RESEARCH PAPER

Curcumin Effects on Vitamin D Levels and Menopausal Symptoms among Postmenopausal Women

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ABSTRACT
The menopausal transition is characterized by estrogen decline, triggering somatovegetative, psychological, and urogenital symptoms, alongside an increased risk of vitamin D insufficiency. Curcumin, possessing anti-inflammatory and neuromodulatory properties, may alleviate these symptoms and modulate vitamin D receptors. This study evaluated the effects of curcumin supplementation on serum vitamin D levels and menopausal symptoms in postmenopausal women. An experimental, one-group pretest-posttest study was conducted involving 44 early postmenopausal women. Participants received 1000 mg of oral curcumin daily for six weeks. Outcome measures included serum 25-hydroxyvitamin D levels and menopausal symptom severity assessed via the Menopause Rating Scale (MRS). Data were analyzed using the Wilcoxon signed-rank test, Marginal Homogeneity test, and Spearman correlation. Following the six-week intervention, median serum vitamin D levels increased significantly from 24.78 ng/mL to 36.20 ng/mL ($p < 0.001$), with 75% of participants achieving normal vitamin D status. Simultaneously, the median total MRS score decreased significantly from 20 to 8.5 ($p < 0.001$), reflecting substantial improvements across all symptom domains. However, correlation analysis revealed no direct, significant association between the magnitude of vitamin D elevation and the extent of menopausal symptom relief ($r = 0.092$, $p = 0.553$). A six-week regimen of daily curcumin supplementation significantly elevates serum vitamin D levels and alleviates menopausal symptoms. The lack of direct correlation between these outcomes suggests curcumin operates via independent pharmacological pathways. Curcumin represents a promising non-hormonal, complementary therapy for managing menopausal syndrome.

Keywords: Curcumin, Vitamin D, Postmenopause, Menopause, Dietary Supplements**.**

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INTRODUCTION

Global female life expectancy is steadily increasing, with projections indicating that approximately 1.2 billion women will be over the age of 50 by 2030 [1,2]. This demographic shift highlights the growing clinical burden of menopause, a natural biological transition characterized by the cessation of menstruation and a significant decline in estrogen production [3,4]. This profound hormonal depletion triggers a myriad of menopausal symptoms encompassing somatovegetative (e.g., hot flashes, joint pain), psychological (e.g., mood swings, sleep disturbances), and urogenital (e.g., vaginal atrophy, dyspareunia) domains [5,6]. For many postmenopausal women, these symptoms frequently reach a severity that profoundly compromises their overall quality of life, daily performance, and sexual health [7].

While hormone replacement therapy (HRT) remains a conventional clinical approach for mitigating these symptoms, associated long-term risks such as thromboembolism, stroke, and breast cancer have catalyzed the search for safer, non-hormonal alternatives [8,9]. Concurrently, maintaining optimal nutritional status, particularly vitamin D, has emerged as a critical factor in postmenopausal health. Up to 70% of menopausal women experience vitamin D deficiency, a condition intricately linked to exacerbated urogenital infections, vaginal atrophy, metabolic syndrome, and compromised bone integrity [10–12]. Because postmenopausal hormonal and metabolic shifts inherently reduce vitamin D bioavailability, addressing this deficiency is paramount for the comprehensive management of menopausal complications [13,14].

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Curcumin, a bioactive polyphenolic compound derived from turmeric (Curcuma longa), has garnered considerable attention as a complementary therapy due to its potent anti-inflammatory, antioxidant, and neuromodulatory properties [15,16]. Emerging molecular evidence suggests that curcumin not only alleviates specific menopausal symptoms but also interacts synergistically with the vitamin D receptor (VDR), potentially enhancing VDR expression and amplifying vitamin D's signaling pathways [17–19]. Despite these promising mechanisms, clinical studies evaluating the simultaneous effects of curcumin supplementation on both serum vitamin D levels and comprehensive menopausal symptom amelioration remain sparse. Therefore, this study aimed to analyze the clinical efficacy of curcumin administration on serum vitamin D levels and the severity of menopausal symptoms, assessed via the Menopause Rating Scale (MRS), in postmenopausal women.

METHODS

Study Design and Participants

This study employed a pre-experimental, one-group pretest-posttest design to evaluate the physiological and clinical changes occurring before and after the administration of curcumin, without the use of a parallel control group. The research was conducted within the working areas of several Primary Health Care centers and women's community groups, including the Family Welfare Empowerment associations, in Makassar, Indonesia.

Participants

The target population comprised postmenopausal women clinically diagnosed with menopausal syndrome. Participants were recruited utilizing a consecutive sampling technique, wherein individuals who met the eligibility criteria were sequentially enrolled until the required sample size was fulfilled. The minimum sample size was statistically calculated based on the estimated population proportion, yielding thirty participants. To account for potential dropouts and missing data, the sample size was increased by approximately 30 to 40 percent, resulting in a final recruited cohort of forty-four participants.

The inclusion criteria comprised women aged 45 years and older, those experiencing spontaneous amenorrhea for at least twelve consecutive months, individuals with a clinical diagnosis of menopausal syndrome confirmed by a physician, and those expressing willingness to participate and provide written informed consent. The exclusion criteria encompassed current or prior use of HRT, a history of chronic respiratory diseases such as tuberculosis or chronic obstructive pulmonary disease, and a history of metabolic disorders including diabetes mellitus and thyroid dysfunction. Furthermore, individuals with a history of tumors or malignancies, particularly gynecological cancers—including those who had undergone surgical or chemotherapeutic interventions—as well as those currently consuming vitamin D or curcumin supplements, were excluded. Participants were withdrawn from the final analysis if they developed an acute illness during the study period, were lost to follow-up, died, or exhibited an intervention compliance rate of less than 80 percent. Adherence was strictly monitored via weekly follow-ups and pill counts.

Intervention Protocol

Upon enrollment, baseline demographic characteristics, clinical parameters, and semi-quantitative food recall data to assess baseline dietary intake of vitamin D and curcumin sources were recorded. The intervention consisted of oral curcumin supplementation administered at a dosage of 1000 mg per day, divided into two 500 mg capsules, for a continuous duration of six weeks.

Outcome Measures

Clinical and biochemical outcome measures were evaluated at two time points: baseline prior to the intervention, and immediately following the six-week supplementation period. To assess serum vitamin D levels, venous blood samples were drawn from the participants and sent to a clinical laboratory. Serum 25-hydroxyvitamin D3 levels were quantified using an Enzyme-Linked Immunosorbent Assay (ELISA) kit (Diagnostics Biochem Canada Inc., London, ON, Canada; catalog no. CAN-VD-510). Based on the results, vitamin D status was categorized into three clinical ranges: deficiency at less than 20 ng/mL, insufficiency between 20 and 29 ng/mL, and normal at 30 ng/mL or greater.

The severity of menopausal symptoms was assessed utilizing the standardized MRS questionnaire [20]. The scale evaluates eleven symptoms divided into three distinct domains. The somatovegetative domain includes hot flashes, heart discomfort, sleep problems, and joint and muscle discomfort. The psychological domain covers depressed mood, irritability, anxiety, and physical and mental exhaustion. The urogenital domain encompasses sexual problems, bladder problems, and vaginal dryness.

Statistical Analysis

All statistical analyses were performed using SPSS software, version 26.0. Descriptive statistics were used to summarize the characteristics of the participants, with categorical variables presented as frequencies and percentages, and continuous variables expressed as medians and ranges or means and standard deviations. The Shapiro-Wilk test was utilized to assess the normality of the data distribution, given the sample size of fewer than fifty participants. Because the data for both symptom scores and vitamin D levels were not normally distributed, non-parametric tests were applied. The Wilcoxon signed-rank test was used to compare continuous paired data before and after the intervention. The Marginal Homogeneity test was employed to evaluate shifts in categorical variables, specifically the distribution of vitamin D status and menopausal symptom severity. Finally, the Spearman rank correlation test was conducted to analyze the relationship between the change in serum vitamin D levels and the change in total symptom scores.

For all analyses, a p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

The study protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine, Hasanuddin University, Makassar, Indonesia (Protocol No. UH25040231). Written informed consent was obtained from all participants, and the study was conducted in strict adherence to the ethical principles outlined in the Declaration of Helsinki.

RESULTS

Characteristics of the Participants

The study included a total of forty-four postmenopausal women who fulfilled the inclusion criteria. The baseline demographic and clinical characteristics of the cohort are detailed in **Table 1**. The mean age of the participants was 51.73 ± 1.45 years, with a range of 49 to 55 years. The average duration since the onset of menopause was 18.34 ± 2.96 months, indicating that all participants were in the early postmenopausal phase. Nutritional status, assessed via Body Mass Index, revealed that the majority of the participants were classified as normal weight (36.4%) or overweight (29.5%), while 34.1% met the criteria for obesity. Dietary habits, evaluated through a semi-quantitative food recall regarding the consumption of natural vitamin D and curcumin sources, showed that nearly half of the participants (45.5%) never consumed these specific sources regularly. The cohort predominantly consisted of individuals with a secondary education level (75.0%) and those who were unemployed or managing households (88.6%).

Table 1. Characteristics of Postmenopausal Women (N = 44)

Variable	Mean ± SD / n (%)
Age (years)	51.73 ± 1.45
Duration of menopause (months)	18.34 ± 2.96
Body Mass Index Category	
Normal weight	16 (36.4%)
Overweight	13 (29.5%)
Obese Class I	7 (15.9%)
Obese Class II	8 (18.2%)
Dietary Intake (Food Recall)	
Never	20 (45.5%)
Rarely	16 (36.4%)
Frequently	8 (18.2%)
Education Level	
Primary	4 (9.1%)
Secondary	33 (75.0%)
Tertiary	7 (15.9%)
Employment Status	
Unemployed	39 (88.6%)
Employed	5 (11.4%)

Effects of Curcumin on Serum Vitamin D Levels

Prior to the intervention, the median serum vitamin D concentration was 24.78 ng/mL, demonstrating that a substantial portion of the cohort was experiencing vitamin D insufficiency. Following six weeks of daily curcumin supplementation, the median vitamin D level increased significantly to 36.20 ng/mL. The Wilcoxon signed-rank test confirmed that this elevation in serum vitamin D was statistically significant ($p < 0.001$), as summarized in **Table 2**.

Table 2. Comparison of Serum Vitamin D Levels and Menopause Rating Scale (MRS) Scores

Variable	Pre-intervention Median (Min–Max)	Post-intervention Median (Min–Max)	Z-score	p-value
Serum Vitamin D (ng/mL)	24.78 (11.81–55.30)	36.20 (16.11–101.63)	-5.777	< 0.001
Total MRS Score	20 (8–27)	8.5 (3–13)	-5.720	< 0.001

Beyond absolute concentrations, the intervention catalyzed a notable shift in the clinical categorization of vitamin D status (**Table 3**). Before the intervention, more than half of the participants (52.3%) were classified as having vitamin D insufficiency, and 20.5% were deficient. Post-intervention, the proportion of participants achieving a normal vitamin D status (≥30 ng/mL) surged from 27.3% to 75.0%. The Marginal Homogeneity test indicated a highly significant positive shift in the distribution of clinical vitamin D categories across the cohort ($p < 0.001$).

Table 3. Distribution of Vitamin D Clinical Status Before and After Intervention

Vitamin D Status	Pre-intervention n (%)	Post-intervention n (%)	Std. MH Statistic	p-value
Deficiency (<20 ng/mL)	9 (20.5%)	5 (11.4%)	-4.642	< 0.001
Insufficiency (20–29 ng/mL)	23 (52.3%)	6 (13.6%)		
Normal (≥30 ng/mL)	12 (27.3%)	33 (75.0%)		

Effects of Curcumin on Menopausal Symptoms

The overall severity of menopausal symptoms, quantified by the total MRS score, decreased substantially following curcumin administration. As presented in Table 2, the median baseline MRS score was 20, reflecting moderate to severe menopausal disturbances. After the intervention, the median score fell to 8.5, indicating a statistically significant clinical improvement ($p < 0.001$).

When analyzing specific symptom domains, statistically significant reductions were observed across all somatovegetative, psychological, and urogenital components (**Table 4**). The most pronounced improvements manifested within the somatovegetative domain, particularly concerning the alleviation of hot flashes and joint or muscle discomfort. Psychological symptoms such as irritability and mental exhaustion, alongside urogenital complaints including vaginal dryness and bladder issues, also demonstrated consistent and significant median reductions.

Table 4. Changes in Specific Menopause Rating Scale (MRS) Symptom Domains

Symptom Domain	Pre-intervention Median (Min–Max)	Post-intervention Median (Min–Max)	p-value
Somatovegetative			
Hot flashes	2 (0–3)	0 (0–1)	< 0.001
Heart discomfort	1 (0–2)	0 (0–1)	< 0.001
Sleep disturbances	2 (0–3)	1 (0–2)	< 0.001
Joint and muscle discomfort	2.5 (1–4)	1 (0–2)	< 0.001
Psychological			
Depressed mood	1 (0–3)	1 (0–2)	< 0.001
Irritability	2 (1–3)	1 (0–2)	< 0.001
Anxiety	1 (0–3)	1 (0–3)	< 0.001
Physical and mental exhaustion	2 (0–3)	1 (0–2)	< 0.001
Urogenital			
Sexual problems	1 (0–3)	0 (0–1)	< 0.001
Bladder problems	2 (0–3)	1 (0–2)	< 0.001
Vaginal dryness	2 (0–3)	1 (0–2)	< 0.001

The clinical significance of these score reductions was further evidenced by the shifting distribution of menopausal symptom severity (**Table 5**). At baseline, the majority of the cohort (63.6%) experienced severe menopausal symptoms. By the conclusion of the six-week intervention, zero participants remained in the severe category. Instead, the cohort transitioned entirely into moderate (50.0%), mild (20.5%), or minimal (29.5%) symptom classifications. The Marginal Homogeneity test confirmed that this categorical shift toward milder symptom severity was statistically significant ($p < 0.001$).

Table 5. Shifts in Menopausal Symptom Severity Categories

Pre-Intervention Severity	Post-Intervention			
	Minimal n (%)	Mild n (%)	Moderate n (%)	Severe n (%)
Mild (n=2)	2 (100%)	0 (0%)	0 (0%)	0 (0%)
Moderate (n=14)	9 (64.3%)	4 (28.6%)	1 (7.1%)	0 (0%)
Severe (n=28)	2 (7.1%)	5 (17.9%)	21 (75.0%)	0 (0%)

Correlation Between Vitamin D Changes and Symptom Improvement

To determine whether the alleviation of menopausal symptoms was directly tied to the elevation in serum vitamin D, a Spearman rank correlation analysis was conducted. The analysis compared the magnitude of change in vitamin D levels against the magnitude of change in total MRS scores. The resulting correlation coefficient was $r = 0.092$ with a p-value of 0.553. This indicates a very weak, positive relationship that did not reach statistical significance. Consequently, while curcumin supplementation independently increased vitamin D levels and improved menopausal symptoms, the data did not demonstrate a direct, significant linear correlation between the degree of vitamin D elevation and the extent of symptom relief at the individual level.

DISCUSSION

The main findings of this study demonstrate that a six-week intervention of daily curcumin supplementation yielded significant clinical and biochemical improvements in early postmenopausal women. The administration of 1000 mg of curcumin per day resulted in a substantial and

statistically significant elevation in serum vitamin D levels, effectively shifting the majority of the cohort from an insufficient status to a normal clinical range. Concurrently, the intervention produced a highly significant reduction in the severity of menopausal symptoms across all domains of the MRS—somatovegetative, psychological, and urogenital—completely eliminating the prevalence of severe symptoms within the study population. Interestingly, despite the simultaneous improvements in both parameters, correlation analysis revealed no direct, statistically significant linear association between the magnitude of vitamin D elevation and the extent of menopausal symptom relief, suggesting that curcumin operates through parallel but mechanistically distinct pathways.

The pronounced amelioration of menopausal symptoms observed in this cohort aligns with the bioactive profile of curcumin, particularly its robust anti-inflammatory and antioxidant properties. The early postmenopausal phase is characterized by rapid estrogen decline, which precipitates neuroendocrine fluctuations, thermoregulatory instability, and a state of low-grade systemic inflammation [7,21,22]. By downregulating pro-inflammatory cytokines such as TNF-α and IL-6, and inhibiting the nuclear factor kappa-B (NF-κB) pathway, curcumin effectively counteracts this inflammatory cascade [23,24]. This mechanism is particularly evident in the substantial relief of somatovegetative symptoms, notably hot flashes and joint discomfort, corroborating previous clinical trials that highlight curcumin's efficacy in mitigating vasomotor and musculoskeletal complaints [15,16]. Furthermore, the reduction in psychological symptoms, such as irritability and exhaustion, can be attributed to curcumin's neuromodulatory effects, which protect the central nervous system against oxidative stress and positively influence neurotransmitter balance during hormonal transitions [25,26]

Alongside symptom alleviation, the significant post-intervention increase in serum vitamin D levels highlights a critical biochemical interaction. Baseline data indicated that more than half of the participants experienced vitamin D insufficiency, a common condition in postmenopausal women exacerbated by increased adiposity and altered metabolism [10,27,28]. The shift of 75% of the cohort into a normal vitamin D status following curcumin supplementation can be explained by curcumin's role as an epigenetic modulator and a natural ligand for the VDR. Recent molecular studies suggest that curcumin upregulates VDR expression and enhances its sensitivity, thereby amplifying the biological signaling and potential bioavailability of existing vitamin D [17,18,29]. Restoring vitamin D to optimal levels holds profound clinical implications for this demographic, as it is essential for maintaining musculoskeletal integrity, regulating immune responses, and mitigating the metabolic derangements frequently associated with menopause [30,31].

Despite the parallel success in raising vitamin D levels and reducing MRS scores, the lack of a significant correlation ($r = 0.092$, $p = 0.553$) indicates that symptom relief is not strictly contingent upon vitamin D elevation. Menopausal syndrome is a highly complex, multifactorial condition influenced by overlapping biological, psychological, and environmental variables. The absence of a linear correlation suggests that while vitamin D plays a supportive role in overall physiological homeostasis, the direct relief of menopausal symptoms in this study was likely driven predominantly by curcumin's independent pharmacological actions—namely, its direct anti-inflammatory, neuroprotective, and mild phytoestrogenic effects—rather than operating strictly through a vitamin D-dependent causal chain. This reflects findings in broader observational research, where the relationship between vitamin D concentrations and the specific severity of menopausal symptoms often yields variable and indirect results [12,13].

Several limitations must be acknowledged when interpreting the results of this study. Primarily, the pre-experimental, one-group pretest-posttest design lacks a randomized placebo control group, which limits the ability to definitively rule out the placebo effect or natural physiological adaptations over time. Additionally, the intervention period of six weeks is relatively short, meaning the long-term sustainability and stability of these clinical improvements remain unknown. The study also relied on semi-quantitative food recall to assess dietary intake, which is inherently subjective and vulnerable to recall bias, thereby preventing strict control over external nutritional variables that might influence vitamin D metabolism. Finally, the absence of direct serum measurements for inflammatory biomarkers or specific reproductive hormones restricts a more comprehensive mechanistic understanding of how curcumin exerts its physiological benefits. Future studies should prioritize randomized controlled trials with extended follow-up periods and objective biomarker profiling to validate these promising preliminary findings.

CONCLUSION

A six-week regimen of daily curcumin supplementation significantly elevates serum vitamin D levels and alleviates somatovegetative, psychological, and urogenital menopausal symptoms in early postmenopausal women. The lack of a direct correlation between vitamin D elevation and symptom improvement suggests that curcumin operates via independent pharmacological pathways, primarily through its anti-inflammatory and neuromodulatory properties. Consequently, curcumin represents a highly promising non-hormonal, complementary therapy for managing menopausal syndrome and supporting metabolic health. Future studies should employ rigorous, double-blind, randomized placebo-controlled trials (RCTs) with larger cohorts, extended durations, and varied dosages to establish optimal therapeutic protocols. To fully elucidate curcumin's molecular mechanisms and long-term safety, subsequent studies must incorporate objective measurements of inflammatory biomarkers and reproductive hormones, while strictly controlling for

external confounders and monitoring potential gastrointestinal adverse effects.

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Author's Contributions
F.A.G. and A.M.T. contributed to the conception and design of the study. F.A.G. performed the data collection, clinical investigations, and statistical analysis. A.M.T., M.F.F., A.A.Z., E.C.J., and S.Q. validated the data and supervised the research process. F.A.G. wrote the first draft of the manuscript. A.M.T., M.F.F., A.A.Z., E.C.J., and S.Q. critically reviewed and revised the manuscript for important intellectual content. All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

Conflict of Interest
The authors declare no conflict of interest

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