Effect of Vitamin D Supplementation in Women with Pelvic Floor Dysfunction: A Systematic Review

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Abstract

Objective: This review systematically analyzes and summarizes existing studies on the association between vitamin D supplementation and symptoms of Pelvic Floor Dysfunction (PFD) in women.

Methods: We conducted a comprehensive literature search based on the Preferred Reporting Items for Systematic Review (PRISMA) Statements’ flow diagram for systematic review. Two independent reviewers searched five online databases using keywords to identify relevant studies from 2018-2023. Excluded were articles with populations other than women, case reports or case series, review papers, and studies that did not report vitamin D supplementation as a means of intervention in the study.

Result: After identifying 2392 references, 13 studies were examined. Three studies explored the correlation between vitamin D supplementation and levator ani muscle strength, revealing a positive association. Results on vitamin D’s effect on urinary incontinence varied: five studies reported a negative correlation, while three showed significant improvement. Two studies indicated that vitamin D supplementation improved sexual function in the intervention group compared to the control group.

Conclusion: Current evidence suggests that vitamin D supplementation is a potential strategy for the prevention and treatment of PFD in women, but relevant studies are severely available.

Key words: Vitamin D, Pelvic Floor Dysfunction, Prolapse, Incontinence

Efek Suplementasi Vitamin D pada Wanita dengan Disfungsi Dasar Panggul: Tinjauan Sistematik

Abstrak

Tujuan: Tinjauan ini bertujuan untuk menganalisis secara sistematis studi yang ada dan meringkas data yang menunjukkan hubungan antara suplementasi vitamin D dan wanita dengan gejala disfungsi dasar panggul.


Kesimpulan: Bukti saat ini menunjukkan bahwa suplementasi vitamin D merupakan strategi pencegahan dan pengobatan yang potensial untuk wanita dengan disfungsi dasar panggul, tetapi penelitiannya masih sangat terbatas.

Kata kunci: Vitamin D, Disfungsi Dasar Panggul, Prolaps, Inkontinensia
Introduction

Throughout women’s life, they experience natural processes such as aging, pregnancy, childbirth, and menopause, which can increase their susceptibility to pelvic floor dysfunction later in life. Pelvic floor dysfunction (PFD) encompasses a wide range of anatomical changes and symptoms arising from abnormal pelvic floor musculature function. Clinically, these symptoms may manifest in various ways, including urologic, gynecologic, and colorectal issues, and often overlap. These include pelvic pain, dyspareunia, urinary and fecal incontinence, and symptoms of organ prolapse. Among women of childbearing age, PFD and pelvic organ prolapse (POP) are highly prevalent, affecting approximately 50% and 36-49% of this population, respectively. Additionally, 65.8% of women over 40 years old report experiencing at least one complaint related to sexual dysfunction. Up to half of older women report urinary incontinence (UI), with the prevalence of all UI types increasing with age, particularly among women post-menopause. By the age of 80, approximately 11% of women will have undergone surgical interventions related to UI or POP.1–3

Given the high prevalence of PFD in women, there is a clear imperative to develop new approaches for prevention and early treatment strategies. Vitamin D supplementation could potentially offer a straightforward intervention to prevent the development of, and reduce symptoms associated with, PFD in women, with minimal risk. Vitamin D receptors present in musculoskeletal tissue influence muscle strength and function, which may have a beneficial effect on alleviating PFD by fortifying pelvic floor muscles. Since vitamin D plays a crucial role in skeletal mineralization and regulation of plasma calcium concentration, pelvic floor weakness is believed to result from decreased muscle strength, increased osmotic diuresis due to impaired calcium metabolism, and heightened detrusor irritability.4,5 In terms of urinary incontinence (UI), vitamin D may assist with stress and emergency UI through the presence of vitamin D receptors (VDR) in the smooth and skeletal muscles of the bladder neck, as well as 1-alpha hydroxylase in prostate cells.4

This review was aimed to systematically analyze the existing studies and summarize existing data demonstrating the association between vitamin D supplementation and women with PFD symptoms.

Methods

Search Strategy and Study Selection

The authors conducted a comprehensive literature search following the flow diagram outlined in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Statement. Two independent reviewers searched five online databases (PubMed, Cochrane Library, Scopus, Science Direct, and Springer Link) using the terms “Vitamin D” AND (“supplementation” or “intake”) AND “women” AND (“pelvic floor” OR “prolapse” OR “incontinence”) to identify relevant studies published between 2018 and 2023. After identifying 2394 references, 2389 articles were excluded based on their title and abstract, leaving 28 articles for further screening based on predefined inclusion and exclusion criteria. Ultimately, 13 studies met these criteria. A PRISMA flow chart is provided in Fig. 1. Each article was subsequently evaluated independently by two reviewers, with any disagreements resolved through discussion with a third party. Relevant information from each study was recorded in Table 1.
Figure 1  Study Search and Selection Process Based on PRISMA Flow Diagram
<table>
<thead>
<tr>
<th>Authors</th>
<th>Study Design</th>
<th>Location</th>
<th>Inclusion Criteria</th>
<th>Sample Size</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Measure</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arjmand, 2022</td>
<td>RCT</td>
<td>Iran</td>
<td>Postmenopausal women with UUI or nocturia more than once at night with vitamin D levels less than 30 ng/ml</td>
<td>I = 48, C = 48, Total = 96</td>
<td>50,000 IU of vitamin D3 tablets weekly for 8 weeks</td>
<td>Placebo pill</td>
<td>Vit D levels pre &amp; post treatment, Modified LUTS EPINCONT questionnaire (status of incontinence and its severity), nocturia and its frequency, five-point Likert scale (patient satisfaction, percieved improvement, and symptom changes), and the impact on the patient’s daily life</td>
<td>Patients in the intervention group reported a significantly decreased nocturia frequency (p&lt;0.001) compared to placebo (p=0.102), reduced impact of nocturia and UI on daily life (p&lt;0.001) compared to placebo (p=0.500), with post-treatment comparison revealing a significant reduction in the supplementation of 50,000 IU Vitamin D3 group compared to the placebo group (p&lt;0.001)</td>
</tr>
<tr>
<td>Aydogmus, et al., 2022</td>
<td>RCT</td>
<td>Turkey</td>
<td>Women with vitamin D deficiency with urinary incontinence, at postpartum 8th week</td>
<td>I = 31, C = 30, Total = 61</td>
<td>Vitamin D 1200 IU daily for 12 weeks</td>
<td>Pelvic Floor Muscle Training</td>
<td>Pre and post-treatment Oxford Score, Pre and post-treatment ICIQ-FLUTS Score, Pre and post-treatment POP-Q Score</td>
<td>Patients in the intervention group reported significant increase in Oxford scores and significant decrease in ICIQ-FLUTS scores. However, there is no significant difference between intra-group and intergroup comparisons before and after treatment in terms of pelvic organ prolapse degrees of the cases</td>
</tr>
<tr>
<td>Kurniadi, et al., 2023</td>
<td>Quasi experimental study with pre-post design</td>
<td>Indonesia</td>
<td>Postmenopausal women diagnosed with grade III and IV uterine prolapse</td>
<td>24 subjects</td>
<td>0.5 mcg of Vitamin D analog supplementation for 3 months</td>
<td>Pre-supplementation</td>
<td>Vitamin D and VDR serum levels, Levator ani muscle strength, Hand grip muscle strength</td>
<td>After the supplementation, there was a significant increase in vitamin D and VDR serum levels (both p&lt;0.001), levator ani muscle strength (p=0.001), and handgrip muscle strength (p=0.001). A significant positive correlation (r = 0.616, p = 0.001) was observed between levator ani muscle strength and handgrip muscle strength, suggesting that a stronger levator ani muscle corresponds to a stronger hand grip muscle.</td>
</tr>
<tr>
<td>Markland, et al., 2023</td>
<td>Ancillary study of a double-blind RCT</td>
<td>United States</td>
<td>Women aged 55 years and older without clinically apparent cardiovascular disease or cancer who responded to UI questions at year 2 and year 5</td>
<td>Randomized: 13.085 subjects, Analyzed: Year 2: 11.646 women, Year 5: 10.527 women</td>
<td>2×2 factorial design: (1) vitamin D plus omega-3 fatty acids; (2) vitamin D plus placebo; 2000 IU of vitamin D3 (cholecalciferol) daily</td>
<td>(3) omega-3 fatty acids plus placebo; and (4) two placebos daily</td>
<td>UI frequency, UI type, UI progression</td>
<td>Vitamin D supplementation of 2,000 IU daily was not associated with reduction in weekly UI prevalence, incidence, or progression</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Country</td>
<td>Participants</td>
<td>Interventions</td>
<td>Outcomes</td>
<td></td>
<td></td>
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</table>
| Markland, et al., 2020                     | Analysis of two large observational studies / cohorts | United States | Cohort 1 (NHS I): Female registered nurses aged 30-55 years  
Cohort 2 (NHS II): Women between 25-42 years | Weekly oral vitamin D from diet and supplements for 12 weeks  
Weekly oral placebo for 12 weeks | Overall percentage change in UUI episodes, daytime frequency, nocturia episodes, daytime urgency, and nighttime urgency, satisfaction with treatment, changes in pelvic floor muscle strength, anal sphincter muscle strength, or Timed Up and Go testing |
| Markland, 2018                             | pilot randomized, double-blind, placebo- controlled trial | US | Postmenopausal, community-dwelling women, aged 50 years or older, with predominant UUI | Weekly oral 50,000 IU vitamin D3 for 12 weeks  
Weekly oral placebo for 12 weeks | In both completion and intention-to-treat analyses, larger reductions in UUI episodes were observed in the vitamin D group compared to the placebo group. There were no between-arm differences for the 12-week change in UI and OAB severity questionnaires, no differences in perceived improvement of satisfaction with treatment, no between-arm differences in changes in pelvic floor muscle strength, anal sphincter muscle strength, or Timed Up and Go testing. |
| Sarebani et al. 2023                       | RCT               | Iran    | Women being menopausal for at least 1 year, being married, being sexually active, and having sexual desire. | Vaginal suppository placebo and no treatment  
Female Sexual Function Scale (FSFI) score | The intervention group showed significantly higher sexual functioning scores than the placebo group at the first and second follow-up (immediately after treatment and 1 months post-treatment), and consistently higher scores at all three follow-up points. |
| Shahrahki, et al., 2022                    | Randomized Clinical Trial | Iran | Literate women aged 40 to 49 years who had serum vitamin D levels below 30ng/ml (18) and confirmed SUIs | Placebo weekly for 3 months  
Severity of stress urinary incontinence (SUI) and the impact of the severity of urinary incontinence on the life of premenopausal women | After the vitamin D supplementation, there was a significant improvement in the quality of life (p<0.001), with significantly lower SUI intensity at 8-12 weeks after supplementation than that of the placebo group (P<0.0001) |
| Sukarsa, et al., 2020                      | Pre-post quasi experimental study | Indonesia | Primiparous women with spontaneous vaginal delivery, with postpartum Vitamin D3 deficiency | Vitamin D3 supplementation for 3 months  
Serum Vitamin D3 Level  
Basal tone strength  
Maximum levator ani contraction | After vitamin D3 supplementation, there was a significant increase in serum vitamin D3 level (p<0.001) and basal tone strength (p<0.001). However, the maximum strength of levator ani muscle contraction did not increase (p<0.829). |
<table>
<thead>
<tr>
<th>Study</th>
<th>Design Type</th>
<th>Location</th>
<th>Participants</th>
<th>Interventions</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaughan et al., 2021</td>
<td>Longitudinal</td>
<td>USA</td>
<td>Postmenopausal women ≥ 50 years with predominant UUI with 25(OH)D level lower than 30 ng/mL</td>
<td>Weekly oral 50,000 IU vitamin D3 12 weeks Placebo for 12 weeks</td>
<td>The percentage change in frequency of UUI, as documented in the 7-day bladder diary Pelvic floor muscle strength improvement Anal sphincter strength</td>
</tr>
<tr>
<td>Vaughan et al., 2023</td>
<td>Cohorts</td>
<td>US</td>
<td>Women 55-98 years from NHS and NHS II with OAB symptoms</td>
<td>Vitamin D intake from supplements and diet</td>
<td>Prevalence of overactive bladder (OAB)</td>
</tr>
<tr>
<td>Vitale et al., 2018</td>
<td>RCT</td>
<td>Italy</td>
<td>Postmenopausal women, age 40 – 60 years old, with vasomotor disturbance</td>
<td>Oral dose of isoflavones (40 mg), calcium (500 mg), vitamin D (300 IU), and inulin (3 g) Placebo pills</td>
<td>Pre and post-treatment Female Sexual Function Index (FSFI) Score after 12 months</td>
</tr>
<tr>
<td>Yoanitha et al., 2020</td>
<td>Pre-post quasi</td>
<td>Indonesia</td>
<td>Postmenopausal women diagnosed with grade III and IV uterine prolapse</td>
<td>Vitamin D analog supplementation (Vit D3 1000 IU 0.5mcg) for 3 months Pre-supplementation Serum vitamin D3 levels</td>
<td>A significant increase in vitamin D level, VDR serum level, hand grip muscle strength, levator ani and gastrocnemius soleus muscle contraction strength after vitamin D3 supplementation (p &lt;0.001)</td>
</tr>
</tbody>
</table>
### Table 2  Quality of Assessment for the Randomized Trials using Jadad Scale

<table>
<thead>
<tr>
<th>Study</th>
<th>Was the study described as random?</th>
<th>Was the randomization scheme described and appropriate?</th>
<th>Was the study described as double blind?</th>
<th>Was the method of double blinding appropriate?</th>
<th>Was there a description of dropouts and withdrawals?</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aydogmus, et al., 2022</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Arjmand, 2022</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Markland, et al., 2018</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Markland, et al., 2023</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Sarebani et al., 2023</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
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<tr>
<td>Shahrahki, et al., 2022</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Vitale et al., 2018</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

### Table 3  Quality of Assessment for the Non-Randomized Trials using Newcastle Ottawa Scale for Cohort

<table>
<thead>
<tr>
<th>Study</th>
<th>Selection</th>
<th>Compatibility</th>
<th>Outcome</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kurniadi et al., 2023</td>
<td>★★★</td>
<td>★</td>
<td>★</td>
<td>High Quality</td>
</tr>
<tr>
<td>Markland et al., 2020</td>
<td>★★★★★</td>
<td>★★</td>
<td>★★★</td>
<td>High Quality</td>
</tr>
<tr>
<td>Sukarsa et al., 2020</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>High Risk</td>
</tr>
<tr>
<td>Vaughan et al., 2021</td>
<td>★★★★★</td>
<td>★★</td>
<td>★★★</td>
<td>High Quality</td>
</tr>
<tr>
<td>Vaughan et al., 2023</td>
<td>★★★★★</td>
<td>★★</td>
<td>★★★</td>
<td>High Quality</td>
</tr>
<tr>
<td>Yoanitha et al., 2020</td>
<td>★★★</td>
<td>★</td>
<td>★</td>
<td>High Quality</td>
</tr>
</tbody>
</table>
Inclusion criteria included papers discussing the effect of vitamin D on female patients exhibiting symptoms of pelvic floor dysfunction. Eligible article types included randomized controlled trials (RCTs), research studies, and journal articles. Excluded were articles involving populations other than women, case reports or series, review papers, and studies lacking vitamin D supplementation as an intervention.

Data Extraction and Analysis

Eligible studies underwent review, and the following data were extracted: authors, year of publication, study design, country, population group, intervention and control group sizes, form of vitamin D intervention, evaluation method, and measured outcomes. The data and summarized findings from these studies were then analyzed descriptively.

Risk of Bias Assessment

To determine the validity of eligible trials, pairs of reviewers independently appraised the studies using standardized critical appraisal instruments. For RCTs, the Jadad Scale or Oxford quality scoring system was employed while non-randomized studies were appraised using the Newcastle-Ottawa scale.

Results

Study Search Result

The literature search and selection process are illustrated in Figure 1. A total of 2392 articles were retrieved from six databases, with 2 records retrieved from other sources. The full text of 28 articles was assessed for eligibility after excluding five duplicated studies. After assessing the full-texts, 15 studies were subsequently excluded due to incompatible study designs (such as case reports or case series, review papers) (n=549), publication before 2018 (n=1734), or lack of relevance to the topic (n=93). Eventually, 13 studies meeting all inclusion criteria were included and analyzed in this paper.

Quality Assessment

A systematic assessment of bias in the included studies was performed using the Jadad Scale or Oxford quality scoring system for RCTs to ensure their validity, with four out of five studies considered high quality (Table 2). For non-randomized trials, five out of six were considered high quality using the Newcastle-Ottawa scale (Table 3).

Result

A total of thirteen studies involving 195,329 subjects analyzed the effect of Vitamin D supplementation on symptoms of pelvic floor dysfunction in women from various countries worldwide. The majority of studies reported interventions in the form of Vitamin D3 supplementation, ranging from 1000 IU daily to 50,000 IU weekly. Detailed interventions for each study can be found in Table 1. Three studies reported the effect of vitamin D supplementation on levator ani muscle strength, showing a positive correlation. However, results regarding the effect of vitamin D supplementation on urinary incontinence in women are contradictory. Among eight studies examining the association between vitamin D and urinary incontinence, five studies showed a negative correlation, while three studies reported significant improvements. Additionally, two studies investigating the effect of vitamin D supplementation on sexual dysfunction showed a positive correlation.

Discussion

Pelvic floor disorders are prevalent, affecting one in every three women. As women age,
their vitamin D levels also decline, partly due to reduced calcium absorption. In recent years, studies have highlighted the role of vitamin D in both skeletal and non-skeletal physiological functions, as well as its clinical effects on pelvic floor muscles. Vitamin D deficiency is considered one potential cause of pelvic floor dysfunction symptoms in women, including urinary incontinence and weakened muscle strength, leading to prolapses in older women. Vitamin D deficiency is defined as a serum 25-hydroxyvitamin D concentration (25(OH) D) of <20 ng/mL (50 nmol/L), while a serum concentration of 21-29 ng/mL (52–72 nmol/L) is categorized as vitamin D insufficiency. This underscores the need for increased attention, especially as women of reproductive age and pregnant women are particularly susceptible to nutritional deficiencies due to the physiological demands of menstruation and childbirth. Vitamin D deficiency can be addressed by boosting vitamin D synthesis through fortification, supplementation, and exposure to sunlight.

Another alternative for preventing and treating PFD is pelvic floor muscle training (PFMT), such as Kegel exercises. However, a recent study found that the effectiveness of vitamin D supplementation in treating urinary incontinence in pregnant women with hypovitaminosis D was significantly greater than PFMT alone. During pregnancy, supplementing with vitamin D alongside PFMT may be beneficial in preventing pelvic floor dysfunction.

The mechanism of action of vitamin D involves 1,25 (OH) D binding to membrane receptors that activate signal transduction, triggering the MAP Kinase (MAPK) and Phospholipase C (PLC) pathways, which facilitate rapid calcium influx into cells.

Vitamin D plays a crucial role in preventing vaginal atrophy by regulating the growth and differentiation of the vaginal epithelium. While high doses may be required for this effect, one potential mechanism is that vitamin D stimulates the proliferation of epithelial cells in the vagina through its receptors located in the basal and parabasal cellular layers of vaginal tissue. Consequently, vitamin D effectively regulates the differentiation of squamous cells and helps restore the vaginal mucosal tissue, thereby aiding in its function during sexual intercourse.

Among the thirteen studies retrieved, three reported a positive correlation between vitamin D supplementation and increased muscle strength. It was noted that basal muscle tone strength, as well as levator ani and gastrocnemius soleus muscle contraction strength, significantly increased with Vitamin D3 supplementation. Regarding the correlation between vitamin D supplementation and urinary incontinence, eight studies were reviewed, with five showing insignificant correlation while three demonstrated significant improvements. Notably, the five studies reporting insignificant correlation shared the same pool of data. Despite recruiting the largest number of subjects, these studies experienced numerous losses to follow-up. Furthermore, the research design did not allow for intervention and control group control, thus presenting a high potential for confounding bias. Two studies indicated that vitamin D supplementation can enhance sexual function, as evidenced by increased FSFI scores in the intervention group compared to the control group.
Limitations of The Study

There were still a limited number of studies, especially randomized controlled trials, exploring different dosages and forms of vitamin D. Furthermore, the reviews included in this study found limited effects of vitamin D on urinary incontinence and sexual function. Although two-thirds of the studies regarding vitamin D supplementation for levator ani muscle strength show promising results, the number of studies in this area is still limited. Among the appraised reports, there were also low-quality articles, although they comprised only a minor portion of the thirteen studies. Further clinical studies are needed to explore the effect of Vitamin D supplementation on the rate of recurrence and the risk of surgery. Additionally, future studies should investigate the dosage of Vitamin D supplementation required based on prolapse severity.

Recommendation

Current evidence suggests that vitamin D supplementation is a potential treatment strategy for women with PFD, especially those with known vitamin D deficiency and postmenopausal women. However, there are still very few studies. For future studies, experiments and well-designed prospective studies, especially randomized controlled trials, would provide more conclusive results regarding the effect of vitamin D supplementation on symptoms of pelvic floor dysfunction in women.

Conflict of Interest

None declared

References

9. Kurniadi A, Dewi AK, Sasotya RMS,


