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Effectiveness of Health Education and Vitamin D3 Supplementation in Preventing Postpartum Depression among Women in Vinh Bao District, Hai Phong

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Abstract: ***Background:*** ***Postpartum depression (PPD) is a global health concern with severe consequences. Previous studies have investigated either health education interventions or the association between serum vitamin D levels and postpartum depression. Therefore, this study was conducted to evaluate the effectiveness of a combined health education and vitamin D3 supplementation intervention on postpartum depression.*** ***Methods:*** ***This was a community-based intervention study with a controlled pre-post comparison design. The study participants were postpartum mothers from six communes in Vinh Bao District, Hai Phong. A total of 204 mothers were randomly assigned to either the intervention or control group. The intervention group received a health education program and vitamin D3 supplementation (2,000 IU/day) for three months. Depression scores (EPDS) were assessed at baseline (T1) and three months post-intervention (T2).*** ***Results:*** ***After three months of intervention, both groups showed a reduction in depression scores, with a greater decrease in EPDS scores in the intervention group compared to the control group (Z = -4.71 vs. Z = -2.41, p < 0.05). The prevalence of probable postpartum depression significantly decreased in the intervention group compared to the control group (3.4% vs. 15.7%, p = 0.027). These results suggest that the combination of health education and vitamin D3 supplementation can effectively reduce postpartum depression.*** ***Conclusions:*** ***Postpartum depression prevention programs should integrate health education and vitamin D3 supplementation to enhance effectiveness. Larger-scale studies are needed to confirm the intervention's impact. Future research should also better control for potential confounding factors influencing postpartum depression.***

Keywords: postpartum depression, prevention, health education, vitamin D3, Hai Phong

1. Introduction

Postpartum depression (PPD) is a global health issue with severe consequences. It not only affects the mother's mental and physical health but also negatively impacts child development and family relationships. Children of mothers with PPD face a higher risk of malnutrition, illness, and cognitive-emotional difficulties.[1,2,3] Globally, the prevalence of PPD in Asia[4] ranges from 7.45% to 56%, while in Vietnam, it varies between 8.2% and 48.1%, depending on the study location, assessment timing, and measurement tools.[5]

Multiple factors influence postpartum depression, including individual, familial, social, and environmental factors.[5] Previous intervention studies have primarily focused on social and environmental factors, as well as family and community support, as key intervention measures. While these factors play a crucial role, they largely depend on external conditions and may not always be modifiable in the short term.

Greater attention should be given to individual factors such as nutritional status, physical activity, personal beliefs, and preventive behaviors for depression. These aspects focus on changing mothers' awareness and behaviors, thereby enhancing their self-care capacity and depression prevention. A review of the literature suggests that health education is effective in preventing and reducing postpartum depression.[6,7,8]

Among modifiable physical factors, vitamin D3 has gained attention not only for its role in bone health but also for its association with postpartum depression.[9,10,11,12] A study by Brandenbarg (2012) involving 4,326 pregnant women[9] found that vitamin D deficiency increased the risk of depression (OR = 1.44; 95% CI: 1.12–1.85; p < 0.001). In 2014, Gur et al[10] studied 687 pregnant women and reported an inverse correlation between vitamin D3 levels and EPDS scores at 1 week, 6 weeks, and 6 months postpartum (r = -0.2; -0.2; -0.3). A study by Wang et al[11] (2023) reported that lactating women with vitamin D deficiency exhibited a significantly higher prevalence of postpartum depression than those with sufficient vitamin D levels (OR = 1.71, 95% CI: 1.01–2.88, p = 0.044). A 2016 randomized trial in Iran demonstrated that supplementing with 2,000 IU of vitamin D3 daily in late pregnancy reduced perinatal depression, reinforcing the role of vitamin D3 in depression prevention.[12]

Furthermore, the high prevalence of vitamin D deficiency among pregnant and postpartum women underscores the urgency of intervention. A study in China involving 2,004 postpartum women found that 85.3% had vitamin D

deficiency (<30 nmol/L), particularly severe during colder seasons.[13] In Vietnam, a study by Tuan et al. on 386 pregnant women reported a vitamin D deficiency rate of 31.09%, which was more common among women with financial difficulties, multiple pregnancies, and limited sun exposure.[14]

The integration of health education with vitamin D3 supplementation offers a comprehensive approach that not only enhances nutritional status but also raises awareness and fosters positive health behaviors, thereby supporting proactive and sustainable prevention of postpartum depression. To date, no studies in Hai Phong have examined the prevention of postpartum depression through a combined intervention of health education and vitamin D3 supplementation. Therefore, this study aims to assess the effectiveness of the intervention program in improving vitamin D3 levels, modifying depression-preventive behaviors, and reducing the risk of postpartum depression. The findings are expected to provide scientific evidence for preventive strategies, contributing to improved mental health outcomes for postpartum mothers.

2. Methods

Setting and participants

This community-based controlled intervention study utilized a pre-post comparison design. Participants were postpartum mothers who met the following inclusion criteria: between 1 week and 6 months postpartum, aged 18 years or older, and willing to participate in the study. They were required to have no language disorders, no psychiatric conditions or severe depression, and no chronic diseases such as hyperthyroidism, hypothyroidism, cardiovascular disease, kidney disease, or liver disease. Additionally, eligible participants had serum vitamin D3 levels below 100 ng/mL and were not receiving similar doses of vitamin D3 supplementation (2,000 IU/day) from other programs. The study was conducted in six communes of Vinh Bao District, Hai Phong, from June to December 2023.

Sample size calculation

The sample size was determined based on the research hypothesis, which aimed to assess the differences between the two groups in term of mean depression scores.

The sample size was calculated using the following formula:

$$n = \frac{\left(Z_{1-\alpha/2} + Z_{\beta}\right)^2 \text{x } 2 \text{ x } \delta^2}{(\mu_1 - \mu_2)^2}$$

Where:

- n is the required sample size per group.
- σ is the common standard deviation of the two groups.
- μ1−μ2: is the expected mean difference between the groups.
- $Z_{1-\alpha/2}$ = is the Z-score corresponding to the significance level, α = 0,05, Z = 1.96
- Z_{β} = is the Z-score corresponding to the statistical power; for 90% power , Z_{β}= 1,28

Based on the differences in depression scores reported in the study by Vaziri et al[12], the required sample size per group was calculated as 36 participants. Considering a 20% dropout rate, the final minimum required sample size for the study was 87 postpartum mothers (44 per group). In fact, we selected 60 participants for each group.

Sampling method

The intervention and control groups were assigned through a random selection process. Three out of six communes were randomly chosen to participate in the intervention program, while the remaining three communes served as the control group. A list of postpartum mothers in each group was compiled, and participants were selected using a systematic sampling method with a sampling interval of k = 2.

Data collection tools

Data was collected through structured interviews, including information on demographics, obstetric history, and postpartum depression. Postpartum depression was assessed using the Edinburgh Postnatal Depression Scale (EPDS) developed by Cox et al.[15] This scale consists of 10 questions, each scored from 0 to 3, with a total score ranging from 0 to 30. Higher scores indicate a greater risk of depression. An EPDS score of ≥13 was used to identify women at risk of probable postpartum depression. The reliability and validity of this tool were previously verified in a study by Thach Tran et al[16], with a Cronbach's α of 0.75.

Intervention

The intervention group (health education and vitamin D3 supplementation) participated in a single health education session conducted in small groups (10–15 participants) at the commune health station. Additionally, they received a daily dose of 2000 IU of Vitamin D3 for three months, initiated after vitamin D test results confirmed serum levels below 100 ng/L. The session was facilitated by the researcher and lasted approximately 40 minutes. The health education content was structured according to the Health Belief Model, addressing key aspects such as recognizing postpartum depression, understanding its consequences, identifying causes and risk factors, adopting preventive behaviors, evaluating treatment effectiveness, and accessing available support resources. To enhance behavior change, participants were provided with two follow-up support calls at one and two months post-intervention, and were included in a Zalo group for continuous updates and encouragement from the research team. The intervention utilized PowerPoint presentations supplemented with printed handouts. Practical strategies were included to overcome barriers to seeking support and adopting preventive behaviors. These aimed to boost participants' confidence in recognizing symptoms and taking action.

Intervention in the control group: The control group received the same health education as the intervention group but without Vitamin D3 supplementation.

Data analysis

The data collected from each interview were checked and entered into SPSS 20.0 for statistical analysis. Descriptive statistics, including percentages and mean scores, were calculated to summarize the data. To compare the results before and after the intervention, a variety of statistical tests were employed, including the Chi-square test, Fisher's Exact Test, Independent Samples t-test, Wilcoxon Signed-Rank Test, and Mann-Whitney U Test, depending on the data type

and distribution. These tests were used to assess differences and identify significant changes resulting from the intervention.

Research ethics

The study was approved by the Ethics Committee of Nam Dinh University of Nursing (Approval No. 1590/GCN-HĐĐĐ) and received consent from the leadership of the district and commune health centers where the research was conducted. All participants were fully informed about the purpose of the study, with assurance of voluntary participation and the right to withdraw at any time. The health education intervention was non-invasive and did not pose any risk to participants' health. For the vitamin D3 supplementation intervention, participants underwent serum vitamin D testing before supplementation. Mothers with excess vitamin D3 levels (>100 ng/mL) were excluded from the study. The supplementation was administered at a dose of 2,000 IU/day within safe limits, and if signs of toxicity occurred, participants were referred for medical examination at Vinh Bao General Hospital and excluded from the study. Women in the control group were advised to supplement with vitamin D3 if necessary after the data collection was completed.

3. Results

Demographic characteristics of participants before the intervention in both study groups

The results in Table 1 show that there were no statistically significant differences between the two groups regarding demographic and social characteristics at baseline ($p > 0.05$). The results in Table 2 show no statistically significant differences between the two groups regarding obstetric characteristics at baseline ($p > 0.05$).

Comparison of depression scores between the two groups before and after the intervention

In the intervention group, the majority of participants showed a reduction in EPDS scores after the intervention ($Z = -4.71$, $p < 0.001$). The control group also exhibited a reduction, but to a lesser extent ($Z = -2.41$, $p = 0.016$). Before the intervention, there was no significant difference in EPDS scores between the two groups ($p = 0.626$). However, after the intervention, this difference became statistically significant ($p = 0.047$) (Table 3).

The results in Table 4 show that before the intervention, the rate of probable postpartum depression (EPDS $\geq$ 13) between the two groups was not significantly different ($p = 0.750$). After the intervention, the intervention group had a significantly lower prevalence of probable postpartum depression compared to the control group (3.4% vs. 15.7%, $p = 0.027$). The rate of probable postpartum depression in the intervention group decreased by 78% compared to the control group ($RR = 0.220$, $p < 0.05$).

4. Discussion

In this study, 60 postpartum mothers were assigned to the intervention group and 60 to the control group. At the start, one mother in the control group did not participate in the baseline survey. After the intervention, data were collected from 58 mothers in the intervention group and 51 mothers in the control group, with missing data due to some participants not returning for follow-up assessments.

Characteristics of the study participants

The results of the analysis of general characteristics before the intervention showed no statistically significant differences between the intervention and control groups in terms of demographic and social factors. The average age of the mothers in the study ranged from 30 to 31 years. This similarity ensures the homogeneity of the study sample, reducing the potential influence of maternal age on the outcomes post-intervention. Educational level and occupation of the mothers also showed no significant differences between the two groups ($p > 0.05$). The majority of mothers had a high school diploma or higher (42.0%), indicating a certain level of understanding regarding pregnancy and postpartum health. Similarly, the educational level and occupation of the husbands showed no significant differences, which helps to eliminate any confounding factors related to family support during the intervention. The average household income was not significantly different between the two groups ($p > 0.05$). This factor is important as income can affect access to nutritious food and healthcare services.

The analysis of obstetric factors showed no significant differences in the number of births between the two groups ($p = 0.65$), ensuring that the number of previous births did not influence the study's outcome variables. Additionally, the proportion of planned pregnancies in the intervention group was higher than in the control group, but no statistical difference was found ($p = 0.21$), suggesting that the level of pregnancy planning was comparable between the two groups. Gestational age at birth and delivery method were also not significantly different between the groups ($p > 0.05$). The majority of mothers in the study had full-term pregnancies (91.6%), and the cesarean section rate was about 50% in both groups. This helps exclude the potential influence of delivery method and gestational age on the study outcomes. Overall, the analysis of baseline characteristics and obstetric factors indicated that the two groups were well-matched.

Effectiveness of the intervention program on postpartum depression scores

Our study's results indicate that the intervention program effectively prevents postpartum depression. The effectiveness of health education on postpartum depression has been reported in several previous studies.[6,7] Howell et al. (2012) implemented a behavioral education program for 540 African American and Latino mothers during their hospital stay after childbirth. The intervention focused on modifiable factors related to postpartum depression, such as physical symptoms, social support, self-efficacy, and infant-related factors. The results showed that the intervention group had lower depression rates compared to the control group at 3 weeks, 3 months, and 6 months postpartum, although the differences did not always reach statistical significance.[6] Top & Karaçam's (2016) study evaluated the effectiveness of a structured education program in reducing postpartum depression scores in 103 Turkish women[7]. The intervention group received health education on topics such

as motherhood sadness, psychosis, depression, frequency, prevalence, symptoms, causes, risk factors, and treatment of depression, as well as the effects of postpartum depression on mothers, their babies, and families, along with recommendations for prevention and overcoming PPD. Educational materials on postpartum depression were also provided, while the control group received routine care. The results showed that the intervention group had a significant reduction in EPDS scores and a lower depression rate compared to the control group (7.7% vs. 25.5%, $p = 0.015$). This demonstrates that health education plays a crucial role in preventing postpartum depression.

In comparison with our study, both studies applied health education interventions to reduce the risk of postpartum depression. However, our study combined health education with three months of vitamin D3 supplementation. The results showed that the intervention group reduced their depression rate from 17.2% to 3.4%, while the control group reduced from 19.6% to 15.7% ($p = 0.027$). This indicates that combining health education with vitamin D3 supplementation may yield more effective results than health education alone.

Several independent studies on the role of vitamin D in depression suggest that vitamin D supplementation is effective.[12,17,18] Vaziri et al investigated the effects of daily supplementation with 2000 IU of vitamin D in 136 pregnant women from 26 to 28 weeks of gestation until childbirth[12]. Their findings revealed that at 8 weeks postpartum, the intervention group had a significantly lower EPDS score (4.19 ± 3.76) compared to the control group (7.18 ± 3.99, $p < 0.001$). Similarly, our study also demonstrated a greater reduction in EPDS scores in the intervention group compared to the control group ($p = 0.047$). In 2018, Rouhi et al[17] conducted a double-blind randomized controlled trial (RCT) involving 80 postpartum mothers at risk for depression (EPDS >12). The intervention group received 1,000 IU of vitamin D daily for 6 months, while the control group received a placebo. The results showed that the intervention group had a significant reduction in EPDS scores and fatigue after 6 months ($p < 0.001$), while the control group showed no significant changes. Amini et al. (2020) conducted a randomized double-blind clinical trial involving 81 mothers with postpartum depression (EPDS >12). The participants were divided into three groups: one group received 50,000 IU of vitamin D3 every 2 weeks + 500 mg of calcium daily, another group received only 50,000 IU of vitamin D3, and the third group received a placebo. The results showed that postpartum depression scores decreased significantly more in the vitamin D + calcium group and the vitamin D + placebo group compared to the placebo-only group (-1.7 ± 3.44; -4.16 ± 5.90; and 0.25 ± 2.81, respectively; $p = 0.008$). The effect of vitamin D on depression scores was greater when used alone compared to when combined with calcium ($p = 0.042$ and $p = 0.004$, respectively). The authors concluded that vitamin D could be effective in improving the clinical symptoms of postpartum depression. However, its mechanism of action may not be entirely through changes in inflammation and/or hormones.[18] Vitamin D affects depression through several biological mechanisms. It acts directly on the central nervous system via vitamin D receptors (VDR), helping to protect and maintain brain cells. Additionally, vitamin D regulates neurotransmitters like serotonin and dopamine, contributing to mood stabilization. Vitamin D also has the ability to inhibit neuroinflammation, reducing pro-inflammatory cytokines such as IL-6 and TNF-α, which are factors linked to depression. It also participates in regulating the hypothalamic-pituitary-adrenal (HPA) axis, controlling stress responses and limiting excessive cortisol levels. Finally, vitamin D affects intracellular calcium and sex hormones, which are key factors in postpartum depression. These mechanisms highlight the important role of vitamin D in supporting mental health and reducing the risk of depression.[19]

This study introduces a novel approach by integrating health education and vitamin D supplementation into a comprehensive intervention, rather than examining their effects separately as in previous research. The findings underscore the dual benefits of combining micronutrient supplementation with awareness enhancement and behavioral modification—not only in improving mental health but also in optimizing maternal nutrition, thereby positively impacting both maternal and infant well-being. Unlike most prior studies that have focused solely on health education, psychological interventions, or the association between vitamin D and depression, this study employed a controlled experimental design to directly assess the combined effects of these two components on postpartum depression. Additionally, the intervention was structured based on the Health Belief Model (HBM) to promote awareness and facilitate behavioral change. These findings provide valuable preliminary evidence suggesting that vitamin D supplementation could be a promising strategy for postpartum depression prevention, paving the way for larger-scale studies with extended follow-up periods

The study controlled for confounding factors; however, due to the multifactorial nature of depression, it was not possible to eliminate them completely. Further research with a larger sample size is needed to evaluate the effectiveness of the intervention. Although the results indicate a significant reduction in depression, determining the optimal vitamin D threshold and comparing its efficacy with other interventions remains necessary. For ethical reasons, the study did not include a completely non-intervention group, which limited comparisons to only two types of interventions. This limitation may affect the conclusions; therefore, long-term studies are required to assess the sustained effects of the intervention

5. Conclusion

This study demonstrates that integrating health education with vitamin D3 supplementation significantly outperforms health education alone in reducing postpartum depression risk, with the intervention group showing a sharper drop in EPDS scores ($Z = -4.71$ vs. $Z = -2.41$, $p < 0.05$) and a lower prevalence of probable PPD (3.4% vs. 15.7%, $p = 0.027$). These findings highlight a promising, practical approach to maternal mental health, though larger studies are needed to confirm long-term efficacy and refine optimal strategies.

6. Recommendations

Healthcare providers should strengthen postpartum depression screening, provide health education, and consider vitamin D supplementation during the first six months postpartum. Nutrition management should be incorporated into prevention programs. Postpartum women should be informed about the importance of seeking support, maintaining a balanced diet, engaging in physical activity, and using vitamin D supplementation if necessary. Health policies should focus on postpartum depression screening and vitamin D deficiency prevention. Future studies should involve larger sample sizes, longer follow-up periods, and explore the optimal vitamin D dose for depression prevention

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Conflict of interest
The author declares that there are no conflicts of interest in this study.

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Table 1: Demographic characteristics of mothers in both study groups before the intervention

Characteristics	Intervention group (n = 60)	Control group (n = 59)	Total	*p*
***Age* (Mean ± SD)**	30.28 ± 6.16	29.92 ± 5.86		0.74[a]
Education level: n (%)				
Primary/Secondary school	15 (25.0)	20 (33.9)	35 (29.4)	
High school	26 (43.3)	24 (40.7)	50 (42.0)	0.53[b]
Higher education	19 (31.7)	15 (25.4)	34 (28.6)	
Mother's occupation: n (%)				
Farmer	6 (10.0)	6 (10.2)	12 (10.1)	
Worker	30 (50.0)	35 (59.3)	65 (54.6)	
Civil servants/ Private company employee	5 (8.3)	4 (6.8)	9 (7.6)	0.87[c]
Private Business	7 (11.7)	5 (8.5)	12 (10.1)	
Other	12 (20.0)	9 (15.3)	21 (17.6)	
Husband's education level: n (%)				
Primary/Secondary school	9 (15.0)	14 (23.7)	23 (19.3)	
High school	32 (53.3)	27 (45.8)	59 (49.6)	0.47[b]
Higher education	19 (31.7)	18 (30.5)	37 (31.1)	
Husband's occupation: n (%)				
Farmer	1 (1.7)	3 (5.1)	4 (3.4)	
Worker	32 (53.3)	36 (61.0)	68 (57.1)	
Civil servants/ Private company employee	3 (5.0)	5 (8.5)	8 (6.7)	0.30[c]
Private Business	14 (23.3)	6 (10.2)	20 (16.8)	
Other	10 (16.7)	9 (15.3)	19 (16.0)	
Average monthly family income (million VND): Mean ± SD	11.68 ± 5.37	13.32 ± 12.41		0,35[d]

Note:(a) Independent Samples Test, (b) Chi Square, (c) Fisher's Exact Test, (d) Mann Whitney U test.

Table 2: Obstetric history characteristics of mothers in the two study groups before intervention

Characteristics	Intervention group (n = 60)	Control group (n = 59)	Total	*p*
Number of deliveries: n(%)				
First time	12 (20.0)	14 (23.7)	26 (21.8)	
2nd time	25(41.7)	19 (32.2)	44 (37.0)	0.56
3rd time or more	23 (38.3)	26 (44.1)	49 (41.2)	
Plan for this pregnancy: n (%)				
Planned	44 (73.3)	37 (62.7)	81 (68.1)	0.21
Unplanned	16 (26.7)	22 (37.3)	38 (31.9)	
Gestational age at birth: n (%)				
Preterm (< 37 weeks)	5 (8.3)	5 (8.5)	10 (8.4)	0.98
Term (≥ 37 weeks)	55 (91.7)	54 (91.5)	109 (91.6)	
Mode of delivery: n (%)				
Vaginal delivery	26 (43.3)	35 (59.3)	61 (51.3)	0.08
Cesarean section	34 (56.7)	24 (46.7)	58 (48.7)	

Note: (p) Chi-square test

Table 3: Comparison of depression scores before and after the intervention between the two groups

Time	Group	n	Median (25th - 75th percentile)	Z	*p*
Pre-Intervention	Intervention	60	7,00 (4,00 – 9,75)	-0.60	0.547[a]
	Control	59	7,00 (4,00 – 11,00)		
Post-Intervention	Intervention	58	4,00 (1,00 – 6,00)	-1.99	0.047[a]
	Control	51	4,00 (2,00 – 10,00)		
Change in EPDS score (T1 - T2)	Intervention	58	2,00 (0,00 – 5,00)	-4.71	< 0.001[b]
	Control	51	1,00 (-1,00 – 6,00)	-2.41	0.016[b]

Note: (a) Man Whitney U test, (b) Wilcoxon Signed Ranks Test

Table 4: Comparison of probable postpartum depression rates between the two groups before and after the intervention

Time	Group	Probable depression (EPDS ≥ 13) n (%)	No depression (EPDS < 13) n (%)	Total	*p*	RR (95% CI)
Pre-Intervention	Intervention	10 (17.2)	48 (82.8)	58	0,750	0.879 (0.398 – 1.941)
	Control	10 (19.6)	41 (80.4)	51		
Post-Intervention	Intervention	2 (3.4)	56 (96.6)	58	0,027	0.220 (0.049 – 0.988)
	Control	8 (15.7)	43 (84.3)	51		