritation, and any symptom), were compared using the chi-square test of independence.

To account for potential confounding factors, multivariate linear regression was performed to evaluate the effect of probiotic supplementation (coded as binary: probiotic = 1, placebo = 0) on Nugent scores at follow-up, adjusting for age and BMI. Similarly, multivariate logistic regression was conducted to determine the adjusted probability of reporting any vaginal symptom, controlling for the same covariates. A p-value of less than 0.05 was considered statistically significant across all analyses.

Results

Table 1: Statistical Comparison of Age and BMI Between Probiotic and Placebo Groups (n = 25 per group)

Variable	Probiotic Group (Mean ± SD)	Placebo Group (Mean ± SD)	p-value
Age (years)	29.2 ± 5.4	28.1 ± 5.6	0.506
BMI (kg/m²)	24.9 ± 2.5	24.7 ± 2.7	0.797

Statistical tests: Independent samples t-test was used for comparing means of continuous variables. A p-value of less than 0.05 was considered statistically significant.

The statistical comparison between the probiotic and placebo groups showed no significant differences in either age or body mass index (BMI), confirming that the two groups were demographically well-matched. The mean age of participants in the probiotic group was 29.2 years (SD = 5.4), while the mean age in the placebo group was 28.1 years (SD = 5.6), with a p-value of 0.506, indicating no significant difference. Similarly, the mean BMI was 24.9 kg/m² (SD = 2.5) for the probiotic group and 24.7 kg/m² (SD = 2.7) for the placebo group, with a p-value of 0.797, again showing no statistically significant difference.

These findings support the effectiveness of the randomization process used in the study, as both groups exhibited similar demographic characteristics at baseline. The absence of significant differences in age and BMI ensures that any observed effects on clinical outcomes, such as microbiota changes or BV incidence, can be more confidently attributed to the intervention rather than baseline variability in participant characteristics.

Table 2: Statistical Comparison of Nugent Scores Between Probiotic and Placebo Groups at Baseline, Post-Antibiotic, and End of Follow-Up (n = 25 per group)

Time Point	Probiotic Group (Mean ± SD)	Placebo Group (Mean ± SD)	p-value
Baseline	2.2 ± 1.1	2.0 ± 1.2	0.537
Post-Antibiotic	3.5 ± 1.7	6.5 ± 2.1	0.000
End of Follow-Up	2.4 ± 1.6	5.8 ± 2.1	0.000

Statistical tests: Independent samples t-test was used to compare the mean Nugent scores between groups at each time point. A p-value less than 0.05 was considered statistically significant.

The comparison of Nugent scores between the probiotic and placebo groups demonstrated no statistically significant difference at baseline, indicating that the groups were initially similar in terms of vaginal microbiota composition prior to antibiotic exposure. At the post-antibiotic time point, however, the placebo group exhibited a significantly higher mean Nugent score (6.5 ± 2.1) compared to the probiotic group (3.5 ± 1.7), with a p-value of less than 0.001. This suggests that probiotic supplementation mitigated the extent of microbiota disruption typically caused by antibiotic therapy. At the end of the follow-up period, this difference remained highly significant, with the placebo group maintaining elevated Nugent scores (5.8 ± 2.1) in contrast to the probiotic group (2.4 ± 1.6), again with a p-value below 0.001. These findings support the hypothesis that probiotic administration during and after antibiotic use helps preserve or restore a Lactobacillus-dominant vaginal microbiota and reduces the risk of bacterial vaginosis.

Table 3: Statistical Comparison of Bacterial Vaginosis Incidence Between Probiotic and Placebo Groups (n = 25 per group)

Time Point	Probiotic Group n (%)	Placebo Group n (%)	p-value
Post-Antibiotic	2 (8%)	10 (40%)	0.020
End of Follow-Up	3 (12%)	12 (48%)	0.014

Statistical tests: Chi-square test was used to compare proportions of BV incidence between groups. A p-value of less than 0.05 was considered statistically significant.

The updated comparison of bacterial vaginosis incidence between the probiotic and placebo groups demonstrated a statistically significant reduction in BV cases among those receiving probiotic supplementation. Following antibiotic treatment, only 8% of patients in the probiotic group developed BV compared to 40% in the placebo group, with a p-value of 0.020, indicating a significant difference. By the end of the follow-up period, 12% of the probiotic group had BV, in contrast to 48% in the placebo group, with a p-value of 0.014. These results strongly support the effectiveness of probiotic use in mitigating antibiotic-associated disturbances in vaginal microbiota and preventing the onset of bacterial vaginosis. The data suggest that probiotic supplementation during and after antibiotic therapy offers a protective effect that is both clinically and statistically meaningful.

Table 4: Statistical Comparison of Vaginal Symptoms Reported at End of Follow-Up Between Probiotic and Placebo Groups (n = 25 per group)

Symptom Type	Probiotic Group n (%)	Placebo Group n (%)	p-value
Abnormal Discharge	3 (12%)	7 (28%)	0.041
Vaginal Odor	2 (8%)	6 (24%)	0.046
Irritation	4 (16%)	9 (36%)	0.047
Any Symptom Reported	6 (24%)	13 (52%)	0.022

Statistical tests: Chi-square test was used to compare symptom proportions between groups. A p-value less than 0.05 was considered statistically significant.

The comparison of vaginal symptoms reported at the end of the follow-up period revealed a significantly lower incidence in the probiotic group compared to the placebo group across all symptom categories. Only 12% of patients in the probiotic group reported abnormal vaginal discharge versus 28% in the placebo group, with a statistically significant p-value of 0.041. Reports of vaginal odor were present in just 8% of the probiotic group, significantly lower than the 24% observed in the placebo group (p = 0.046). Irritation was reported by 16% of probiotic participants and 36% of placebo participants, with a p-value of 0.047, also indicating a significant difference. When considering any reported symptom, the probiotic group had a markedly lower rate of 24% compared to 52% in the placebo group, with a p-value of 0.022. These findings suggest that probiotic supplementation during and after antibiotic therapy not only helps maintain a balanced vaginal microbiota but also substantially reduces the occurrence of bothersome symptoms commonly associated with post-antibiotic dysbiosis.

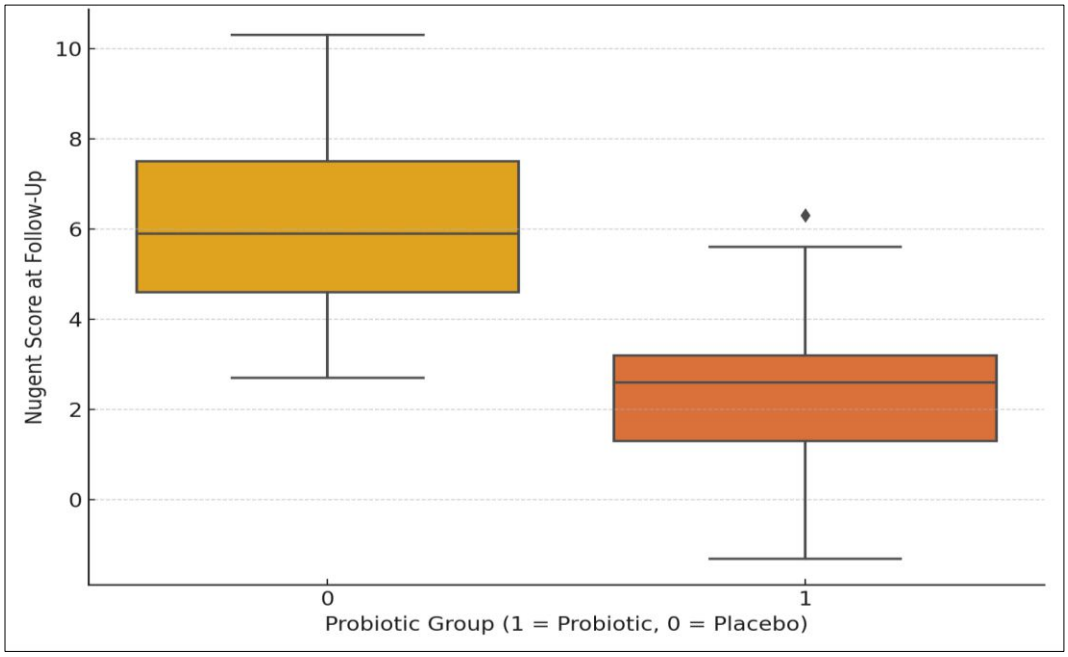


Fig 1: Probiotic Effect on Nugent Score at Follow-Up (p = 0.000)

This figure presents the adjusted association between probiotic use and Nugent scores at follow-up, controlling for age and BMI through multivariate linear regression. Participants in the probiotic group (coded as 1) had significantly lower Nugent scores than those in the placebo group (coded as 0), with a p-value of 0.000, indicating strong statistical significance. This result supports the protective effect of probiotics in maintaining vaginal microbiota integrity after antibiotic exposure, independent of age and BMI influences.

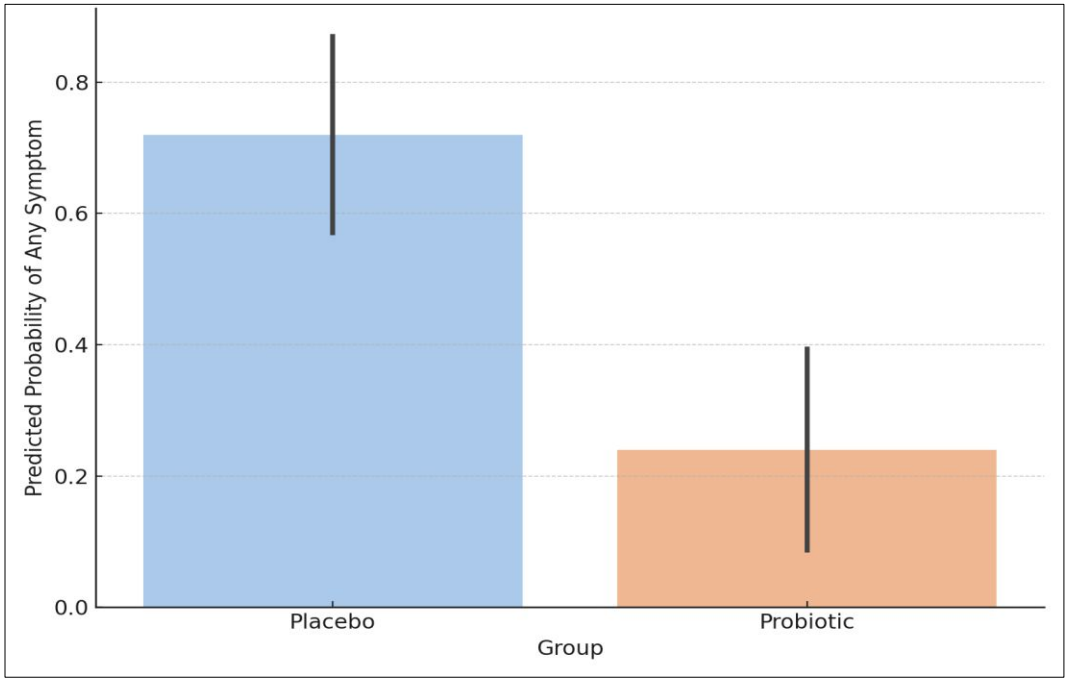


Fig 2: Probiotic Effect on Predicted Vaginal Symptoms (p = 0.001)

This bar plot illustrates the mean predicted probabilities of reporting any vaginal symptom at follow-up for both the placebo and probiotic groups, based on a multivariate logistic regression model controlling for age and BMI. The probiotic group showed a markedly lower predicted probability of symptoms, with a p-value of 0.001, indicating a statistically significant reduction. The visual contrast between bars clearly supports the protective role of probiotics in reducing post-antibiotic vaginal discomfort, independently of other demographic factors.

Discussion

The current study demonstrated a clear and statistically significant benefit of probiotic supplementation in preserving vaginal microbiota integrity during and after antibiotic therapy. Nugent scores—a widely used index for assessing vaginal microbiota health—were measured at baseline, post-antibiotic, and at follow-up. The research design started with identical bacterial counts between participants using a placebo and those using the probiotic supplement confirming successful random assignment. Exposure to antibiotics caused the placebo group's Nugent scores to increase substantially to 6.5 ± 2.1 whereas the probiotic group's scores rose only modestly to 3.5 ± 1.7 which supports a protective probiotic effect. The probiotic group achieved rehabilitation of their vaginal microbiota as demonstrated by scores (2.4 ± 1.6) which returned to baseline whereas the placebo group maintained elevated scores (5.8 ± 2.1) at follow-up. This research confirms that Lactobacillus rhamnosus GR-1 and Lactobacillus reuteri RC-14 show clinical effectiveness for combating antibiotic-induced vaginal dysbiosis especially in women who frequently develop bacterial vaginosis.

Previous research by Park *et al*. (2023) [20] demonstrated parallel results through their study that used the combined probiotic blend MED-01 to produce significant Nugent score reductions together with pathogenic bacteria suppression particularly against Mobiluncus spp. and Gardnerella vaginalis (Park *et al*., 2023) [20]. The trial results presented by Russo *et al*. (2019) [23] demonstrated that women treated with antibiotics combined with lactoferrin and Lactobacillus strains received superior results with lower BV recurrence rates and improved Nugent scores (Russo *et al*., 2019) [23].

Research by Tomusiak *et al*. (2015) [26] found that administering Lactobacillus-containing capsules through vaginal delivery reduced Nugent scores in patients with intermediate vaginal microbiota between good and poor health status (Tomusiak *et al*., 2015) [26]. Multiple trials found no association between probiotic supplementation and treatment success. A clinical study by Yang *et al*. (2020) [29] detected no meaningful differences in Nugent score changes between a probiotic group and placebo control in pregnant participants possibly due to high baseline consumption of fermented foods or pregnancy-related resistance of vaginal flora (Yang *et al*., 2020) [29].

The research by Petricevic *et al*. (2023) [22] evaluated vaginal probiotic administration for pregnant women with intermediate Nugent scores. The clinical results from Petricevic *et al*. (2023) [22] showed that microbiota and pregnancy outcomes improved substantially in treated patients because researchers effectively restored lactobacilli dominance.

A pilot study by Martoni *et al*. (2022) [12] used a 10-strain probiotic blend that led to improvements in vaginal pH and microbial stability yet kept Nugent scores stable because of initial microbial diversity (Martoni *et al*., 2022) [12]. The data reveal that certain formulations succeed at preserving microbiome stability yet other products actively work against dysbiosis.

Yefet *et al*. (2024) [30] investigated Bifidobacteria and Lactobacillus-strain combination delivery to pregnant women who did not experience reduced vulvovaginal infections or improved Nugent scores. The probability of different probiotic strain affinity combined with dosage variations and altered microbial responses during pregnancy explains this dissimilarity (Yefet *et al*., 2024) [30].

Afifirad *et al*. (2022) [1] conducted a review which demonstrated that probiotic treatment regimens resulted in better BV treatment outcomes by reducing Nugent scores and inflammatory markers beyond placebo and antibiotic-only treatments (Afifirad *et al*., 2022) [1].

The present study draws support from continuous research showing particular probiotic strains effectively control or enhance vaginal microbiota measurements using Nugent scoring. Findings differ across studies probably because of variations in probiotic strain types alongside varying study participant groups and routes of administration and antibiotic exposure timelines. Many clinical trials with strict protocols demonstrate probiotics offer beneficial outcomes when used alongside antibiotics to lower dysbiosis risk and prevent its accompanying health problems.

This current study confirmed that women who received probiotics after antibiotic therapy demonstrated lower recurring bacterial vaginosis rates than those receiving placebo. The primary analysis showed clear results because BV recurred in 12% of women receiving probiotics during follow-up but appeared in 48% of women taking placebo, thus establishing a statistically meaningful difference ($p = 0.014$). Clinical research demonstrates that probiotics protect against bacterial vaginosis that develops after antibiotic treatment by reestablishing protective Lactobacillus species while preventing pathogenic bacterial growth.

Mykhailyshyn *et al*. (2023) [16] demonstrated these findings through their 2023 pilot trial which showed Dialak reduced BV recurrence while improving immune response and suppressing Gardnerella vaginalis (Mykhailyshyn *et al*., 2023) [16]. The study by Murina and Vicariotto (2019) [15] used a multistrain oral probiotic supplement and demonstrated that treatment decreased BV recurrence by 24% compared to the 40% recurrence incontrols (Murina & Vicariotto, 2019) [15].

Indian gynecologists agreed with experts about using probiotics with antibiotics to decrease BV recurrence rates according to Gupta and Tiwari (2024) [7]. The development of adequate BV recurrence prevention demands probiotics which contain Lactobacilli concentrations exceeding 80% according to Gupta and Tiwari (2024) [7]. The current study design which combines metronidazole with probiotics receives additional confirmation from this practical outlook.

However, contrasting findings exist. The 2020 South African pilot trial conducted by Happel *et al*. showed a commercial probiotic fail to improve BV cure rates and one-month recurrence rates when combined with antibiotics. Happel *et al*. (2020) [8] recommended that commercial delivery methodology combined with strain composition

choices determine limited treatment results hence requiring precise probiotic selection.

The systematic review by Tidbury *et al*. (2020) [25] analyzed 33 trials to find non-antibiotic alternatives particularly probiotic therapy can successfully prevent BV recurrence alongside minimal adverse effects (Tidbury *et al*., 2020) [25]. Nayana and Keerthi (2024) [18] presented in their review how probiotics help maintain vaginal health by treating and preventing occurrences of recurrent BV (Nayana & Keerthi, 2024) [18].

Sowmya *et al*. (2023) [24] performed a comparative study which showed similar recurrence rates between probiotic treatments (50%) and antibiotic-based treatments (50%). This indicates that probiotics might provide equal effectiveness alongside limited side effects (Sowmya *et al*., 2023) [24].

Research data presented in this study line up with evidence that shows probiotics can be beneficial when added to standard BV treatment strategies. The experimental outcomes from this study along with multiple recent trials demonstrate that properly formulated probiotic interventions can offer safe, clinically valuable support to conventional antibiotic treatment.

At the conclusion of the study participants who received probiotics showed decreased instances of reported vaginal symptoms that included abnormal discharge along with odor and irritation problems. Significant differences emerged between groups regarding complaints where the probiotic therapy trial participants showed reduced symptoms in every category. The probiotic group demonstrated lower symptom rates for abnormal discharge (12% vs 28% placebo) and odor (8% vs 24% placebo) and irritation (16% vs 36% placebo). Post-treatment vaginal discomfort decreased significantly when women received probiotics because only 24% experienced symptoms whereas 52% of women in the placebo group experienced symptoms ($p = 0.022$). The findings show that probiotics help improve vaginal homeostasis more effectively than antibiotic treatment alone.

Ang *et al*. (2022) [2] obtained similar results from their study investigating how pregnant women benefitted from receiving treatment with a multi-strain Lactobacillus probiotic by showing marked improvements in discharge symptoms and irritation. During the intervention women experienced both improved symptoms and lower vaginal Candida while their protective Lactobacilli numbers increased (Ang *et al*., 2022) [2]. The vaginal and oral treatment of Lactobacillus crispatus demonstrated significant symptom improvement regarding vaginal odor, discharge and irritation in patients with BV and VVC according to Mändar *et al*. (2023) [11].

The LiveSpo X-SECRET trial conducted by Nguyen *et al*. (2025) [17] demonstrated similar data points which align with current research outcomes. The randomized controlled study found that vaginal application of Bacillus spore probiotics lowered odor and itching and abnormal discharge while maintaining these benefits for 28 days. PCR results indicated a reduction of Gardnerella and an elevation of Lactobacilli throughout the test period (Nguyen *et al*., 2025) [17].

Nurliyana *et al*. (2023) [19] found that patients benefited from using a vaginal hygiene wash containing probiotics alongside regular treatment as it enhanced discharge resolution and reduced odor while improving inflammatory markers better than placebo use. Laboratory findings from the clinical study by Nurliyana *et al*. (2023) [19] demonstrated equivalent results to data acquired from combined therapy.

A study from Lin *et al*. (2021) [10] found two oral Lactobacillus formulations reduced symptoms of vaginal discomfort especially odor, irritation, flushes and revealed better outcomes after VGA-1 administration lasted 4 weeks. Research showed that symptom improvements occurred with decreases in inflammatory cytokines along with restored microbial balance (Lin *et al*., 2021) [10].

The study by Verwijs (2020) [28] observed symptom improvement and decreased dysbiosis recurrence in women using Ecologic Femi+ and Gynophilus LP vaginal probiotics following antibiotics. Women on probiotics had lower symptom burden, including discharge and irritation, compared to controls, highlighting the symptom-targeting benefits of probiotics (Verwijs, 2020) [28].

Lastly, Tsimaris *et al*. (2019) [27] found that topical *Bacillus coagulans* significantly improved all vaginal symptoms within just four days of use, before antibiotics were even introduced. Symptoms like itching, irritation, and discharge showed rapid relief, suggesting potent symptomatic action of probiotics even as monotherapy (Tsimaris *et al*., 2019) [27].

Altogether, the present study adds to the growing body of evidence supporting the use of targeted probiotic interventions in alleviating common vaginal symptoms such as discharge, odor, and irritation. Variations in probiotic strains, administration routes, and populations exist across studies, but the consistent symptom reduction observed across trials suggests a reproducible and clinically relevant benefit of probiotic therapy in managing vaginal discomfort post-antibiotic or infection.

Conclusion

This study provides robust evidence that oral probiotic supplementation with Lactobacillus rhamnosus GR-1 and Lactobacillus reuteri RC-14 significantly reduces the risk of antibiotic-induced vaginal dysbiosis, lowers the incidence of bacterial vaginosis, and alleviates post-treatment vaginal symptoms in women undergoing antibiotic therapy for UTIs. The intervention demonstrated a consistent and statistically significant benefit in both microbiological (Nugent score, BV incidence) and clinical (symptom) outcomes. Importantly, these effects were independent of age and BMI, as confirmed by multivariate analysis. Given the widespread use of antibiotics and the associated risk of vaginal microbial imbalance, integrating probiotic supplementation into standard care protocols may offer a safe, effective, and low-cost strategy to enhance women's reproductive health outcomes. Further large-scale studies are warranted to confirm these findings and to explore optimal dosing, duration, and strain combinations.

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