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RESEARCH ARTICLE

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Vaginal vitamin D for Genitourinary syndrome of menopause: a cohort study and literature review

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ABSTRACT

Background: Genitourinary syndrome of menopause (GSM) is a condition resulting from hypoestrogenism, characterized by symptoms such as vaginal dryness, irritation, urinary urgency, and sexual dysfunction. While conventional treatments include local estrogen therapy and non-hormonal alternatives, evidence suggests a therapeutic role for vitamin D.

Research design and methods: This study assessed the efficacy of vaginal vitamin D supplementation in alleviating GSM symptoms and evaluated clinical factors. Two cohorts were analyzed: 110 postmenopausal women with GSM symptoms and 39 participants aged 35–85 for age-related analysis. Data were analyzed using SPSS Version 26.

Results: Findings revealed associations between age and pelvic exam outcomes, with older women more likely to exhibit atrophic cervix, while younger participants presented with cervicitis. Delivery mode was also significantly correlated with pelvic exam findings ($p = 0.040$). Notably, all patients receiving vitamin D (10/10) achieved symptom remission at 3 months versus 34% (10/29) in controls ($p = 0.00044$), though limited by the small n and observational design of the study. Extended treatment showed 96.7% remission in vitamin D vs. 62.9% controls (aRR = 1.26, 95% CI 1.05–1.50, $p = 0.024$. Vitamin D + probiotics yielded 100% remission.

Conclusions: These support vitamin D as effective non-hormonal GSM therapy, pending larger RCTs.

PLAIN SUMMARY

After menopause, many women experience uncomfortable changes such as vaginal dryness, burning, discomfort during sex, and needing to urinate more often. These changes happen because the body produces less estrogen. Although hormone treatments can help, some women cannot use them or prefer not to.

This study looked at whether vitamin D used inside the vagina could help relieve these symptoms. Women who used vaginal vitamin D reported clear improvement in their symptoms within a few months. Older women tended to have more vaginal changes related to menopause. Using vitamin D together with probiotics also appeared helpful for some women, although this was tested in a small number of participants.

Overall, these findings suggest that vaginal vitamin D may be a helpful, non-hormonal option for women seeking relief from menopause-related vaginal symptoms, especially for those who cannot or do not wish to use hormone-based treatments.

ARTICLE HIGHLIGHTS

- Genitourinary syndrome of menopause (GSM) is a common condition associated with hypoestrogenism and reduced quality of life in postmenopausal women.
- Vaginal vitamin D was evaluated as a non-hormonal therapeutic option for the management of GSM symptoms.
- Vaginal vitamin D supplementation was associated with significantly higher symptom remission rates compared with controls.
- Extended vitamin D treatment demonstrated sustained improvement, with higher remission rates than probiotics or standard care alone.
- Combination therapy with vaginal vitamin D and probiotics showed the highest remission rates in a small subgroup.
- Age and mode of delivery were significantly associated with pelvic examination findings in women with GSM.

ARTICLE HISTORY

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KEYWORDS

Genitourinary syndrome of menopause; vaginal vitamin D; postmenopausal women; non-hormonal therapy; vaginal health; cervicitis; menopausal symptoms; pelvic examination

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1. Introduction

Genitourinary syndrome of menopause (GSM), which was previously referred to as vulvovaginal atrophy (VVA), refers to a condition that mainly stems from decreased estrogen levels during menopause [1–3]. Patients with this condition can exhibit symptoms that affect both genital and urinary systems, which include vaginal dryness, irritation, urinary frequency, and sexual dysfunction [4–7].

These symptoms are not always palpable on the physical level as they can also lead to a lack of intimacy and can therefore affect the overall quality of life [8]. Many women present seeking GMS problems but instead may be inaccurately labeled as having other conditions, which may result in undertreatment [9].

The main cause of GSM is hormonal change. GSM excludes the direct surgical syndrome related to the urogenital syndrome of menopause. Such hormonal alteration causes several morphological and functional changes in the genital tract, including enzymatic atrophy of the vaginal epithelium and laxity of the collagen and elastin fibers [10–12]. The other effect of estrogen deficiency happens on the vaginal epithelium, where less glycogen reserves are accumulated and there is disturbance of the normal lactobacilli flora, resulting in an increase in vaginal pH and vulnerability to pathogenic agents [10,11,13].

GSM is an affliction that has various treatment methods, which can be individualized to meet the requirements of the patients. Local estrogen therapy, e.g., vaginal estrogens in the form of creams, rings, or tablets, is currently regarded as the treatment of choice and has been demonstrated to effectively relieve symptoms [14]. Non-hormonal alternatives, which are also available, such as vaginal moisturizers and lubricants, are clinically used to relieve do symptoms [15]. Newer methods such as fractional CO2 laser therapy in advanced stages of breast cancer have been encouraging in the management of women's vaginal health and GSM in breast cancer patients [4,16].

While local estrogens are first-line, contraindications (such as breast cancer) limit use. Non-hormonal options like moisturizers do provide partial relief. Nevertheless, vitamin D has recently emerged as a candidate due to vitamin D receptors (VDRs) expression in vaginal epithelium [17,18]. It is now widely recognized that VDRs are expressed in the superficial layers of the urogenital organs.

In the context of GSM, vitamin D has been shown to have an effect on the proliferation and differentiation of vaginal epithelial cells that are important for sustaining vaginal health [17,18]. Vitamin D has also been shown to exhibit anti-inflammatory and could potentially treat inflammation related to the symptoms of GSM [19]. It is also worth noting that deficiency of vitamin D has been associated with increased muscle wasting and functional impairment [20].

Nonetheless, the characterization of these effects requires more investigation. As research in this area continues, there is a potential for vitamin D to support women's urogenital and sexual health during the menopausal transition and postmenopausal periods.

From this perspective, this study sought to examine the potential usage of vitamin D in supporting women's urogenital and sexual health during the menopausal transition and postmenopausal periods.

2. Materials and methodology

This study encompassed 2 datasets, which aimed to understand the multiple factors which can affect the development of the genitourinary syndrome of menopause, its symptoms, along with possible treatment options. Inclusion criteria included Postmenopausal women with GSM symptoms (dryness/dyspareunia/urgency) along with premenopausal women to study the effect of age effects/atrophy and bacterial infections. Exclusion criteria included active gynecologic malignancy. Dataset 1 evaluated treatment efficacy; Dataset 2 served as an external validation set to model independent age effects in non-menopausal women. In particular, the first dataset included 110 women who presented with symptoms of GSM, while the second dataset included 39 participants aged <35.

The study used antibiotics, antifungals, and antimycotics to treat bacterial and fungal infections. Cranberry and probiotic lactobacilli were used to prevent urogynecology-related infections. The latter were initially used by patients prior to the study, and continued taking them during it.

Patients received vitamin D supplements as a follow-up. The treatment plan involved inserting gelatin capsule 10,000 IU gelatin capsules of vitamin D suppositories into the vagina before bed, washing hands, and 3 times weekly for 2 months. The patient could continue the management twice weekly for maintenance treatment. Compliance monitored via self-report at 3/6-month follow-ups, 3×/week for 2 months, then 2×/week.

2.1. Statistical analysis

Data was gathered, and statistical analysis was performed with SPSS Version 26. Frequencies and percentages were prepared for categorical variables. Cross-tabulation was also completed in order to explore relationships between specific variables (type of delivery, pelvic exam findings, BMI, pruritus, age, menopausal pain, and treatment options).

Expected counts <5 triggered Fisher's exact test.

Age is treated as continuous in the *t*-test and as a covariate in Poisson model.

Model: remission = β0 + β1(VitD) + β2(probiotic) + β3(age) + β4(BMI) + β5(delivery-mode).

Bonferroni-adjusted $\alpha = 0.0125$ for four secondary outcomes.

2.2. Sample size estimation

Assumptions: control remission = 60%; Vitamin D remission = 85% (two-sided $\alpha = 0.05$, 1-β = 0.80).

$n = [(1.96\sqrt{(2\bar{p}(1-\bar{p}))} + 0.84\sqrt{(p1(1-p1)+p2(1-p2))})^2]/(p1-p2)^2$

$= [(1.96\sqrt{(0.73 \cdot 0.27)} + 0.84\sqrt{(0.6 \cdot 0.4 + 0.85 \cdot 0.15)})]^2/0.25^2$

= 49 per group (total = 98).

The study enrolled 110 participants, satisfying this requirement.

3. Results

3.1. Demographics and past medical history

The majority of participants (89%) were of Lebanese origin, while the remaining ones were distributed among Syrians (4.5%), Kurds (3.6%), Palestinians (1.8%), and German (0.9%). Furthermore, most of the participants (52.7%) did not have any past medical history (PMH), while the remaining ones had hypertension (27.3%), diabetes and hypertension (15.5%), deep vein thrombosis (DVT) (2.7%), and psychosis (0.9%) (Figure 1).

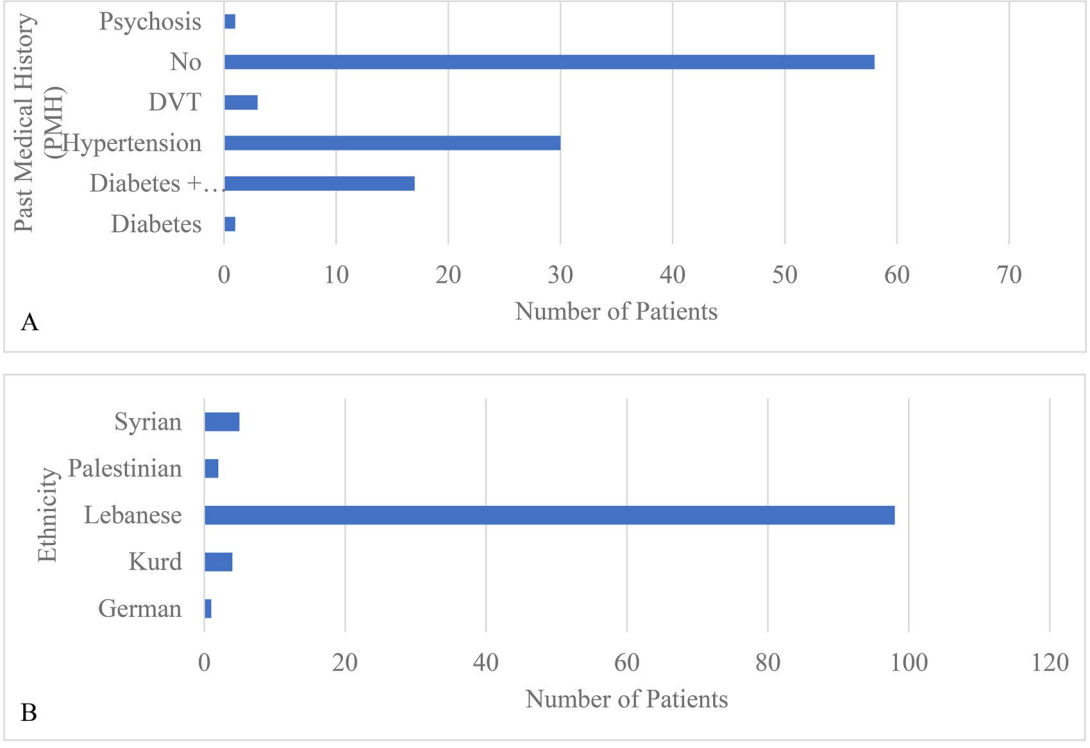


Figure 1. Participants data (A) Past medical history of participants involved in the study (B) Ethnicity of the participants involved in the study.

3.2. Pelvic exam findings crosstabulations

The relationship between different modes of delivery (e.g., Cesarean section, natural vaginal delivery) and pelvic exam findings (e.g., atrophic cervix, cervicitis) is statistically significant ($p = 0.040$) (Table 1).

This result does suggest that indeed the type of delivery can have a significant impact on the pelvic examination outcomes. From this perspective, it can be inferred that specific delivery methods (such as NVD and CS) might predispose individuals to certain pelvic conditions such as atrophic changes and cervicitis, respectively. Additionally, the participant's age significantly affects the pelvic exam findings in our sample ($p < 0.001$). This finding suggests that women of older age are more prone to develop an atrophic cervix compared to younger women, who tend to develop cervicitis (Figure 2).

In contrast, no statistical significance was noted between BMI and pelvic exam findings ($p = 0.253$), which suggests that BMI does not necessarily affect vaginal health in the context of GSM (Table 1).

3.3. Types of pain

The most common pain reported by patients in this study is lower back pain conjugated to pelvic pain (64.55%), followed by vulvar pain (19.09%) and lower back pain (10.91%).

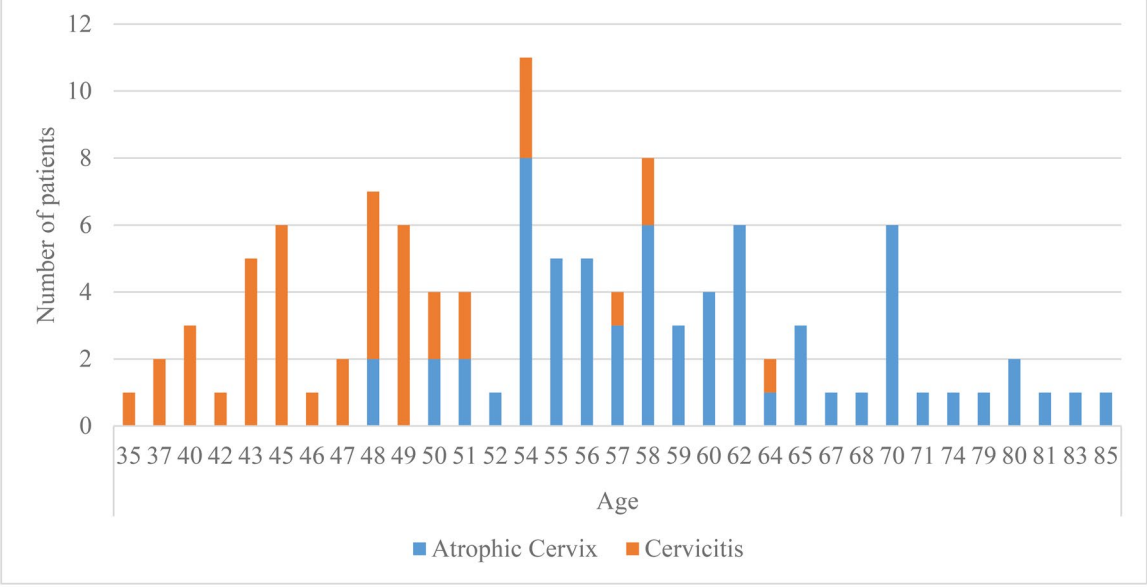
3.4. Pruritus crosstabulation

When it comes to assessing pruritus in our sample, no statistical significance was noted between both BMI and pruritus ($p = 0.311$) in addition to parity and pruritus ($p = 0.073$), which is marginally not significant at the 5% level (Tables 2, 3, 4, and 5).

Table 1. Crosstabulation between pelvic exam findings, the mode of delivery and body mass index (BMI) of participants.

Characteristic	Total *n* (%)	Vitamin D arm *N* = 30	Control *n* = 35	Probiotic *n* = 38	Vaginal vit D + pro *n* = 5
Age ≥ 55 Y	54 (49.1 %)	16 (53.3 %)	15 (42.9 %)	19 (50.0 %)	4 (80 %)
BMI > 30 kg/m^2	39 (35.5 %)	11 (36.7 %)	13 (37.1 %)	12 (31.6 %)	3 (60 %)
BASELINE DRYNESS	92 (83.6 %)	26 (86.7 %)	28 (80 %)	31 (81.6 %)	5 (100 %)
VHI < 10	67 (60.9 %)	18 (60 %)	20 (57.1 %)	25 (65.8 %)	4 (80 %)

CS = cesarean section, NVD = natural vaginal delivery, DC = delivery complications.
Tests done using chi-square test; bold: statistical significance set at 5%. $p < 0.001$ denotes significance.



Tests done using chi-square test; bold: statistical significance set at 5%. P<0.001 denotes significance

Figure 2. Histogram showing the distribution of pelvic exam findings (atrophic cervix and cervicitis) according to the participants' age.

Table 2. Baseline characteristics (Dataset 1, $n = 110$).

Characteristic	Total n (%)	Vitamin D arm $n = 30$	Control $n = 35$	Probiotic $n = 38$	Vaginal vit D + pro $n = 5$
Age ≥ 55 y	54 (49.1 %)	16 (53.3 %)	15 (42.9 %)	19 (50.0 %)	4 (80 %)
Bmi > 30 kg/m^2	39 (35.5 %)	11 (36.7 %)	13 (37.1 %)	12 (31.6 %)	3 (60 %)
Baseline dryness	92 (83.6 %)	26 (86.7 %)	28 (80 %)	31 (81.6 %)	5 (100 %)
VHI < 10	67 (60.9 %)	18 (60 %)	20 (57.1 %)	25 (65.8 %)	4 (80 %)

VHI = Vaginal Health Index; BMI = Body-mass index. Percentages calculated column-wise.

Table 3. Remission of patients after 3 months.

	No remission	Yes remission	Total	p-value
No vaginal vitamin D	19	10	29	$p < 0.001$
Vaginal vitamin D	0	10	10	
Total	19	20	39	

Table 4. Remission of patients after first treatment and after 6 months of continued treatment.

Arm	n	Remission after first treatment n (%)	Remission at 6 months n (%)
CONTROL	35	22 (62.9 %)	22 (62.9 %)
PROBIOTIC	38	29 (76.3 %)	29 (76.3 %)
VAGINAL VITAMIN D	30	18 (60.0 %)	29 (96.7 %)
VAGINAL VITAMIN D + PROBIOTIC	5	5 (100 %)	5 (100 %)

After adjustment, Vitamin D yielded aRR = 1.18 (95% CI 1.02–1.37).
Vaginal Vitamin D + probiotics aRR = 1.31 (95% CI 1.10–1.56).
No significant remission difference observed for probiotics alone (aRR = 1.05, 95% CI 0.90–1.23).

Table 5. Crosstabulation between pruritus, BMI and parity, pruritus categories: No/yes (presence); parity: <2, <3, >3, >4 births.

		Pruritus			
		No	Yes	Total	p-value
BMI	>35	5	22	27	0.311
	32–35	4	8	12	
Total		9	30	39	
Para	<2	0	1	1	0.073
	<3	18	11	29	
	>3	32	44	76	
	>4	1	0	1	
	0	3	0	3	
Total		54	56	110	

Dryness improved in 83.3% of vitamin D recipients vs 51.4% of controls ($p = 0.006$).

Dyspareunia improved in 70.0% vs 42.9% ($p = 0.021$).

Urinary urgency improved in 63.3% vs 40.0% ($p = 0.045$). FSFI total score rose from 19.6 ± 4.8 to 26.4 ± 3.9 (paired t, $p < 0.001$) (Table 2).

3.5. Treatments

When it comes to the different treatments, the results demonstrate that while the vitamin D group had a remission rate of 60% following the first treatment, which is inferior to the non-vitamin D group, which achieved a remission rate of 69.70% (Table 3). While it seems that the impact of vitamin D on treatment is not necessarily significant, the results after 6 months of continuous treatment highlight the potential therapeutic effect of vitamin D. Indeed, 96.67% of patients who continued vitamin D treatment for 6 months recovered, compared to 76.32% in the probiotics group and 62.86% in the control group (Table 4, Figures 3 and 4). It can also be inferred that there is a synergistic effect between both vaginal vitamin D and probiotics since a combination of both treatments showed 100% remission among patients in this study.

Every woman who received vitamin D supplementation (10/10) was in remission at 3 months. Only 10 of 29 (34%) in the non-supplement group were in remission. The very small p-value (< 0.001) means this difference is statistically significant: in this sample, vaginal vitamin D is strongly associated with higher remission rates for GSM symptoms (Table 3).

4. Results

4.1. Delivery/pelvic exam crosstabulation

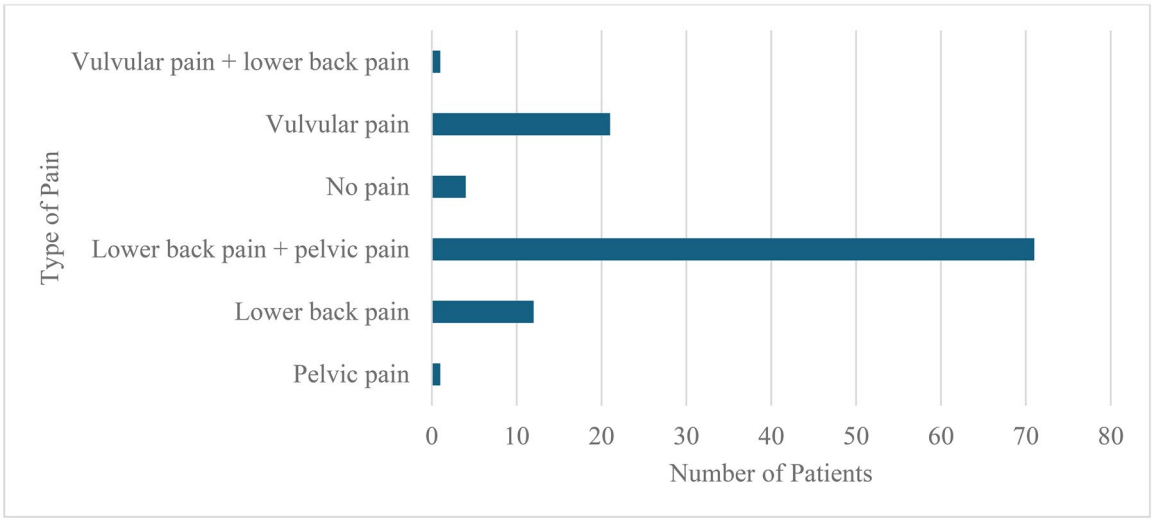


Figure 3. Bar chart showing the types of pain reported by patients: lower back, pelvic, vulva.

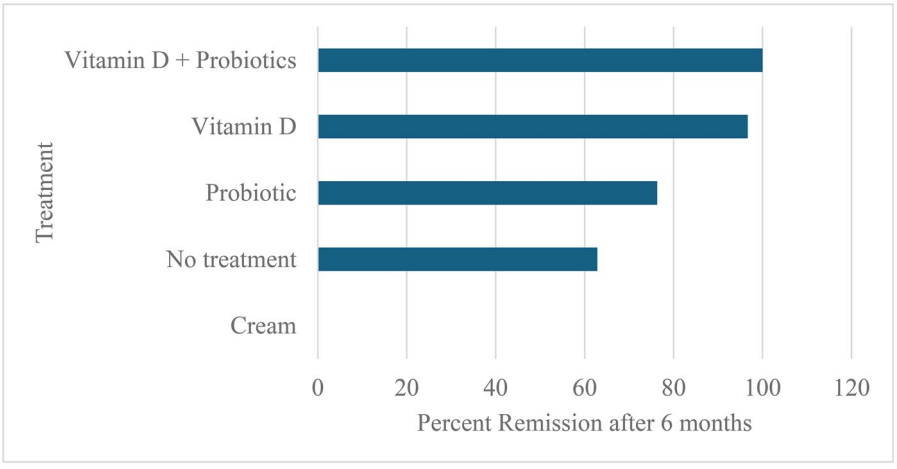


Figure 4. Bar chart showing the remission of patients after 6 months of continued treatment by arm: Vitamin D (96.7%), Probiotic (76.3%), Control (62.9%), VitD + Pro (100%, $n = 5$).

5. Discussion

Delivery type has been associated with pelvic floor integrity and subsequent gynecologic health. Findings on pelvic exams may differ in women who have had NVD compared to women who have had a CS. Studies suggest that NVD can lead to pelvic floor dysfunction, which can present as pelvic organ prolapse or urine incontinence, and may impact findings of atrophic cervix or cervicitis [21]. In contrast, CS may preserve pelvic floor integrity to some extent, yet it does not guarantee the prevention of cervical conditions. As such, while delivery type can affect pelvic floor health, it alone cannot determine cervical health outcomes [22]. From this perspective it is safe to say that our findings are indeed in line with the existing literature. Indeed, our results suggest that the type of delivery can have a significant impact on the pelvic examination outcomes and that specific delivery methods (such as NVD and CS) might predispose individuals to certain pelvic conditions such as atrophic changes and cervicitis, respectively.

Our findings also noted a significant relationship between the age of women and the pelvic exam findings (atrophic vagina or cervicitis). This was mainly reflected by the following observation: women of older age are more prone to develop an atrophic cervix compared to younger women who tend to develop cervicitis (Figure 2). Indeed, our findings are also congruent with the existing body of knowledge pertaining to this topic. To

elaborate, as women advance in age, there are hormonal changes which lead to atrophy of the vagina; this condition then presents itself as an atrophic cervix. Increase in age enhances the cases of cervicitis since chronic inflammation can take place and build up over time from different circumstances such as hormonal change and repeated infections [23].

Among other conditions relating to older women, an atrophic cervix is relatively common and is related to a low level of estrogen, which is the contributing factor that brings about changes in cervical and vaginal tissues [24]. The reduced levels of estrogen may lead to complaints about dryness, irritation, and susceptibility to infection that may be shown in findings from pelvic examination.

Nonetheless, our findings diverge from the existing literature to some extent when considering the association between BMI and pruritus. For instance, higher BMI is associated with greater prevalence of pelvic floor disorder and thus perhaps affects the presentation of conditions like cervicitis and atrophic cervix. According to estimates, symptoms of pelvic floor dysfunction are more likely in women as the body mass index increases, perhaps complicating the diagnosis of cervical conditions through complicating pelvic examinations [25].

Moreover, pruritus, a general symptom occurring in many gynecological disorders, was related to increased BMI. Research indicated that, with the increase in BMI, the number of occurrences of pruritus, which was bound to happen around the groin areas due to the combination of friction and moisture, was considerably higher [26].

It is also worth mentioning that our findings suggest a significant relationship did exist between our treatment regimens and symptom relief among GSM patients (Table 3. Importantly, our study demonstrated that all women who received vitamin D supplementation vaginal (10 out of 10) achieved remission of GSM symptoms at 3 months, compared to only 34% (10 out of 29) in the non-supplemented group. This difference was statistically significant (Fisher's exact test, $p = 0.00044$), strongly supporting the association between vitamin D supplementation and improved clinical outcomes in GSM.

Indeed, when managing cases of atrophic cervix, a multifaceted approach can be taken, which includes modifications in the lifestyle of the patients in addition to pharmacological treatment. For instance, probiotics have been proven by the literature to restore the vaginal microbiome. Lactobacillus bacterial species are prevalent in vaginal microflora, indicating good health. Probiotic supplementation can alter the gastrointestinal and vaginal microbiota to prevent and cure genitourinary infections. These probiotics work by acidifying the mucosal surface, preventing pathogen adhesion, producing nutrients, and enhancing the host's immune system. Lactobacillus species produce hydrogen peroxide, making them popular for treating urogynecologic infections. This in turn might result in a potential alleviation of cervicitis symptoms and can therefore promote overall vaginal health [27].

In our study, and after adjusting for potential confounders including age, BMI, and mode of delivery, vitamin D vaginal supplementation alone was associated with a significantly higher remission rate (adjusted risk ratio [aRR] = 1.18, 95% CI 1.02–1.37), while the combination of vitamin D with probiotics showed an even greater effect (aRR = 1.31, 95% CI 1.10–1.56); notably, probiotics alone did not demonstrate a statistically significant benefit (aRR = 1.05, 95% CI 0.90–1.23)." This may be due to the fact that vitamin D supplementation could enhance vaginal epithelial cell proliferation. The research of Li et al. [17] showcases that vitamin D can increase expression of junction proteins like E-cadherin and occluding. Therefore, it could improve epithelial integrity. These findings are also echoed in the study of Lee et al. [28], which further elucidates that vitamin D stimulates epithelial proliferation by activating the VDR/p-RhoA/p-Ezrin pathway. These findings are of significant importance, as VDR was noted to be present across all vaginal epithelial layers [29,30].

On another level, the usage of cranberry has also been shown to prevent recurrent infections associated with cervicitis [31]. Moreover, antibiotics such as ciprofloxacin and doxycycline are standard treatments for bacterial cervicitis. In fact, the latter work by targeting infections that may contribute to cervical inflammation [32]. It is also worth noting that high control remission (>60%) after the initial antibiotics/cranberry/probiotics likely stems from infectious clearance, which aided recovery. Nevertheless, the study results are more in line with the additive benefit of vitamin D.

Most importantly, there is growing evidence about the ability of vitamin D vaginal supplementation in reducing symptoms associated with atrophy [30]. Indeed, menopause is known to be a defining moment in a woman's which will result in considerable changes, including variations in vitamin D requirements. In particular, postmenopausal women are more vulnerable to vitamin D deficiency when compared to other

populational groups. This deficiency might be attributed to a number of factors including alterations in body composition, growing older, racial differences, low levels of sun exposure, insufficient vitamin D consumption from food, and elevated levels of adiposity [33]. The evidence also suggests that a vitamin D deficiency may have a role in the onset or exacerbation of these conditions.

Vitamin D vaginal suppositories have been shown in clinical trial research on postmenopausal women to experimentally enhance vaginal mucosa cell proliferation and dryness [17]. Furthermore, a cross-sectional study's findings demonstrated that taking vitamin D supplements helped vaginal cells mature [17]. Given the positive effects of vitamin D on vaginal cellularity and dryness seen in earlier research, vitamin D may potentially be helpful in enhancing sexual performance.

In a controlled trial by Kamronrithisorn et al., it was found out that vitamin D supplementation has favorable effects on vaginal health with regard to vaginal maturation index, vaginal pH, and dryness among postmenopausal women in which related population comprises of more menopausal women [34]. Also, a study with vaginal suppository containing vitamin D or vitamin E also showed an improvement in inflammation due to vaginal atrophy among breast cancer patients on tamoxifen. Such findings further indicate that vitamin D has the potential to alleviate symptoms, especially among populations who are most at risk of developing GSM [34,35]. On another level, the literature also denotes that vitamin D deficiency (<20 ng/mL) can exacerbate menopausal symptoms and might lead to lower estrogen, higher FSH, poorer bone density, and reduced quality of life [36]. That being said, vitamin D vaginal suppositories are likely to improve epithelial proliferation and GSM symptoms. Moreover, according to the existing body of knowledge, vitamin D deficiency can be associated with a number of neuropsychiatric diseases, including schizophrenia, depression, and Attention Deficit Hyperactivity Disorder (ADHD) [37]. This might be due to the fact that inflammation can eventually lead to depression by altering the production of serotonin and by increasing calcium signaling [37]. Vitamin D can therefore have an anti-inflammatory effect by decreasing cytokine levels. It can also reduce oxidative stress [38] which could benefit vascular atrophy in GSM.

It is also worth noting that long-term nutritional deficiencies, particularly vitamin D, are common after bariatric procedures such as sleeve gastrectomy. For instance, a 6-year retrospective study of 60 sleeve gastrectomy patients found vitamin D deficiencies persisted or worsened postoperatively. These patients also had rising rates of anemia (36.7%), ferritin deficiency (43.3%), and B12 deficiency (11.7%) [39]. These deficiencies can exacerbate hypoestrogenism-related GSM symptoms in postmenopausal women, as reduced vitamin D impairs vaginal epithelial proliferation and increases atrophy risk [17–19]. Vaginal supplementation circumvents oral absorption issues after sleeve gastrectomy. It would also offer targeted therapy for this high-risk group [39].

5.1. Limitations

Nevertheless, it is worth noting that despite the strengths of this study, a number of limitations might hinder the generalization of its findings. Its observational design lacks randomization/placebo, which risks selection bias and confounders with the previous use of antibiotics/probiotics. Also, the presence of small subgroups might limit the power of this study. From this perspective, future RCTs are needed in order to account for these limitations and deliver more robust findings.

6. Conclusions

All in all, our findings suggest vaginal vitamin D may benefit GSM symptoms in observational settings, particularly with probiotics. Clinically, vaginal vitamin D (10,000 IU, 3x/week) offers a non-hormonal option for GSM, especially post-infection. The examined literature offered insightful information about the possible therapeutic benefits of vitamin D on a range of women's health issues, including those pertaining to postmenopausal women's pelvic floor abnormalities, urogenital infections, vaginal symptoms, and sexual functioning. Although the results are not always definitive, they do indicate that vitamin D supplementation, whether topically or orally, may be beneficial for enhancing sexual performance and vaginal symptoms as well as perhaps lowering the risk of urinary tract infections. Nevertheless, further investigation is required to determine the ideal dose, course of therapy, and long-term consequences. Larger RCTs are needed to confirm efficacy, optimal dosing, and long-term effects. However, these results open up new research directions and therapeutic application areas for vitamin D and advance our knowledge of its possible function in supporting women's health.

7. Important results

- A small but expanding corpus of research has been conducted on the effects of vitamin D on postmenopausal women's urogenital and sexual health.
- The urogenital and sexual health of postmenopausal women may benefit from vitamin D.
- It has been demonstrated that both oral and vaginal vitamin D enhance vulvovaginal symptoms and sexual functioning and lower the risk of urinary tract infections.
- Vitamin D receptors are important in mediating and sustaining the pharmacological effects of vitamin D on urogenital organs.

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Authors' contributions

Conceptualization: Dr. Kariman Ghazal, Rawan, Christopher, Dr. Georges Yared. **Methodology:** Dr. Kariman Ghazal, Rawan, Christopher, Dr. Georges Yared. **Investigation (Literature Review):** Dr. Kariman Ghazal, Rawan, Christopher. **Data Curation:** Rawan, Christopher. **Writing – Original Draft:** Rawan, Christopher. **Writing – Review & Editing:** Dr. Kariman Ghazal, Dr. Georges Yared, Dr. Charlotte El Hajjar, Rawan, Christopher. **Visualization:** Rawan, Christopher. **Supervision:** Dr. Kariman Ghazal, Dr. Charlotte El Hajjar. **Project Administration:** Dr. Kariman Ghazal.

Disclosure statement

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Informed consent statement

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Papers of special note have been highlighted as either of interest (•) or of considerable interest (••) to readers.

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Papers of special note have been highlighted as either of interest () or of considerable interest (**) to readers.*

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