GAPS IN CURRENT RESEARCH AND THE NEED FOR FURTHER STUDIES ON PATHOLOGICAL VAGINAL MICROBIOME IN WOMEN OF DIFFERENT AGE GROUPS

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Abstract. The human vaginal microbiome plays a pivotal role in maintaining reproductive and general health across a woman's lifespan. However, current research predominantly focuses on women of reproductive age, leaving significant knowledge gaps in other age groups. This review highlights the limitations of existing studies and underscores the need for further research into the pathological alterations of the vaginal microbiota in adolescent, perimenopausal, and postmenopausal women. Understanding age-specific patterns of microbial imbalance is essential for developing tailored diagnostic and therapeutic strategies.

Keywords: vaginal microbiome, dysbiosis, aging, women's health, adolescent, menopause, microbiota research gaps

Introduction. The vaginal microbiome is a complex and dynamic ecosystem that undergoes significant shifts throughout a woman's life due to hormonal, immunological, and lifestyle-related changes. While Lactobacillus spp. dominate the vaginal flora of healthy women of reproductive age, other

microbial compositions are more prevalent during childhood and after menopause [1,2]. Despite growing interest in the human microbiome, there remains a striking imbalance in the representation of different age groups in vaginal microbiota studies.

The purpose of this review is to outline the main research gaps and advocate for expanded studies on the pathological microbiome across all stages of a woman's life.

1. The understudied vaginal microbiota in adolescents

Adolescence marks the initial formation of stable vaginal microbiota after puberty. However, studies focusing on this age group are limited. Early-life microbiome disturbances may have long-term implications, including increased susceptibility to infections and reproductive disorders [3]. Moreover, adolescent girls often receive antibiotics or hormonal contraceptives, both of which may alter microbial balance. Yet, the longitudinal impact of such interventions on the maturing vaginal microbiome remains poorly understood. A lack of normative data also hinders the diagnosis of pathological states in this population.

2. Insufficient Research in Perimenopausal and Postmenopausal Women

Menopause is associated with estrogen withdrawal, which significantly affects the vaginal environment—pH increases, Lactobacillus colonization declines, and anaerobic organisms may proliferate. These changes are linked to conditions such as atrophic vaginitis, urinary tract infections, and increased risk of STIs [4].

However, most studies exclude women over 50, creating a critical gap in knowledge. More data is needed on how the pathological microbiota develops in menopausal women, particularly in the context of hormone replacement therapy and chronic comorbidities such as diabetes and cardiovascular disease [5].

3. Age-Specific Dysbiosis and Disease Associations

There is increasing evidence that dysbiosis manifests differently depending on age. For example, BV in adolescents often presents without the classic symptoms found in older women, leading to underdiagnosis [3]. Similarly, postmenopausal dysbiosis may contribute to genitourinary syndrome and decrease quality of life, but is rarely addressed in clinical practice. Research must go beyond reproductive outcomes to investigate how vaginal microbial alterations impact overall health and systemic inflammation across age groups [6].

4. Methodological limitations and the need for standardization

Another major obstacle is the lack of standardized methodology in microbiome studies. Variations in sample collection, sequencing technology, and data interpretation hinder comparison across studies. Furthermore, the definition of a "healthy" microbiome remains age-dependent and elusive [2,7]. Establishing standardized protocols and longitudinal cohort studies are critical steps toward better understanding the pathological microbiota in different life stages.

Conclusion. Despite the recognized importance of the vaginal microbiome in women's health, there are significant research gaps concerning adolescent and postmenopausal populations. Age-specific studies are essential to uncover the full spectrum of microbial dysbiosis and its implications. Future research must address these deficiencies through inclusive cohort designs, improved methodologies, and interdisciplinary approaches. Only with comprehensive, age-sensitive data can truly effective diagnostics and treatments for vaginal dysbiosis be developed for all women.

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