ORIGINAL RESEARCH

DOI: 10.5336/jcog.2020-74215

Evaluation of the Relationship Between the Level of Vitamin D in Maternal Blood and Breast Milk and Postpartum Depression

Hilal USLU YUVACI[a], Hayrullah YAZAR[b], Elif KÖSE[c], Betül Nur ÇOBAN[a], Mehmet Musa ASLAN[a], Esra YAZICI[d], Nermin AKDEMİR[a], Arif Serhan CEVRİOĞLU[a]

[a]Sakarya University Faculty of Medicine, Department of Obstetrics and Gynecology, Sakarya, TURKEY
[b]Sakarya University Faculty of Medicine, Department of Biochemistry, Sakarya, TURKEY
[c]Sakarya University Faculty of Medicine, Department of Public Health, Sakarya, TURKEY
[d]Sakarya University Faculty of Medicine, Department of Psychiatry, Sakarya, TURKEY

ABSTRACT Objective: This study aimed to evaluate the relationship between postpartum depression (PPD) and vitamin D levels in maternal blood and breast milk. **Material and Methods:** The study included women who presented to a polyclinic between December 2017 and August 2018, 4-6 weeks after having given live birth, who were aged between 18 and 40 years and married, gave birth after a planned single pregnancy, were feeding their baby with only breast milk and stated that they were taking vitamin D supplementation at the dose recommended by the Ministry of Health. The depression status of the women who agreed to participate in the study by signing the volunteer informed consent form was evaluated using the Edinburgh Postpartum Depression Scale (EPDS). Two groups were formed as Group 1: EPDS score <13 (n=44) (without PPD) and Group 2: EPDS score ≥13 (n=31) (with PPD). The vitamin D levels in breast milk and maternal blood in both groups were compared. **Results:** 75 female patients included in the study had a mean age of 29.80±4.54 years. The mean vitamin D levels in breast milk and maternal blood were found to be 13.26±5.39 ng/mL and 17.14±6.79 ng/mL, respectively. In terms of depression status, no statistically significant difference was found between the groups regarding the serum vitamin D levels and the mean level of vitamin D in breast milk (p=0.463, p=0.847). **Conclusion:** No significant correlation was determined between the vitamin D levels in maternal blood and breast milk and PPD, while vitamin D was found to be low both in maternal blood and breast milk.

Keywords: Postpartum depression; vitamin D; breast milk

Postpartum depression (PPD) is a prevalent mood disorder which may affect the infant and the mother negatively during the puerperium.[1] Similar to major depression disorders, PPD often causes sadness, feeling of worthlessness and anxiety, feeling of parental guilt, sleep and appetite disturbance, fatigue, nervousness and inadequacy in baby care. Women in severe conditions of this disorder may consider committing suicide or harming the baby. Moreover, PPD may have a negative impact on development of the bond between the mother and the baby. It may also lead to negative consequences on mental, motor and emotional development in babies in later periods.[2] The relationship of vitamin D deficiency with metabolic syndrome, abnormal glucose metabolism, obesity, hypertension and cardiovascular diseases has been reported.[3,4] Additionally, vitamin D deficiency has been shown to be related to depression in adults.[5,6]

In addition to its role in calcium homeostasis and the bone metabolism, vitamin D is a steroid hormone whose effects on reproduction and fertility, immune function and mental health have been proven.[7] Vitamin D is a cholesterol derivative neuro-steroid hor-

Correspondence: Hilal USLU YUVACI
Sakarya University Faculty of Medicine, Department of Obstetrics and Gynecology, Sakarya, TURKEY
E-mail: hilaly@sakarya.edu.tr

Peer review under responsibility of Journal of Clinical Obstetrics & Gynecology.

Received: 18 Feb 2020 ***Received in revised form:*** 12 May 2020 ***Accepted:*** 17 May 2020 ***Available online:*** 10 Jun 2020

mone that may have an important role in development of depression. Receptors for vitamin D are present on neuronal and glial cells in regions of the brain which have been implicated in the pathophysiology of depression.[8] The role vitamin D plays in neuroimmunomodulation and neuroplasticity, expression of vitamin D receptors in glia and neurons in the central nervous system and its protective effect from psychiatric disorders by causing changes in proliferation in nerve cells through such mechanisms as calcium regulation in neurons and nitric oxide synthase inhibition are well established.[9-11]

Though the prevalence of vitamin D deficiency is high in all age groups, it is frequently observed especially in women in their reproductive period during and after pregnancy as a result of the need of the developing fetus. It has been shown that vitamin D deficiency during pregnancy and delivery in different populations living in different latitudes is seen in people with light complexion by 5-20% and by 30-70% in people with dark complexion or shrouded populations.[12]

Besides, there is evidence regarding the relationship between postpartum depression and abnormal concentrations of poly unsaturated fatty acids, homocysteine and vitamin D.[13] In a recently published review, it was reported that there may be a relationship between vitamin D deficiency and depression risk in pregnancy and the postpartum period, but that due to the low methodological quality of available studies in the literature, the results are still debated.[14]

The best indicator of the serum level of vitamin D is the 25-hydroxy vitamin D3 [25(OH)D3] concentration, since it shows vitamin D both received through diet and synthesized in the skin.[15] There is no agreement on the required normal interval of vitamin D in pregnant women. However, the Endocrine Society identified lack of vitamin D as <20 ng/ml (<50 nmol/l), its deficiency as 21-29 ng/ml and its adequacy as 30-100 ng/ml. Though these intervals show some variations in the literature, the minimum target for vitamin D is 30 ng/ml.[16]

The number of studies investigating the relationship between vitamin D deficiency and postpartum depression is limited, and their results are debatable. Differently from the literature, this study aimed to investigate the relationship between postpartum depression and vitamin D levels both in maternal blood and breast milk.

MATERIAL AND METHODS

Approval for the study was obtained from the Clinical Research Ethics Committee of Sakarya University (Project ID number: 16214662/050.01.04/77). The patients (n=201) were chosen among women who presented to a gynecology and obstetrics clinic between December 2017 and August 2018 after having given live birth and fed their children only with breast milk by excluding risk factors for PPD stemming from psychological (depression history, pre-delivery depression and anxiety, stressful life experiences, poor marriage relationship and lack of social support), social (low socio-economic status, marital status and unplanned/undesired pregnancy) and biological (obesity, tobacco and alcohol use, multiple pregnancy, adolescent pregnancy, etc.) reasons.[17] We used a questionnaire form about risk factors which are reported in the literature. Married women at the ages of 18-40, who gave birth following a planned/desired single pregnancy, whose body mass index (BMI) values were 20-30 kg/m^2 with parity ≤3, who had a minimum of 8 years of education, whose income levels were medium and above, who were non-smoking and Turkish-speaking women and who stated that they had vitamin D supplementation on the level recommended by the Ministry of Health were included in the study. Patients who had psychiatric disorders before and during pregnancy, those who had chronic diseases such as hypertension and diabetes, those who had collagen vascular disease (autoimmune disease) history, nephropathy, epilepsy or other seizure disorders, active or chronic liver disease, heart disease, those who had tobacco, illegal drugs and alcohol use and those whose pregnancies were terminated due to major fetal anomaly or death were excluded from the study. Out of 88 women who were informed about the study, 13 women refused to participate. Demographic information of the patients who agreed to participate in the study and signed the voluntary informed consent form (n=75) was recorded. Postpartum depression diagnosis is a situation which requires a clinical interview. Moreover,

some standardized self-report screening tools have been developed for evaluation of mental status. The Edinburgh Postpartum Depression Scale (EPDS) is a scale that is widely used in the literature which aims to measure depression symptoms and provides information about the degree of psychological stress.[18] We also preferred to use this scale in our research and formed groups by evaluating the women's depression status. The groups were formed as Group 1: EPDS score <13 without PPD according to the scale results (n=44), Group 2: EPDS score ≥13 with PPD according to the scale results (n=31) (Figure 1). Additionally, the women diagnosed with PPD according to the scale scores were referred to the psychiatry clinic for psychiatric evaluation.

SAMPLE COLLECTION AND STORAGE

5-6 ml of breast milk was taken from the participating mothers into Eppendorf tubes, and venous blood samples were taken into biochemical tubes simultaneously. The samples in the primary tubes were kept for a maximum 24 hours at room temperature (18-22 °C). Following clotting, all samples were subjected to a cooling centrifuge process for 5 minutes at 4000 rpm. Later, the separated serums were stored in capped Eppendorf tubes (Isolab centrifuge tubes 2.0 ml, flat cap-without skirt) and preserved until the day of the study.

In the study, IDS-iSYS Multi-Discipline Automated System with serial number B0509 (Made in France) was used. The working method of the device was automated chemiluminescence immunoassay (CLIA). As the study kit, DS-iSYS 25-Hydroxyvitamin Ds was employed. The reportable interval of the test is 7 -125 ng/mL (18 -133 nmol/L). Any value read below 7 ng/mL (18 nmol/L) was reported as "<7 ng/mL (18 nmol/L)".

On the day of the study, blood serums and breast milk samples were taken out from -80 °C to room temperature and allowed to thaw. After thawing, ini-

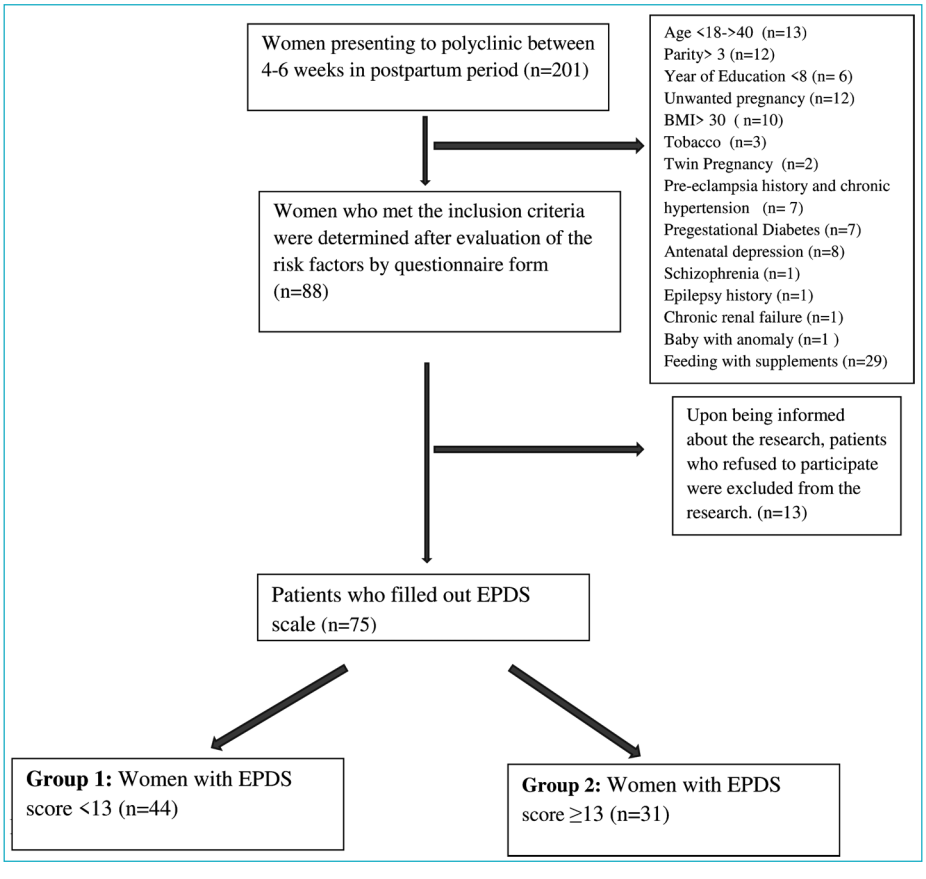

FIGURE 1: This diagram shows patients were chosen among women who presented to gynecology and obstetrics clinic.

tially, the 1.25-dihydroxyvitamin D [1.25(OH)2D] values in the blood serums were measured. After that, as indicated in the kit insert, "particulate" breast milk serums were subjected to a re-centrifuge process (5 minutes at 4000 rpm), and when the serums became transparent, the 1.25(OH)2D vitamin values in the breast milk serums were measured.

EDINBURGH POSTPARTUM DEPRESSION SCALE

The Edinburgh Postpartum Depression Scale (EPDS) that was developed by Cox and Holden (1987) is a self-report scale used for identifying the presence and/or risk of postpartum depression. The 4-point scale consists of 10 items.[18] EPDS was adapted to Turkish by Engindeniz et al., and if EPDS score is <13, it is described as "no depression, while an EPDS score of ≥13 indicates "depression".[19]

STATISTICS

The data were analyzed by using the SPSS Statistics 23 software. In data analysis, frequency distribution (number, percentage) for the categorical variables are presented, while the numerical variables are presented by descriptive statistics (mean, standard deviation). The difference between the categorical variables of the two groups was tested through "the significance test for the difference between two mean scores" (independent-samples t-test), and the relationship between two categorical variables was analyzed by chi-squared test.

RESULTS

The mean age of the women included in the study was 29.80±4.54. Of the women, 40% had normal vaginal delivery, while 60% had Cesarean section. Of the infants, 34.7% were girls, and 65.3% were boys. The demographic characteristics of the patients are presented in Table 1. There was no statistically significant difference between the groups in terms of their demographic characteristics. The mean breast milk and maternal blood vitamin D levels of the patients were found to be 13.26±5.39 ng/mL and 17.14±6.79-ng/mL, respectively.

In terms of depression status, no statistically significant difference was determined in the groups between the serum vitamin D levels and breast milk vitamin D levels (Table 2). Accordingly, the mean vitamin D in maternal blood and breast milk of the patients without depression did not show any significant difference in comparison to the patients who had depression.

TABLE 1: Demographic characteristics of the participants.

	Grup 1 (n=44)	Grup 2(n=31)	p
Age	30.13±4.76	29.32±4.21	0.447
Gravida*	2(1-6)	2(1-4)	0.222
Parity*	2(1-3)	1(1-3)	0.176
Abortion*	0(0-4)	0(0-2)	0.932
Delivery week*	39(30-40)	39(4-41)	0.581
Baby birth weight	3277.72±862.05	3372.25±467.49	0.581
Delivery type			
Vaginal delivery	17	13	0.778
Caesarean delivery	27	18	

*Mann-Whitney U testi.

TABLE 2: Evaluation of the difference in 25(OH)D3 in terms of groups.

	Mean (ng/ml)	Std. Deviation	t	p
Serum vitamin D				
Group 1	16.87	6.37	-0.676	0.463
Group 2	17.54	7.42		
Breast milk vitamin D				
Group 1	13.10	5.41	-0.766	0.847
Group 2	13.48	5.44		

Independent sample t test.

DISCUSSION

Vitamin D deficiency is a widespread health problem in Turkey. In the study, when the cut-off value was taken as ≤20 ng/ml, the prevalence of vitamin D deficiency was found to be 74.9%.[20] In a study conducted on 258 healthy pregnant women with ≥37 gestational weeks, the mean vitamin D level was determined to be 11.5±5.4 ng/ml.[21] In our study, the mean blood vitamin D level of the women in their postpartum period was found as 17.14±6.79 ng/ml (Table 1).

Results regarding the relationship between PPD and vitamin D are controversial in the literature. In

this study, no statistically significant difference was observed between the group with and without depression symptoms in terms of their maternal serum vitamin D and breast milk vitamin D concentrations. In the study carried out by Robinson et al. which included 796 women, a significant relationship was found between low levels of vitamin D in the 18th week of pregnancy and PPD symptoms on the third day after delivery.[22] In a prospective study conducted by Gür et al., when women with serum vitamin D deficiency in the second trimester of their pregnancy were followed in the 1st week, 6th week and 6th month, they were found to have increased depressive symptoms up to the postpartum 6 months.[17] In another study which demonstrated the relationship between postpartum depression and vitamin D, a relationship was determined between low serum vitamin D levels in blood samples taken at 24th hour, 48th hour and in the 3rd month after delivery and depression symptoms.[23] Nevertheless, similar to our results, in the literature, there also exist some studies which showed that there is no significant relationship between low vitamin D levels and postpartum depression.[24,25]

The relationship between levels of vitamin D in breast milk and vitamin D in maternal blood was shown in the literature.[26] Breast milk vitamin D levels were found to be positively correlated with maternal serum concentrations.[27] Healthy and breastfeeding women have a relatively small amount of 25-hydroxyvitamin D (25 (OH) D) in their breast milk.[28] Breast milk contains a little amount of vitamin D, and there is less transfer to babies whose mothers have vitamin D deficiency.[29] In our study, the levels of vitamin D in breast milk were also determined to be low in proportion to the levels in maternal blood. No significant difference was observed between the breast milk of the mothers with and without depression in terms of the vitamin D levels. Though no study was found in the literature to compare the results regarding this matter, the level of vitamin D in breast milk was determined to be low as expected.

The World Health Organization recommends feeding babies with only breast milk during the six months following delivery.[30] Therefore, infants fed with only breast milk will be more prone to vitamin D deficiency. The Endocrine Society recommends routine vitamin D supplementation during pregnancy and the breastfeeding period as a result of increased metabolic need in terms of the mother.[16] Thus, it was stated that, when the mother's vitamin D intake is insufficient amounts, the transfer of vitamin D will be enough to meet the infant's needs.[31] In Turkey as well, as of 2011, the Turkish Ministry of Health recommended all pregnant women to get vitamin D supplementation at a dosage of 1200 IU/day starting with their 12th week of pregnancy till the postpartum 6th month.[32] In our study, it was found that, although pregnant women who stated that they were using vitamin D prophylaxis were included in the study, low levels of vitamin D were identified in both breast milk and maternal blood. This may be attributed to the mothers' insufficient adaptation to vitamin D prophylaxis or low levels of basal vitamin D starting with gestation.

The low levels of vitamin D in breast milk and maternal blood could also be the result of the laboratory conditions. Some studies on this matter in the literature report that vitamin D is unstable in milk due to light, heat and oxidation, while some other studies which investigated the stability of milk in glass and plastic bottles and polyethylene bags reported that vitamin D is stable in these conditions.[33,34] In our study, all samples of breast milk were placed in plastic Eppendorf tubes and kept under the same conditions at -80 °C until the day of the analysis. In addition to personal and cultural factors that affect depression during and after gestation, some factors such as geographical location and seasons are known to have an impact on vitamin D levels in serum and breast milk.[35] Not investigating some other factors which constitute a risk such as exposure to Ultraviolet B, season, ethnic origin, diet status and adaptation to vitamin D supplementation that could affect vitamin D status was a limitation of our study. Moreover, the number of patients included in the study and not knowing the patients' levels of vitamin D during their pregnancy were other limitations of our study.

In studies conducted on this subject, some diagnostic tools such as EPDS and the Beck Depression

Inventory were used. In this study, as in other studies in the literature, EPDS was employed. This scale, which yields a numerical score for comparison of symptoms, does not evaluate the duration or intensity of depression and does not make a clinical diagnosis. Another limitation of the study was not having made a clinical evaluation.

CONCLUSION

Vitamin D is a hormone which plays a critical role for both medical and mental health. Although no significant relationship was found between PPD and vitamin D levels, the vitamin D levels in both the maternal blood and breast milk of the participants were determined to be low. Therefore, it is important that women in the risk group are identified, and vitamin D intake is continued in the postpartum period.

Acknowledgements

We would like to thank Dursune Pangal who works as a midwife at our clinic for her help.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Hilal Uslu Yuvacı;* ***Design:*** *Hilal Uslu Yuvacı, Nermin Akdemir;* ***Control/Supervision:*** *Arif Serhan Cevrioğlu, Nermin Akdemir;* ***Data Collection and/or Processing:*** *Betül Nur Çoban, Hilal Uslu Yuvacı;* ***Analysis and/or Interpretation:*** *Hilal Uslu Yuvacı, Mehmet Musa Aslan, Elif Köse;* ***Literature Review:*** *Betül Nur Çoban, Elif Köse, Hilal Uslu Yuvacı;* ***Writing the Article:*** *Hilal Uslu Yuvacı, Mehmet Musa Aslan;* ***Critical Review:*** *Nermin Akdemir, Arif Serhan Cevrioğlu;* ***References and Fundings:*** *Hilal Uslu Yuvacı, Mehmet Musa Aslan, Betül Nur Çoban;* ***Materials:*** *Hilal Uslu Yuvacı, Betül Nur Çoban.*

REFERENCES

1. Kingston D, McDonald S, Austin M-P, Tough S. Association between prenatal and postnatal psychological distress and toddler cognitive development: a systematic review. PLoS One. 2015;21;10(5):e0126929. [Crossref] [PubMed] [PMC]
2. Villegas L, McKay K, Dennis C-L, Ross LE. Postpartum depression among rural women from developed and developing countries: a systematic review. J Rural Health. 2011;27(3): 278-88. [Crossref] [PubMed]
3. Zhang Y, Gong Y, Xue H, Xiong J, Cheng G. Vitamin D and gestational diabetes mellitus: a systematic review based on data free of Hawthorne effect. BJOG. 2018;125(7):784-93. [Crossref] [PubMed]
4. Serrano-Díaz NC, Gamboa-Delgado EM, Domínguez-Urrego CL, Vesga-Varela AL, Serrano-Gómez SE, Quintero-Lesmes DC. [Vitamin D and risk of preeclampsia: a systematic review and meta-analysis]. Biomedica. 2018;1;38 Suppl 1:43-53. [Crossref] [PubMed]
5. Anglin RES, Samaan Z, Walter SD, McDonald SD. Vitamin D deficiency and depression in adults: systematic review and meta-analysis. Br J Psychiatry. 2013;202:100-7. [Crossref] [PubMed]
6. Parker GB, Brotchie H, Graham RK. Vitamin D and depression. J Affect Disord. 2017;208:56-61. [Crossref] [PubMed]
7. McCann JC, Ames BN. Is there convincing biological or behavioral evidence linking vitamin D deficiency to brain dysfunction? FASEB J. 2008;22(4):982-1001. [Crossref] [PubMed]
8. Bivona G, Gambino CM, Iacolino G, Ciaccio M. Vitamin D and the nervous system. Neurol Res. 2019;41(9):827-35. [Crossref] [PubMed]
9. Fernandes de Abreu DA, Eyles D, Feron F. Vitamin D, a neuro-immunomodulator: implications for neurodegenerative and autoimmune diseases. Psychoneuroendocrinology. 2009;34 Suppl 1:S265-77. [Crossref] [PubMed]
10. Buell JS, Dawson-Hughes B. Vitamin D and neurocognitive dysfunction: preventing "D"ecline? Mol Aspects Med. 2008;29(6):415-22. [Crossref] [PubMed] [PMC]
11. DeLuca GC, Kimball SM, Kolasinski J, Ramagopalan SV, Ebers GC. Review: the role of vitamin D in nervous system health and disease. Neuropathol Appl Neurobiol. 2013; 39(5):458-84. [Crossref] [PubMed]
12. Nielsen NO, Strøm M, Boyd HA, Andersen EW, Wohlfahrt J, Lundqvist M, et al. Vitamin D status during pregnancy and the risk of subsequent postpartum depression: a case-control study. PLoS One. 2013;27;8(11):e80686. [Crossref] [PubMed] [PMC]
13. Trujillo J, Vieira MC, Lepsch J, Rebelo F, Poston L, Pasupathy D, et al. A systematic review of the associations between maternal nutritional biomarkers and depression and/or anxiety during pregnancy and postpartum. J Affect Disord. 2018;232:185-203. [Crossref] [PubMed]
14. Aghajafari F, Letourneau N, Mahinpey N, Cosic N, Giesbrecht G. Vitamin D deficiency and antenatal and postpartum depression: a systematic review. Nutrients. 2018;10(4):478. [Crossref] [PubMed] [PMC]
15. Lukaszuk JM, Luebbers PE. 25(OH)D status: effect of D(3) supplement. Obes Sci Pract. 2017;3(1):99-105. [Crossref] [PubMed] [PMC]
16. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an endocrine society clinical practice guideline. J Clin Endocrinol Metab. 2011;96(7):1911-30. [Crossref] [PubMed]
17. Gur EB, Gokduman A, Turan GA, Tatar S, Hepyilmaz I, Zengin EB, et al. Mid-pregnancy vitamin D levels and postpartum depression. Eur J Obstet Gynecol Reprod Biol. 2014;179:110-6. [Crossref] [PubMed]

18. Cox JL, Holden JM, Sagovsky R. Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. Br J Psychiatry. 1987;150:782-6. [Crossref] [PubMed]
19. Engindeniz AN, Küey L, Kültür S. Edinburgh Doğum Sonrası Depresyon Ölçeği Türkçe formu geçerlilik ve güvenilirlik çalışması. 1st ed. Ankara: Psikiyatri Derneği Yayınları. 1996. p.51-2.
20. Hekimsoy Z, Dinç G, Kafesçiler S, Onur E, Güvenç Y, Pala T, et al. Vitamin D status among adults in the Aegean region of Turkey. BMC Public Health. 2010;23;10:782. [Crossref] [PubMed] [PMC]
21. Halicioglu O, Aksit S, Koc F, Akman SA, Albudak E, Yaprak I, et al. Vitamin D deficiency in pregnant women and their neonates in spring time in western Turkey. Paediatr Perinat Epidemiol. 2012;26(1):53-60. [Crossref] [PubMed]
22. Robinson M, Whitehouse AJ, Newnham JP, Gorman S, Jacoby P, Holt BJ, et al. Low maternal serum vitamin D during pregnancy and the risk for postpartum depression symptoms. Arch Womens Ment Health. 2014;17(3):213-9. [Crossref] [PubMed]
23. Fu CW, Liu JT, Tu WJ, Yang JQ, Cao Y. Association between serum 25-hydroxyvitamin D levels measured 24 hours after delivery and postpartum depression. BJOG. 2015;122(12):1688-94. [Crossref] [PubMed]
24. Accortt EE, Schetter CD, Peters RM, Cassidy-Bushrow AE. Lower prenatal vitamin D status and postpartum depressive symptomatology in African American women: Preliminary evidence for moderation by inflammatory cytokines. Arch Womens Ment Health. 2016;19(2):373-83. [Crossref] [PubMed] [PMC]
25. Gould JF, Anderson AJ, Yelland LN, Smithers LG, Skeaff CM, Gibson RA, et al. Association of cord blood vitamin D at delivery with postpartum depression in Australian women. Aust N Z J Obstet Gynaecol. 2015;55(5):446-52. [Crossref] [PubMed]
26. Weisman Y, Bawnik JC, Eisenberg Z, Spirer Z. Vitamin D metabolites in human milk. J Pediatr. 1982;100(5):745-8. [Crossref] [PubMed]
27. Specker BL, Tsang RC, Hollis BW. Effect of race and diet on human-milk vitamin D and 25-hydroxyvitamin D. Am J Dis Child. 1985;139(11):1134-7. [Crossref] [PubMed]
28. Bae YJ, Kratzsch J. Vitamin D and calcium in the human breast milk. Best Pract Res Clin Endocrinol Metab. 2018;32(1):39-45. [Crossref] [PubMed]
29. Holick MF. Resurrection of vitamin D deficiency and rickets. J Clin Invest. 2006;116(8):2062-72. [Crossref] [PubMed] [PMC]
30. WHO. Global Strategy on Infant and Young Child Feeding. Geneva: World Health Organization; 2003. p.30.
31. Thiele DK, Senti JL, Anderson CM. Maternal vitamin D supplementation to meet the needs of the breastfed infant: a systematic review. J Hum Lact. 2013;29(2):163-70. [Crossref] [PubMed]
32. Hatun S, Ozkan B, Bereket A. Vitamin D deficiency and prevention: Turkish experience. Acta Paediatr. 2011;100(9):1195-9. [Crossref] [PubMed]
33. Grady LT, Thakker KD. Stability of solid drugs: degradation of ergocalciferol (vitamin D2) and cholecalciferol (vitamin D3) at high humidities and elevated temperatures. J Pharm Sci. 1980;69(9):1099-102. [Crossref] [PubMed]
34. Blanco D, Fernandez MP, Gutierrez MD. Simultaneous determination of fat-soluble vitamins and provitamins in dairy products by liquid chromatography with a narrow-bore column. Analyst. 2000;125(3):427-31. [Crossref] [PubMed]
35. Kull Jr M, Kallikorm R, Tamm A, Lember M. Seasonal variance of 25-(OH) vitamin D in the general population of Estonia, a Northern European country. BMC Public Health. 2009;19;9:22. [Crossref] [PubMed] [PMC]