Scientific Research Publishing

Advances in Microbiology, 2026, 16(1), 1-15
https://www.scirp.org/journal/aim
ISSN Online: 2165-3410
ISSN Print: 2165-3402

Comparative Study of Vaginal Microecological Characteristics in Populations with Different Disease Types

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How to cite this paper: Lu, M.Y., Wang, T.C., Luo, S.Q., Tang, X., Huang, P., Xie, M., Zhao, Q. and Liu, F.X. (2026) Comparative Study of Vaginal Microecological Characteristics in Populations with Different Disease Types. *Advances in Microbiology*, **16**, 1-15.
https://doi.org/10.4236/aim.2026.161001

Received: December 11, 2025
Accepted: January 13, 2026
Published: January 16, 2026

Abstract

Objective: To compare and analyze the differences in vaginal microecological characteristics between populations with Diminished Ovarian Reserve (DOR) and Polycystic Ovary Syndrome (PCOS), providing a scientific basis for the clinical diagnosis and treatment of reproductive health in women of childbearing age. **Methods:** A total of 2278 patients who visited our hospital from January 2024 to December 2024 were selected as study subjects, including 65 DOR patients and 177 PCOS patients. Using 35 years of age as the cut-off point, experimental group 1 (DOR patients) and control group 1, as well as experimental group 2 (PCOS patients) and control group 2, were established by 1:1 matching. The detection results of vaginal microecological indicators were compared and analyzed between groups. **Results:** Comparison between experimental group 1 and control group 1: Among individuals under 35 years old, there were no statistically significant differences in any vaginal microecological indicators ($P > 0.05$); among individuals aged 35 years and above, the positive rate of sialidase, indicators related to fungal vaginitis, microbial density, and Nugent score in experimental group 1 were lower than those in control group 1, with statistically significant differences ($P < 0.05$). Comparison between experimental group 2 and control group 2: Among individuals aged 35 years and above, there were no statistically significant differences in any indicators ($P > 0.05$); among individuals under 35 years old, the proportion with Gram-positive large bacilli as the dominant bacteria in experimental group 2 was significantly lower than that in control group 2, and there was a significant difference in Nugent score ($P < 0.05$). Comparison between experimental group 1 and experimental group

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2: The proportion of normal vaginal microecological status in experimental group 1 was lower than that in experimental group 2, with a statistically significant difference ($P < 0.05$). **Conclusion:** There are significant differences in the vaginal microecological characteristics between DOR and PCOS patients. Vaginal microecological changes are more pronounced in DOR patients aged ≥35 years, while vaginal microecological abnormalities in PCOS patients are mainly concentrated in those under 35 years old. This difference may be related to the age-related onset trends of the two diseases and also provides a basis for precise microecological interventions tailored to different ages and disease types.

Keywords

Vaginal Microecology, Diminished Ovarian Reserve, Polycystic Ovary Syndrome, Dominant Bacteria, Microbial Diversity

1. Introduction

The vaginal microecology of women of childbearing age is a core component of the vaginal microecosystem, composed of various microorganisms such as fungi, bacteria, and viruses. Under normal physiological conditions, it maintains a dynamic balance and plays a key role in ensuring vaginal health [1]. Once this balance is disrupted, it can easily lead to gynecological diseases such as vaginal infections, thereby affecting reproductive health. In recent years, with the deepening of clinical understanding of vaginal microecology, its association with gynecological diseases has attracted increasing attention [2] [3].

The International Federation of Gynecology and Obstetrics defines pregnant women aged 35 and above as advanced maternal age. Female fertility gradually declines with age, especially after 35 years old when ovarian reserve function significantly declines, leading to more prominent fertility issues [4]. Currently, there is no clear conclusion on whether there are specific changes in the vaginal microecology of women aged 35 and above, and whether these changes affect fertility. Existing research on vaginal microecology mostly focuses on cervical lesions, pregnancy, and infertility patients, lacking a systematic exploration of vaginal microbial status in women with different diseases and age groups. This study compares the differences in vaginal microecology between DOR and PCOS patients among women of childbearing age aged 35 and above versus under 35, exploring the impact of vaginal microecological changes on reproductive capacity to provide a basis for clinical diagnosis and treatment.

2. Materials and Methods

2.1. General Information

A total of 2278 patients who visited the outpatient clinic of our hospital from Jan-

uary 2024 to December 2024 were selected as the study subjects. Among them, 65 were diagnosed with DOR and 177 were diagnosed with PCOS. Based on age and season (to control for potential seasonal fluctuations in microecology due to climate, lifestyle habits, etc.), 1:1 matching was performed to establish experimental group 1 (65 DOR patients), with an average age of (37.78 ± 4.93) years; control group 1 (65 non-DOR individuals), with an average age of (37.78 ± 4.93) years; experimental group 2 (177 PCOS patients), with an average age of (31.21 ± 4.61) years; and control group 2 (177 non-PCOS individuals), with an average age of (31.20 ± 4.63) years. Each group was further divided into subgroups of ≥35 years and <35 years. There were no statistically significant differences in baseline characteristics between groups ($P > 0.05$). This study was approved by the hospital's ethics committee, and all enrolled subjects signed informed consent forms.

2.1.1. Inclusion Criteria

PCOS diagnosis met the 2003 Rotterdam diagnostic criteria (meeting 2 of the following 3 items: 1) oligo-ovulation or anovulation; 2) clinical or biochemical hyperandrogenism; 3) ultrasound findings of polycystic ovaries [5]). DOR diagnosis met the relevant criteria of the *Expert Consensus on Clinical Diagnosis and Treatment of Diminished Ovarian Reserve* (AMH < 1.1 ng/ml and AFC < 5 - 7 [6]). Patients were premenopausal, underwent vaginal microecological examination, and had complete clinical data.

2.1.2. Exclusion Criteria

Individuals with severe systemic diseases; those who were pregnant or lactating; those with a history of vaginal medication, vaginal douching, or sexual intercourse within 3 days prior to examination; and those with no history of sexual intercourse.

2.2. Detection Methods

All patients underwent vaginal microecological testing as follows: Under the assistance of a sterile speculum, vaginal secretions from the anterior one-third of the vaginal wall were collected and divided into two tubes for morphological and functional examination, respectively.

2.2.1. Morphological Examination

A dropper was used to aspirate the specimen immersion fluid and drop it onto a glass slide. Specimen cleanliness and bacterial morphology (e.g., *Candida*, *Lactobacillus*) were observed under a high-power microscope. The slide was then dried and stained, and microbial diversity, dominant bacteria, and density were observed under an oil immersion lens (×1000).

2.2.2. Functional Examination

Another sample was diluted with dilution solution and then sent to an automatic vaginitis detector to measure pH, enzyme activity, and metabolites of bacteria and fungi.

2.3. Vaginal Microecological Indicator Judgment Criteria

Definition of Normal Vaginal Microecology: Microbial density grade II - III, diversity grade II - III, dominant bacteria being *Lactobacillus*, pH 3.8 - 4.5, normal *Lactobacillus* function (normal hydrogen peroxide H_2O_2 secretion), negative indicators such as leukocyte esterase; if abnormalities occur in indicators such as microbial diversity, dominant bacteria, vaginal secretion leukocyte count (inflammatory response indicators), as well as pH, *Lactobacillus* function, etc., a state of microecological imbalance is diagnosed.

Indicators examined in this study included: vaginal pH, dominant bacteria category *Lactobacillus* Grading (LBG): Grade I refers to abundant polymorphic *Lactobacillus* with no other bacteria; Grade IIa refers to mixed flora but mainly *Lactobacillus*; Grade IIb refers to mixed flora but *Lactobacillus* proportion significantly reduced, less than other flora; Grade III refers to severe reduction or absence of *Lactobacillus*, with overgrowth of other bacteria. The morphological description "Gram-positive large bacilli" in this context primarily refers to *Lactobacillus*, and its grading is assessed via the aforementioned LBG system. Microbial diversity, microbial density, presence of bacterial vaginosis, as well as H_2O_2, sialidase, leukocyte esterase, etc. The Nugent score is a Gram-stain-based scoring system for diagnosing BV, with a total range of 0 - 10; a score of ≥7 is typically diagnostic for BV.

Microbial Diversity Grading: Number of distinguishable vaginal bacterial species under microscope: 1 - 3 species = Grade I; 4 - 6 species = Grade II; 7 - 9 species = Grade III; >9 species = Grade IV. **Microbial Density Grading:** Average number of bacteria per field of view: 1 - 9 = Grade I; 10 - 99 = Grade II; >99 = Grade III; bacteria densely covering mucosal epithelial cells or aggregated into clumps = Grade IV. Normal microbial diversity is grade II - III, normal microbial density is grade II - III. Positivity for H_2O_2, sialidase, and leukocyte esterase indicates abnormality.

2.4. Observation Indicators

Comparison of vaginal microecological detection results between experimental group 1 and control group 1;

Comparison of vaginal microecological detection results between experimental group 2 and control group 2;

Comparison of vaginal microecological detection results between experimental group 1 and experimental group 2.

2.5. Statistical Methods

R-4.3.3 software was used for data processing. Count data were expressed as (n, %), measurement data as ($\bar{x} \pm s$). Nugent score, microbial density, and *Lactobacillus* grading were treated as ordinal variables; other indicators were treated as categorical variables. Inter-group comparisons were performed using the chi-square test; Fisher's exact test was used for small samples ($n < 40$) or when ex-

pected frequency was <5. $P < 0.05$ indicated a statistically significant difference.

3. Results

3.1. Comparison of Vaginal Microecology between Diminished Ovarian Reserve and Normal Populations

In the comparison of the total population (65 DOR patients vs 65 non-DOR controls), most indicators showed no statistical differences. Only the positive rates of sialidase, blastospores, and spores showed differences ($P < 0.05$). The positive rate of sialidase in DOR patients (3.08%) was lower than that in the control group (15.38%), while the positive rates of blastospores and spores (35.38% and 36.92%, respectively) were higher than those in the control group (16.92% and 15.38%, respectively).

Further stratified analysis by age revealed no significant differences in any indicators in the subgroup under 35 years old. However, in the subgroup aged 35 years and above, DOR patients exhibited multiple characteristic changes: a lower positive rate of sialidase (3.92% vs 15.69%), a predominance of grade II microbial density (58.82% vs 39.22%), a lower proportion with Nugent score ≥ 7 (3.92% vs 23.53%), and higher positive rates for fungal infection-related indicators (blastospores and spores, both approximately 39% vs approximately 18%). All differences were statistically significant ($P < 0.05$). Details are shown in Tables 1-3.

Table 1. Comparison of vaginal microecological indicators between Diminished Ovarian Reserve (DOR) group and control group (total population) [n (%)].

Indicator	Control Group 1 (N = 65)	Experimental Group 1 (DOR, N = 65)	P-value	Interpretation of Difference
Sialidase Positive	10 (15.38)	**2 (3.08)**	**0.015**	Significantly lower in DOR group
Blastospores Positive	11 (16.92)	**23 (35.38)**	**0.017**	Significantly higher in DOR group
Spores Positive	10 (15.38)	**24 (36.92)**	**0.005**	Significantly higher in DOR group
Normal Vaginal Microecology	24 (36.92)	20 (30.77)	0.447	No significant difference
BV Prevalence*	16 (24.62)	7 (10.77)	0.134	No significant difference
VVC Prevalence*	7 (10.77)	**15 (23.08)**	0.134	Higher value, but $P > 0.05$

Note: BV (Bacterial Vaginosis) based on comprehensive diagnosis; VVC (Vulvovaginal Candidiasis) based on fungal indicators. WST is a comprehensive diagnostic category.

Table 2. Comparison of vaginal microecological indicators between diminished ovarian reserve patients and control group (age ≥ 35 years).

Indicator	Control Group 1 (n = 51)	Experimental Group 1 (DOR, n = 51)	P-value	Explanation of Difference
Sialidase Positive	8 (15.69%)	**2 (3.92%)**	**0.046**	Significantly lower in DOR group
Microbial Density Grade III	26 (50.98%)	**14 (27.45%)**	**0.012**	Lower density in DOR group
Nugent Score ≥ 7	12 (23.53%)	**2 (3.92%)**	**0.039**	Lower proportion of high score in DOR
Blastospores Positive	9 (17.65%)	**20 (39.22%)**	**0.016**	Significantly higher in DOR group
Spores Positive	8 (15.69%)	**20 (39.22%)**	**0.008**	Significantly higher in DOR group
Normal Vaginal Microecology	18 (35.29%)	15 (29.41%)	0.149	No significant difference
BV Prevalence	13 (25.49%)	6 (11.76%)	0.149	No significant difference
VVC Prevalence	5 (9.80%)	13 (25.49%)	0.149	Higher value, P > 0.05

Table 3. Comparison of vaginal microecological indicators between diminished ovarian reserve patients and control group (age < 35 years).

Indicator	Control Group 1 (n = 14)	Experimental Group 1 (DOR, n = 14)	P-value	Explanation of Difference
Sialidase Positive	2 (14.29%)	0 (0.00%)	0.481	No significant difference
Microbial Density Grade III	3 (21.43%)	5 (35.71%)	0.598	No significant difference
Nugent Score ≥ 7	0 (0.00%)	0 (0.00%)	-	No difference
Blastospores Positive	2 (14.29%)	3 (21.43%)	1.000	No significant difference
Spores Positive	2 (14.29%)	4 (28.57%)	0.648	No significant difference
Normal Vaginal Microecology	6 (42.86%)	5 (35.71%)	0.637	No significant difference
BV Prevalence	3 (21.43%)	1 (7.14%)	0.637	No significant difference
VVC Prevalence	2 (14.29%)	2 (14.29%)	0.637	No difference

3.2. Comparison of Vaginal Microecology between Polycystic Ovary Syndrome Patients and Control Population

In the comparison of the total population, there were no statistically significant

differences in any indicators between PCOS patients and the control group ($P > 0.05$). Age-stratified analysis revealed that differences were mainly evident in the population under 35 years old. In this subgroup, the proportion of PCOS patients with Gram-positive large bacilli as the dominant bacteria (52.24%) was significantly lower than that in the control group (65.67%), and there was a difference in the distribution of Nugent scores ($P < 0.05$), with a higher proportion of high scores (≥7) (18.66% vs 12.69%). In the population aged 35 years and above, there were no significant differences in any indicators between the two groups. Details are shown in Tables 4-6.

Table 4. Comparison of key vaginal microecological indicators between Polycystic Ovary Syndrome (PCOS) patients and control group (age < 35 years subgroup).

Key Indicator	Control Group 2 (N = 134)	Experimental Group 2 (PCOS, N = 134)	P-value	Clinical Significance
Dominant Bacteria: G+ Large Bacilli	88 (65.67)	70 (52.24)	0.025	Decreased proportion of dominant *Lactobacillus* in PCOS group
Nugent Score Distribution	-	-	0.049	Difference in score composition ratio
Of Which: Score ≥ 7	17 (12.69)	25 (18.66)	-	Higher proportion of high scores in PCOS group
Normal Vaginal Microecology	66 (49.25)	52 (38.81)	0.222	No significant difference
BV Prevalence	21 (15.67)	36 (26.87)	0.222	Higher value, but $P > 0.05$

Table 5. Comparison of vaginal microecological indicators between polycystic ovary syndrome patients and control group (age ≥ 35 years).

Indicator	Control Group 2 (n = 43)	Experimental Group 2 (PCOS, n = 43)	P-value	Explanation of Difference
Dominant Bacteria: G+ Large Bacilli	26 (60.47%)	30 (69.77%)	0.365	No significant difference
Nugent Score ≥ 7	4 (9.30%)	2 (4.65%)	0.169	No significant difference
Blastospores Positive	8 (18.60%)	3 (6.98%)	0.106	No significant difference
Spores Positive	8 (18.60%)	3 (6.98%)	0.106	No significant difference
Normal Vaginal Microecology	17 (39.53%)	23 (53.49%)	0.704	No significant difference
BV Prevalence	9 (20.93%)	7 (16.28%)	0.704	No significant difference
VVC Prevalence	5 (11.63%)	2 (4.65%)	0.704	No significant difference

Table 6. Comparison of vaginal microecological indicators between polycystic ovary syndrome patients and control group (age < 35 years).

Indicator	Control Group 2 (n = 134)	Experimental Group 2 (PCOS, n = 134)	P-value	Explanation of Difference
Dominant Bacteria: G+ Large Bacilli	**88 (65.67%)**	**70 (52.24%)**	**0.025**	Significantly lower in PCOS group
Nugent Score ≥ 7	17 (12.69%)	**25 (18.66%)**	**0.049**	Higher proportion of high score in PCOS
Blastospores Positive	24 (17.91%)	21 (15.67%)	0.624	No significant difference
Spores Positive	23 (17.16%)	21 (15.67%)	0.742	No significant difference
Normal Vaginal Microecology	66 (49.25%)	52 (38.81%)	0.222	No significant difference
BV Prevalence	21 (15.67%)	**36 (26.87%)**	**0.222**	Higher value, P > 0.05
VVC Prevalence	14 (10.45%)	10 (7.46%)	0.222	No significant difference

3.3. Direct Comparison of Vaginal Microecology between Diminished Ovarian Reserve and Polycystic Ovary Syndrome Patients

Compared with PCOS patients, DOR patients had a significantly lower proportion of normal vaginal microecological status (30.77% vs 42.37%, P < 0.05). Additionally, the positive rates of fungal infection indicators (blastospores, spores) were significantly higher in DOR patients than in PCOS patients (both approximately 35% vs approximately 14%).

Table 7. Comparison of key indicators between Diminished Ovarian Reserve (DOR) and Polycystic Ovary Syndrome (PCOS) patients.

Comparison Indicator	Experimental Group 2 (PCOS, N = 177)	Experimental Group 1 (DOR, N = 65)	P-value	Summary of Differences
Normal Vaginal Microecology	**75 (42.37)**	20 (30.77)	**0.001**	Lower normal proportion in DOR group
Blastospores Positive	24 (13.56)	**23 (35.38)**	**<0.001**	Higher fungal indicators in DOR group
Spores Positive	24 (13.56)	**24 (36.92)**	**<0.001**	Higher fungal indicators in DOR group
VVC Prevalence	12 (6.78)	**15 (23.08)**	**0.001**	Higher VVC prevalence in DOR group

Table 8. Comparison of vaginal microecological indicators between DOR and PCOS patients (age ≥ 35 years).

Indicator	Experimental Group 2 (PCOS, n = 43)	Experimental Group 1 (DOR, n = 51)	P-value	Explanation of Difference
Normal Vaginal Microecology	**23 (53.49%)**	**15 (29.41%)**	**0.021**	Lower normal proportion in DOR group
Blastospores Positive	3 (6.98%)	**20 (39.22%)**	**<0.001**	Significantly higher in DOR group
Spores Positive	3 (6.98%)	**20 (39.22%)**	**<0.001**	Significantly higher in DOR group
VVC Prevalence	2 (4.65%)	**13 (25.49%)**	**0.021**	Significantly higher in DOR group
BV Prevalence	7 (16.28%)	6 (11.76%)	0.021	No significant difference

Table 9. Comparison of vaginal microecological indicators between DOR and PCOS patients (age < 35 years).

Indicator	Experimental Group 2 (PCOS, n = 134)	Experimental Group 1 (DOR, n = 14)	P-value	Explanation of Difference
Normal Vaginal Microecology	52 (38.81%)	5 (35.71%)	0.096	No significant difference
Blastospores Positive	21 (15.67%)	3 (21.43%)	0.701	No significant difference
Spores Positive	21 (15.67%)	4 (28.57%)	0.257	No significant difference
VVC Prevalence	10 (7.46%)	2 (14.29%)	0.096	No significant difference
BV Prevalence	36 (26.87%)	1 (7.14%)	0.096	No significant difference

After age stratification, among individuals aged 35 years and above, the VVC prevalence in DOR patients (25.49%) was significantly higher than that in PCOS patients (4.65%), and the proportion of normal vaginal microecology was lower (29.41% vs 53.49%), with statistically significant differences ($P < 0.05$). In the population under 35 years old, there were no significant differences in most indicators between the two groups. This suggests that the differences in vaginal microecological characteristics between the two diseases are age-specific. Details are shown in Tables 7-9.

4. Discussion

4.1. Vaginal Microecological Characteristics of Patients with Diminished Ovarian Reserve

Ovarian function decline can lead to decreased estrogen levels, which indirectly

causes disturbances in vaginal microecological balance, leading to structural imbalance of vaginal flora, weakened mucosal barrier function, and increased risk of infection [7]. The pathogenesis and disease progression of DOR are not yet fully understood, and exploration of its related reproductive health issues from a broader perspective is still needed [8].

In recent years, an increasing number of studies have pointed out a significant correlation between reproductive health and the vaginal microbiota. Infertile women exhibit different microbial compositions in the lower and/or upper reproductive tract. The microbiota has been confirmed as a key factor affecting reproductive health [9] [10]. This study found significant differences in microbial density, Nugent score, sialidase, and fungal vaginitis-related indicators between DOR individuals aged 35 and above and the control group. Among these, sialidase positivity is a specific indicator suggesting Bacterial Vaginosis (BV), and the Nugent score is an internationally recognized diagnostic method for BV. The results showed that the proportion of BV in DOR patients aged 35 and above was lower than that in the normal population, while the proportion of Vulvovaginal Candidiasis (VVC) was higher, indicating that BV is not the main cause of infertility in this population, and attention should be focused on the prevention and treatment of VVC.

The lower vaginal microbial density observed in DOR individuals aged 35 and above in this study is consistent with reports by Wang *et al.* [11], reflecting the characteristic of decreased microbial density in patients with ovarian function decline. A possible reason is: the core pathological change of ovarian function decline is the reduction in the number and quality of follicles, leading to insufficient or fluctuating secretion of estrogen (mainly estradiol). The stability of vaginal microecology depends on the estrogen-regulated epithelial cell-*Lactobacillus* axis. Estrogen deficiency disrupts *Lactobacillus* proliferation and host mucosa, leading to a decrease in the proportion of Gram-positive large bacilli and abnormal elevation in H_2O_2 positivity. The survival and proliferation of *Lactobacillus* require "glycogen" provided by vaginal epithelial cells. Estrogen is a key hormone promoting glycogen synthesis in epithelial cells. Its deficiency leads to nutritional deprivation for *Lactobacillus*, resulting in reduced numbers and loss of dominant status [12]. Additionally, when ovarian function declines, vaginal pH increases. This environment is more conducive to the proliferation of H_2O_2-producing miscellaneous bacteria, making H_2O_2 positivity appear to increase. However, the number of "H_2O_2-producing *Lactobacillus*" that actually plays a protective role is decreasing. This abnormal elevation in H_2O_2 positivity instead suggests structural disorder of the flora [13]. However, this study did not find significant differences in H_2O_2 in the vaginal microecology of DOR populations, and this issue requires further exploration.

4.2. Vaginal Microecological Characteristics of Patients with Polycystic Ovary Syndrome

Ma *et al.* [14] reported that the proportion of leukocytes > 10/HP and the rate of vaginal microecological imbalance in PCOS patients of childbearing age were sig-

nificantly higher than those in non-endocrine disease patients of childbearing age, and the severity increased with the degree of hormonal imbalance. They believed that vaginal microecological imbalance occurs at a higher rate in the PCOS population and may be involved in the occurrence of PCOS.

The reasons may be analyzed as follows: PCOS is a disease of reproductive and metabolic dysfunction. Hormonal imbalance is its fundamental cause, with ovulation disorders and hyperandrogenism being the core pathological features. These pathological changes can affect the local vaginal microenvironment, disrupt the balanced state, leading to or exacerbating vaginal microecological imbalance [15]. On the other hand, vaginal microecological imbalance, especially overgrowth of pathogenic bacteria, can trigger chronic low-grade inflammation. Inflammation, as an important pathological change in PCOS, can induce the occurrence of PCOS [16] [17]. Furthermore, overgrowth of pathogenic bacteria may also ascend and infect, affecting endometrial receptivity and reducing pregnancy success rates in patients [18].

However, in this study, no significant differences were found in the proportion of leukocytes > 10/HP or the rate of vaginal microecological imbalance between PCOS patients and non-PCOS patients, which differs from the report by Ma *et al.* [14]. The discrepancy may stem from heterogeneity in the study populations (e.g., degree of hormonal imbalance, comorbidities), sample size, or subtle differences in the criteria for defining "microecological imbalance". This study found that in PCOS patients under 35 years old, the proportion with Gram-positive bacilli as the dominant bacteria was lower than that in the control group, and the proportions with Nugent score ≥ 7 and BV prevalence were higher than those in the control group. Chopra *et al.* observed a significant reduction in lactobacilli in women with idiopathic infertility. Vaginal microbiome analysis showed a significant increase in the presence of *Gardnerella*, *Prevotella*, *Proteobacteria*, and *Enterococcus*, while the relative abundance of Firmicutes decreased in infertile patients [19], suggesting that reduced *Lactobacillus* in PCOS patients may be a suspected factor for infertility. In the vaginal microecology of healthy women, *Lactobacillus* is the main dominant species, playing a key role in maintaining vaginal microecological balance and preventing infection. Once *Lactobacillus* loses its dominant status, the vaginal microenvironment will deviate from the normal state. Vaginal microbiome dysbiosis can lead to BV, one of the most common gynecological inflammations in women of childbearing age and an important disease affecting fertility. In BV patients, the concentration of *Lactobacillus* decreases, and various opportunistic bacteria (mainly *Gardnerella vaginalis* and other anaerobes) dominate [20], increasing the risk of reproductive tract diseases. When *Lactobacillus* is the dominant flora, vaginal pH can be maintained below 4.5, preserving an acidic environment. pH imbalance leads to increased risk of infection. Vaginal flora helps maintain a healthy pH balance, reducing the risk of pathogenic microorganism proliferation. A homogeneous composition and balance of the microbiome in the reproductive tract are crucial for female reproductive system health [21].

4.3. Comparison of Vaginal Microecological Characteristics between Polycystic Ovary Syndrome and Diminished Ovarian Reserve Patients

Both PCOS and DOR are common gynecological diseases. Although there is no direct causal relationship between them and vaginal microecology, they can indirectly participate in the occurrence and development of both diseases through mechanisms such as local immune imbalance, changes in inflammatory state, and hormonal imbalance [22]. This study compared the vaginal microecological results of PCOS and DOR patients and found that the PCOS population was generally younger than DOR patients, which aligns with the age characteristics of the two diseases—PCOS is prevalent in the 20 - 40 age group, with a high incidence stage between 15 - 30 years old, while DOR mostly occurs in women after 35 years of age.

Regarding vaginal microecological indicators, the incidence of VVC was lower in PCOS patients than in DOR patients (6.78% vs 23.08%), and there were significant differences in vaginal microecological evaluation between the two, with DOR patients being more prone to microecological imbalance (13.85% vs 9.04%). Age-stratified analysis showed that the above differences remained significant in the population aged 35 and above, while they were not obvious in the population under 35, indicating that this difference mainly exists in the group aged 35 and above. Based on this, the population aged 35 and above with DOR needs to focus on the risk of VVC and BV infection. This suggests that clinical interventions can be more targeted. For example, for DOR patients aged ≥35 years, routine screening and management of fungal infections could be considered during fertility assessment. For PCOS patients aged <35 years, attention should be paid to their reduced vaginal *Lactobacillus* and BV risk. Exploring the use of probiotics or local pH modulators might be considered, potentially positively impacting fertility outcomes while improving the microecology. While the PCOS population under 35 needs to pay attention to the risk of BV infection. In studies comparing similarities and differences between different diseases, 35 years remains an important dividing line for female reproductive age.

Therefore, for women aged 35 and above with fertility intentions, clinicians should comprehensively consider various factors affecting fertility to improve their pregnancy success rates.

5. Conclusion

There are significant differences in the vaginal microecological characteristics between PCOS and DOR patients. The vaginal microecological changes in DOR patients are more pronounced, manifested as increased positive rates of VVC and BV, decreased proportion of microbial density, and a higher proportion of vaginal microecological imbalance. In contrast, the vaginal microecological changes in PCOS patients are relatively less obvious, with abnormalities mainly concentrated on those under 35 years old. Specifically, vaginal microecological abnormalities in

DOR patients are mainly found in those aged 35 and above, while in PCOS patients, they are mainly found in those under 35. This difference may be related to the age-related onset trends of the two diseases. Clarifying the vaginal microecological characteristics of patients with different diseases and age groups not only deepens our understanding of the association between reproductive health and microecology but also provides an important reference for implementing precise clinical interventions, such as differentiated microecological management strategies based on age and diagnosis.

6. Study Limitations

This study is a single-center study, and all samples came from a specialized reproductive hospital, which may involve selection bias. The generalizability of the results needs further verification. The study did not conduct an in-depth analysis of factors such as patients' hormone levels and lifestyle habits that may affect vaginal microecology, failing to clarify the association between these factors and vaginal microecological changes. The sample size of DOR patients was only 65, which is relatively small and may affect the stability of some statistical results. Future studies need to expand the sample size for further research. This study is a cross-sectional study and cannot establish a causal relationship between vaginal microecological changes and disease occurrence and development. Prospective studies are needed for further exploration.

Acknowledgements

We thank the hospital's ethics committee for approving and guiding this study. We are grateful to all participating patients for their understanding and cooperation. We also thank our colleagues in the department for their support and assistance during sample collection and data organization.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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