J Prev Epidemiol. 2020;5(1):e17 Original Article

doi 10.34172/jpe.2020.17 Journal of Preventive Epidemiology http jprevepi.com

The relationship between maternal vitamin D level with infants' birth-weight, height and head circumference at birth

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Received: 7 September 2020
Accepted: 4 November 2020
ePublished: 24 November 2020

Keywords: Vitamin D level, Mother, Infant, Weight, Height, Head circumference

Abstract

Introduction: Prevalence of vitamin D deficiency has been reported from all over the world since lower levels of vitamin D has been one of word's problem in the 21st century; especially pregnant women are the most prominent one.
Objectives: This study aims to investigate the relationship between mothers' vitamin D level with infants' birth-weight and head circumference.
Patients and Methods: A cross-sectional study was conducted in the department of obstetrics and gynecology of Akbarabadi hospital during 2017-2018. Regarding two groups, infants' three main characteristics including their weight, head circumference and height were studied.
Results: The mean blood levels of vitamin D in mothers with normal-born neonates were 15.23 ± 7.14 (ng/mL) and in the mothers who gave birth to low-birth weight were 10.02 ± 8.06 (ng/mL), which was significantly lower than the mothers of normal-weight infants ($P=0.018$). The mean blood levels of vitamin D in mothers who gave birth to a normal head circumference neonate were 16.07 ± 8.1 (ng/mL) and in mothers with infants' head circumference of less than 33 cm, was 9.87 ± 7.57 (ng/mL), which was significantly lower from mothers of normal-head circumference infants ($P=0.007$). The serum levels of vitamin D in mothers with normal-height infants were 14.74 ± 7.52 (ng/mL) and in the mothers with a height of less than 47 cm were 15.17 ± 7.91 (ng/mL), that does not suggest any significant difference ($P=0.341$). The mean serum vitamin D level in mothers who had normal vaginal delivery was lower than those with cesarean delivery, however there was no significant difference ($P=0.174$).
Conclusion: Nutrition improvement and prescribing vitamin D supplements can positively be effective in the way of curbing low-birth weight infants. Moreover, Exposure to sunlight and letting rays strike skin is essential for maintaining a healthy vitamin D status for girls and women.

Citation: Moradi A, Zadeh S. The relationship between maternal vitamin D level with infants' birth-weight, height and head circumference at birth. J Prev Epidemiol. 2020;5(1):e27. doi: 10.34172/jpe.2020.17.

Introduction

Prevalence of vitamin D deficiency is reported from all over the world and lower levels of vitamin D, compared to its normal level, had been recognized as a worldwide problem in the 21st century (1). However, some groups of people are exceeding prone to risk of vitamin D deficiency. Pregnant women are known as the most prominent group with vitamin D deficiency. Hence, vitamin D deficiency is a common phenomenon among them (2) mainly because of more need for vitamins in gestation period (3). Vitamin D deficiency is considerably observed in prenatal period and even known as a pandemic. Therefore, estimates have put the prevalence of this kind of vitamin deficiency at 21%-85% for pregnant women (4,5).

About two in each three pregnant women in the United States, present lower threshold of normal level of vitamin D, which is associated with higher prevalence in native and black American women (6,7). Factors like age, season, latitude, sunlight exposure, skin type, clothing and sunscreen utilization can affect the ynthesis of vitamin D (8). Urbanization and lower exposure to sunlight, which is chiefly due to social, geographical and occupational circumstances, lead to vitamin D decline in the body (9). Recent studies have maintained insufficient levels of vitamin D as a basic problem during pregnancy and lactation (10).

Hence, pregnant and lactating mothers and their breastfed infants must be counted among at-risk groups; since low level of vitamin D during pregnancy is associated

Key point

In a study on 110 participants, we found a significant correlation between infants' low-weight and maternal vitamin D serum level.

with health problems (11). Studies indicate that low levels of vitamin D can lead to low birth weight, neonatal calcium deficiency, poor postnatal growth, bone fracture and increase in autoimmune disease (12,13).

Affecting parathyroid hormone and calcium hemostasis, vitamin D plays a key role in fetal growth. Studies have confirmed that prenatal vitamin D deficiency impressively affects endochondral ossification and at birth SGA (small for gestational age) occurrence. Term and preterm neonates below 2500 g, who may be classified in SGA or intrauterine growth restriction (IUGR) groups, are 40 times more at risk of death compared to those who have normal weight. Vast numbers of researches have reported the effect of vitamin D nutrition on birth weight.

Despite abundance of sunny days in Iran, clothing style and malnutrition lead to vitamin D insufficiency which is a common problem among mature women. Therefore, we have surveyed on the relationship between maternal vitamin D level with neonatal birth weight, head circumference and height in Akbarabadi hospital.

Objectives

This study aims to investigate the relationship between mothers' vitamin D level with infants' birth-weight and head circumference.

Patients and MethodS

A cross-sectional study was conducted in department of obstetrics and gynecology of Akbarabadi hospital during 2017-2018. Defining two groups, infants' three main characteristics including their weight, head circumference and height were examined. Target population of the study included infants with normal weight (≥2500 g) and low weight neonates (<2500 g), infants with normal head circumference (up to 33 cm) and infants with small head circumference (<33 cm), neonates who had normal weight (≥47 cm) and who had small height (<47 cm).

Exclusion criteria were; pre-eclampsia, eclampsia, postpartum hemorrhage, insulin-dependent diabetes, chronic and systemic disease, hematologic disorders, mothers under pharmacotherapy, multiple pregnancy, drug utilization, body mass index ((BMI) greater than 30 kg/m^2, newborn infants diagnosed with congenial malformation and torch infection.

Mothers and their infants' characteristics including gender, age, weight, birth weight, birth height, head circumference at birth, gestational age, delivery type, maternal age and parity were recorded. After delivery, 5 cc of mother's blood was extracted to evaluate 25 vitamin D (OH). Mothers were categorized into four groups based on their serum level of vitamin D; 1) severe deficiency, 2) deficiency 3) normal range and 4) toxic.

Ethical issues

Human rights were respected in accordance with the Helsinki Declaration 1975, as revised in 1983. The ethical committee of Iran University of Medical Sciences approved the study (Ethical Code; IR.IUMS.FMD.REC.1399.452). The informed consent was taken from all mothers. This paper was extracted original research from the specialty medical thesis of Arezou Moradi in Iran University of Medical Sciences (Thesis # 5010).

Statistical analysis

The sample size was 110 participants. After data entry, information was analyzed by SPSS 23 and sample cases underwent statistical methods such as descriptive analysis, frequencies, frequency percentage, cumulative percentage and charts. Descriptive-quantitative and qualitative data were reported according to their average amount and frequency (percentage) respectively. In order to analyze data, independent *t* test and chi-square test were established. To report results, 5% was considered as significance level and 95% as confidence interval.

Results

The average age for mothers was 24.8 ± 5.3 years old and mean ± SD of gestational age was 37.4 ± 3.1 weeks. Newborns' mean ± SD for birth weight, birth height and head circumference at birth were 2951.4 ± 426.37 g, 49.2 ± 7.84 centimeters and 34.3 ± 4.21 centimeters respectively (Table 1). Among studied mothers, 49% were suffering from severe vitamin D deficiency (<10 ng/mL), 27% with insufficient (10-24 ng/mL) and 24% were in normal range (25-50 ng/mL).

Mean of serum vitamin D levels for mothers with normal-born neonates was 15.23 ± 7.41 (ng/mL) and for mothers with low-birth weight infants was 10.02 ± 8.06 (ng/mL) which was significantly lower than levels for mothers with normal weight infants (P = 0.018) (Table 2).

The blood levels of vitamin D for mothers who gave birth to a normal head circumference neonate were 16.07 ± 8.21 (ng/mL) and for mothers with infants' head circumference of less than 33 cm, was 9.87 ± 7.57 (ng/mL), which was significantly lower from mothers of normal-head circumference infants (P = 0.007). The serum levels of vitamin D for mothers with a normal-height infant were 14.74 ± 7.52 (ng/mL) and in the mothers with a height of less than 47 cm were 15.17 ± 7.91 (ng/mL), that does not suggest any significant difference (P = 0.341). The mean serum vitamin D level in mothers who had normal vaginal delivery was lower than those with cesarean delivery,

Table 1. Mothers and their infants' characteristics

Characteristic	Mean ± SD
Gestational age (wk)	24.8 ± 5.3
Maternal age (y)	37.4 ± 3.1
Birth weight (g)	2951.4 ± 426.37
Height at birth (cm)	49.2 ± 7.84
Head circumference (cm)	34.3 ± 4.21

Table 2. Infants' characteristics and mother's vitamin D level

Characteristics		Average level of Vit D (ng/mL)	Sufficient (25-50) No. (%)	Insufficient (10-24) No. (%)	Deficient (<10) No. (%)	N	*P* value
Weight	Mothers with infants' weigh of <2500 g	10.02 (SD: 8.06)	3 (6.8)	13 (29.5)	28 (63.7)	44	0.018
	Mothers with infants' weigh of ≥2500 g	15.2 (SD: 7.4)	28 (42.4)	17 (25.7)	21 (31.9)	66	
HC	Mothers with infants' HC <33 cm	9.87 (SD: 7.57)	1 (2.6)	12 (31.57)	25 (65.7)	38	0.007
	Mothers with infants' HC ≥33 cm	16.07 (SD: 8.21)	30 (41.6)	18 (25)	24 (33.3)	72	
Height	Mothers with infants' height of<47 cm	14.7 (SD: 7.5)	9 (26.4)	9 (26.4)	16 (47)	34	0.341
	Mothers with infants' height of ≥47 cm	15.1 (SD: 7.9)	22 (28.9)	22 (27.6)	33 (43.4)	76	

HC, head circumference.

however there was no significant difference ($P=0.174$) (Table 3).

Discussion

Several studies have been performed in Iran in order to evaluate maternal vitamin D. Around half of the mothers were suffering from vitamin D deficiency in our study. Other studies also have reported a high prevalence of vitamin D deficiency in Iran, e.g. 66.8% of mothers in Tehran (14) 86% in Zanjan (15) and 76% in Bushehr (16). This kind of vitamin deficiency is common in the world, for example, serum vitamin D level below 11 ng/mL was reported for 89.5% of Japanese pregnant women (17), 61% of New Zealand pregnant women (18) and 72.1% of Indian (19). Al-Kindi's study presented a correlation between 25-hydroxy vitamin D deficiency and lack of sun exposure (20). Dawodu et al mentioned that limitation of cutaneous contact with sunshine is the most important factor that determines vitamin D status in samples. Gaafar and Badr reported that vitamin D deficiency risk is five times more prevalent for people who are exposed shorter than five minutes to sunlight compared to those who get more than 31 minutes sunlight (22).

Brooke et al focused on the correlation between dietary factors for Asian women with inappropriate dietary condition concerning vitamin D. They mentioned the correlation between dietary factors such as vegetarianism, insufficient nutrient intake, mainly because of religious attitudes and ban on having some sort of nutrients with inadequate vitamin D nutrition (23,24).

In another study by Shany et al on Bedouin women and Jewish women, the role of diet and religious attitude in vitamin D ingredients was revealed (25).

Another study on comparing effect of diet and vitamin D status among pregnant Pakistani women inhabiting Oslo with Norwegian women, showed "avoidance of sunshine exposure", "lower dietary intake of vitamin D throughout nutrients", "no use of supplementation" as main reasons for vitamin D deficiency among Pakistani women. Other sources of vitamin D were limited to margarine for these women. Fish consumption was low among them compared to Norwegian women. High phytate intake by Pakistani women leads to impaired absorption of calcium and generates increased demands of 25OHD. It seems that insufficient calcium reception and extra phytate receptions lead to an intensification of calcium hemostasis. Other source of vitamin D for this group of women was limited to margarine while their fish consumption was lower than Norwegian women. Calcium deficiency resulting from low-reception of calcium or high phytate intake causes increase in 25 hydroxy vitamin D catabolism in the liver and need for vitamin D becomes vital. Promulgation of western dietary pattern among immigrants often causes additional absorption of fat and sugar, accompanied by overweight especially, associates with cardiovascular disease, diabetes mellitus and other health problems for immigrants inhabiting industrial areas (26-28). Nigerian teenage women are also known for vitamin D deficiency mainly because of malnutrition and no use of supplements and sunlight. In addition, in a study in Tehran, it was revealed that around 75% of female from 10 to 29 years old were diagnosed with vitamin D deficiency while median of vitamin D serum levels was below 25 ng/mL for all age categories especially for those girls and women aged from 10 to 40 years. Training society members, especially girls and women, on the matter of more exposure of skin to sunlight during the day, was suggested as an approach to modify vitamin D deficiency (29). We found a significant correlation between infants' low weight and maternal vitamin D serum level.

Table 3. Gestation type and mothers' vitamin D level

Gestation type	Average level of Vit D (ng/mL)	N
Normal vaginal delivery	14.5	41
Caesarean section	15.7	69

Conclusion

Results suggest a significant relationship between neonatal low birth weight and maternal vitamin D deficiency. Accordingly, nutrition improvement and prescribing vitamin D supplements can positively be effective in the

way of curbing low birth weight. Moreover, Exposure to sunlight and letting rays strike skin is essential for maintaining a healthy vitamin D status for girls and women.

Suggestions

- Dietary improvement and prescribing vitamin D supplements can positively effect on low birth weight.
- Using sunlight during the day to improve vitamin D level among women and girls.
- Nevertheless, further study is required in this area of research in order to improve maternal and neonatal health.

Limitations of the study

During the research, we encountered some problems such as inconsistencies in implementation and time constraints.

Acknowledgements

The authors would like to thank the Shahid Akbarabadi Clinical Research Development Unit, Iran University of Medical Sciences (IUMS), Tehran, Iran for their support and sincere cooperation throughout the period of study.

Authors' contribution

AM and FSZ designed the study, observed accuracy and validity of the study. AM and FSZ collected the data and supervised the project. All authors edited and revised the final manuscript and accepted its publication.

Conflicts of interest

The authors declare that they do not have any conflict of interest.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

Funding/Support

Iran University of Medical Sciences supported the study (Grant # 5010).

References

1. Holick MF, Chen TC. Vitamin D deficiency: a worldwide problem with health consequences. Am J Clin Nutr. 2008;87:1080S-6S. doi: 10.1093/ajcn/87.4.1080S.
2. Holick MF. Vitamin D deficiency. N Engl J Med. 2007; 357:266-81. doi: 10.1056/NEJMra070553
3. Zarean E, Jamal A. Vitamin D and pregnancy. National Assoc Iran Gynecol Obstet. 2011;6(3):13-20. (Parsian).
4. Fairfield KM, Fletcher RH. Vitamins for chronic disease prevention in adults: scientific review. JAMA. 2002;287:3116-26. doi: 10.1001/jama.287.23.3116.
5. Mulligan ML, Felton Sk, Riek AE, Bernal Mizrachi C. Implications of vitamin D deficiency in pregnancy and lactation. Am J Obstet Gynecol. 2010;202:429. doi: 10.1016/j.ajog.2009.09.002.
6. Bodnar LM, Catow JM, Simhan NH, Holick MF, Powers RW, Roberts JM. Maternal Vitamin D deficiency increases the risk of preeclampsia. J Clin Endocrinol Metab. 2007;92:3517-22. doi: 10.1210/jc.2007-0718.
7. Looker AC, Pfeiffer CM, Lacher DA, Schleicher RL, Picciano MF, Yetley EA. Serum 25- hydroxyvitamin D status of the US population: 1988-1994 compaired with 2000-2004. Am J Clin Nutr. 2008;88:1519-27. doi: 10.3945/ajcn.2008.26182.
8. Marrone G, Rosso I, Moretti R, Valent F, Romanello C. Is vitamin D status know among children living in Northern Italy? Eur J Nutr. 2012;51:143-9. doi: 10.1007/s00394-011-0200-9.
9. Mendoza V, Villanueva MT, Vargas G, Gonzalez B, Halabe J, Simon J, et al. Vitamin D deficiency among medical residents and its relationship with metabolic indicates. Endocr Pract. 2013;19:59-63. doi: 10.4158/EP12185.OR.
10. Ainy E,Ghazi AA, Azizi F. Changes in calcium 25(OH) vitamin D3 and other biochemical factors during pregnancy. J Endocrinol Invest. 2006;29:303-7. doi: 10.1007/BF03344100.
11. Ponsonby AL, Lucas RM, Lewis S, Haliday J. Vitamin D status during pregnancy and aspects of offspring health. Nutrients. 2010;2:389-407. doi: 10.3390/nu2030389.
12. Amirlak I, Ezimokhai M, Dawson A, Dawson KP, Kochiyil J, Thamas L, et al. Lurrent maternal–infant micronutrient status and the effects on birth weight in the United Arab Emirates. East Mediterr Health J. 2009;15(6):1399-406.
13. Morley R, Carlin JB, Pasce JA, Wark JD. Maternal 25-hydroxyvitamin D and parathyroid hormone concentrations and offspring birth size. J Clin Endocrinol Metab. 2006;91(3):906-12. doi: 10.1210/jc.2005-1479.
14. Maghbooli Z, Hossein Nezhad A, Shafaei A, Karimi F, Madani FS, Larijani B. Vitamin D status in pregnant women and their newborns. Sci J Kurdistan Univ Med Sci. 2006;11:64-73. [Persian].
15. Kazemi A, Sharifi F, Jafari N, Mousavinasab N. High prevalence of vitamin D deficiency among pregnant women and their newborns in an Iranian population. J Womens Health (Larchmt). 2009;18:835-9. doi: 10.1089/jwh.2008.0954.
16. Hatami G, Ahmadi S, Motamed N, Eghbali SS, Amiriani S. 25-OH vitamin D serum level in pregnant women in Bushehr. Iran South Med J. 2014;16:410-18.
17. Shibata M, Suzuki A, Sekiya T, Sekiguchi S, Asano S, Udagawa Y, et al. High prevalence of hypovitaminosis D in pregnant Japanese women with threatened premature delivery. J Bone Minera Metab. 2011;29:615-20. doi: 10.1007/s00774-011-0264-x.
18. Judkins A, Eagleton C. Vitamin D deficiency in pregnant New Zealand women. N Z Med J. 2006;119:U21440.
19. Chauhan R, Chauhan M, Baghel P. Prevalence of vitamin D deficiency and its outcome in pregnancy at tertiary center. Int J Med Appl Sci. 2015;4:170-7.
20. Al-kindi MK. Vitamin D status in healthy Omani women of childbearing age: Study of female staff at the Royal Hospital, Muscat, Omani. Sultan Qaboos Univ Med J. 2011;11:59-61.
21. Dawodu A, Kochiyil J, Altaye N. Pilot study of sunligh exposure and vitamin D status in Arab women of childbearing age. East Mediterr Health J. 2011;17:570-4.
22. Gaafar M, Badr S. An alarming high prevalence of vitamin D deficiency among healthy adults. Life Sci J. 2013;10:3292-8.
23. Brooke OG, Brown IR, Bone CD, Carter ND, Cleeve HJ, Maxwell JD, et al. Vitamin D supplements in pregnant Asian women: effects on calcium status and fetal growth. Br Med J. 1980;280:751-4. doi: 10.1136/bmj.280.6216.751.
24. Brooke OG, Brown IR, Cleeve HJ, Sood A. Observations on the vitamin D state of pregnant Asian women in London. Br J Obstet Gynaecol. 1981;88:18-26. doi: 10.1111/j.1471-0528.1981.tb00931.x.
25. Shany S, Biale Y, Zuili I, Yankowitz N, Berry JL, Mawer EB.

Feto-maternal relationships between vitamin D metabolites in Israeli Bedouins and Jews. Am J Clin Nutr. 1984;40:1290-4. doi: 10.1093/ajcn/40.6.1290.
26. Henriksen C, Brunvand L, Stoltenberg C, Trygg K, Haug E, Pedersen JI. Diet and vitamin D status among pregnant Pakistani women in Oslo. Eur J Clin Nutr. 1995;49:211-8
27. Sanchez PA, Idrisa A, Bobzom DN, Airede A, Hollis BW, Liston DE, et al. Calcium and vitamin D status of pregnant teenagers in Maiduguri, Nigeria. J Natl Med Assoc. 1997;89:805-11.
28. Pitkin RM. Calcium metabolism in pregnancy and the perinatal period: a review. Am J Obstet Gynecol. 1985;151:99-109.
29. Azizi F, Ra'iszadeh F, Misaid Ghazi AA. Vitamin D deficiency for a group of Tehran residents. Journal of Research in Medicine. 2001;2:291-303.