Research Article

The Role of Vitamin D in Pregnant Women in Birth Weight of Neonates

Peran Vitamin D pada Ibu Hamil terhadap Berat Badan Lahir Neonatus

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Abstract

Objective: To determine the relationship between serum vitamin D levels in third trimester mothers and newborn birthttweight.

Method: The study was conducted at the maternity ward of Dr. Zainoel Abidin General Hospital in Banda Aceh, Indonesia. Maternal and infant serum vitamin D levels were measured using the Automatic Chemiluminescence Immunoassay Analyzer (CLIA) method. Blood samples were collected from mothers in the third trimester and from infants after delivery. Spearman's correlation rank test was employed with a confidence level of 95%. Vitamin D levels were categorized as sufficient, insufficient, and deficient.

Results: A total of 39 pregnant women with an average age of 30.38 ± 6.21 years participated in the study, with a predominance of 38-39 weeks of gestation (35.9%). The mean vitamin D levels in mothers and neonates were 17.4 ng/mL and 17.6 ng/mL, respectively (p = 0.003, R = 0.462). The average birth weight of the babies was 3,100 grams, ranging from 2,100 grams to 4,200 grams (p = 0.185, R = 0.217). Both variables showed a positive correlation with varying strength of the relationship.

Conclusion: Maternal serum vitamin D levels in the third trimester exhibited a positive correlation with serum vitamin D levels in neonates with moderate strength, but there was no correlation with birth weight. The evaluation of maternal third-trimester serum vitamin D levels can serve as a predictor of neonatal vitamin D levels.

Keywords: birth weight, neonates, pregnancy, vitamin D.

Abstrak

Tujuan: *Untuk menilai pengaruh hubungan kadar vitamin D serum ibu trimester ketiga terhadap kadar vitamin D dan berat badan neonatus yang dilahirkan.*

Metode: *Penelitian ini studi observasional korelatif dengan desain potong lintang yang dilakukan pada kamar bersalin RSUD dr. Zainoel Abidin Banda Aceh. Pengukuran kadar vitamin D serum ibu dan bayi dilakukan dengan metode Automatic Chemiluminescence Immunoassay Analyzer (CLIA). Analisis data dengan melakukan Uji Spearman's correlation rank test untuk menilai kekuatan hubungan dua variabel.*

Hasil: *Sebanyak 39 ibu hamil usia 30,38 ± 6,21 tahun terlibat dalam penelitian ini dengan dominasi usia kehamilan 38–39 minggu (35,9%). Rerata kadar vitamin D ibu dan bayi secara berurutan adalah 17,4 ng/mL dan 17,6 ng/mL (p = 0,003, R = 0,462). Rerata berat badan bayi yang dilahirkan adalah sebesar 3.100 gram dengan rentang 2.100 gram hingga 4.200 gram (p = 0,185, R = 0,217). Kedua variabel didapatkan korelasi positif dengan kekuatan hubungan bervariasi.*

Kesimpulan: *Kadar vitamin D serum ibu trimester ketiga berkorelasi positif terhadap kadar vitamin D serum neonatus yang dilahirkan dengan kekuatan sedang namun tidak berkorelasi terhadap berat badan lahir bayi. Kadar vitamin D serum ibu pada trimester ketiga dapat dijadikan prediktor kadar vitamin D neonatus saat dilahirkan.*

Kata kunci: *berat badan lahir, kehamilan, neonatus, vitamin D.*

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INTRODUCTION

Vitamin D is an active metabolite that takes a major responsibility in the body mainly in maintaining hemostasis of calcium, phosphate and bone metabolism.[1] During pregnancy, maternal metabolism undergoes various physiological changes to support fetal development.[2] However, the causes of vitamin D deficiency during pregnancy aren't fully comprehended. In recent decades, several observational studies have found a link between maternal and neonatal vitamin D levels. A systematic review and meta-analysis study concluded that over 50% of pregnant women and neonates are deficient in vitamin D globally.[3]

Pregnancy complications, such as pre-eclampsia, caesarean section (C-section) delivery, and gestational diabetes have all been linked to vitamin D deficiency.[4] In addition to affecting the mother, vitamin D deficiency can also have adverse effects on the fetus. Fetal bone development relies heavily on maternal 25(OH)D and calcium stores. Skeletal mineralization is significantly dependent on calcium, which is actively transported through the fetal bloodstream. Severe calcium deficiency in the mother can lead to skeletal defects, hypocalcemia, and rickets in the neonate. This condition arises when vitamin D deficiency goes undetected during pregnancy or is detected after delivery.[5-7] Another consequence of maternal vitamin D deficiency during pregnancy is the possibility of preterm labor and giving birth to small neonates not suitable for gestational age. Various research studies have shown a correlation between vitamin D levels and birth weight.[8]

In clinical application, examination of 25(OH)2D levels is not commonly performed because it has a short half-life and does not provide an overview of long-term vitamin D status.[4] Maternal 25(OH) D concentrations will cross the placenta and serve as the primary source of vitamin D in fetus. Fetal serum concentrations of 25(OH)D (cord blood) were reduced by an average of 25% compared to maternal serum concentrations of 25(OH)D.[9] Several studies have found a link between serum vitamin D deficiency and poor pregnancy outcomes. Based on the background above, researchers are interested in investigating the relationship between maternal and newborn vitamin D levels. The findings of this study are expected to serve as a scientific reference source to form the basis for vitamin D supplementation in pregnant women and thereby prevent various pregnancy complications caused by vitamin D deficiency.[10]

METHODS

This is a cross-sectional study with a correlational design conducted in the delivery room at the Regional General Hospital Dr. Zainoel Abidin Banda Aceh (RSUDZA). Ethical approval was obtained from the Health Research Ethics Committee (KEPK) of the Faculty of Medicine, Universitas Syiah Kuala - RSUDZA. The study was carried out during the period from March to June 2022.

The sample for this research consisted of pregnant women and neonates who gave birth at RSUDZA Banda Aceh. The inclusion criteria were third-trimester pregnant women with a single live fetus. However, those with fetal distress, fetal anomalies, and mothers suffering from chronic hypertension, pre-eclampsia, kidney disease, and pregestational diabetes were excluded. The subjects for this study were selected using a correlative analytic study sampling formula, resulting in a sample size of 39 individuals.

Upon receiving an explanation regarding the purpose and benefits of the research, the subjects were asked for approval to become research samples. Covariate data collected included maternal age, gestational age, gestational status (GPA), history of vitamin supplementation, body mass index (BMI), blood routine, blood sugar during pregnancy (GDS), and levels of Ur, Cr, SGOT, and SGPT. Subsequently, 3 cc of venous blood was drawn to check the levels of 25(OH)D3 using the CLIA method. Additionally, after delivery, 3 cc of blood was taken from the umbilical cord to examine 25(OH)D, which represents the level of vitamin D in the neonate.

The bivariate analysis used in this research using the Spearman alternative test with a 95% confidence level. The ethical approval from the Ethic Committee of the Faculty of Medicine, Syiah Kuala University no 365/EA/FK-RSUDZA/2021.

RESULTS

The inclusion and exclusion criteria were met by 39 pregnant women and their unborn children who were used as research subjects. The following are the characteristics of the study participants:

Tablei 1. Research Characteristics Data

Characteristics	n	%	Mean	*P-value*
Age, mean± SD			30.38± 6.21	0.104
BMI (kg/m2), mean ± SD			26.82 ± 2.94	0.105
Occupation,				
Housewife	29	74.4		
Government Employee	8	20.5		
Self employee	2	5.1		
Parity, n (%)				0.322
P0	12	30.8		
P1	11	28.2		
P2	11	28.2		
P3	4	10.3		
P6	1	2.6		
Gestasional Age, n (%)				
34 – 35	1	2.6		
37 – 38	8	20.5		
38 – 39	14	35.9		
39 – 40	6	15.4		
40 – 41	7	17.9		
41 – 42	3	7.7		

The table above presents data on the characteristics of the research subjects involved. The average age of the mothers was 30.38 years, and their body mass index was 26.82, which falls under the overweight category. The subjects' occupation was predominantly housewives. Most of the subjects came from Aceh Besar and Banda Aceh. The predominant pregnancy status in this study was G1, P1, and A0, with a predominance of caesarean delivery. There were 10.3% of subjects with a history of vitamin D supplementation.

Table 2. Maternal and Neonatal Vitamin D Status

Vitamin D level	Mother	Neonates
Sufficiency	7 (17.7)	14 (35.9)
Insufficiency	29 (74.4)	15 (38.5)
Deficiency	3 (7.7)	10 (25.6)

Table 2 above present the distribution of maternal and fetal vitamin D status. Known as much as 7.7%. Vitamin D deficiency affects pregnant women in their third trimester.

Table 3. Correlation Analysis between Vitamin D Levels of Third Trimester Mothers and Neonates

Characteristic (n=39)	Median (min-max)	R	*P-value**
Vitamin D level (mother)	17.4 (8.6-38.9)	0.462	0.003
Vitamin D level (neonate)	17.6 (6.2-45.8)		

**Spearman's correlation rank test*

Furthermore, it is known that 25.6% of neonates born have vitamin D deficiency.

The results of the Spearman's correlation rank test on the correlation between maternal vitamin D levels in the third trimester and neonatal vitamin D levels are shown in Table 3. The average maternal vitamin D value was 17.4 ng/mL, and that of the neonates was 17.6 ng/mL. Statistically, maternal vitamin D levels were found to be significantly correlated with neonatal vitamin D levels with a moderate correlation strength (p = 0.003, R = 0.462).

Table 4. Correlation Analysis between Third Trimester Maternal Vitamin D Levels and Fetal Birth Weight

Characteristic (n=39)	Median (min – max)	R	*P-value*
Mother Vit. D level	17.4 (8.6 – 38.9)	0.217	0.185
Neonates Vit. D level	3.100 (2.100 – 4.200)		

** Spearman's correlation rank test*

Correlation analysis between third trimester maternalivitamin Dilevels and neonates birth weight is presented in table 4 above. The average birth weight of babies is 3,100 grams with a range of 2,100 grams to 4,200 grams.

DISCUSSION

According to this study, the consumption of vitamin D supplementation during pregnancy is low. Research by Pratumvinit et al. in Bangkok, which examined maternal vitamin D status and the factors influencing it, found that the consumption rate for vitamin D supplementation tends to be low, at only 10.2%.[11] This low supplement consumption rate is thought to be related to the incidence of vitamin D deficiency in pregnant women. Vitamin D dosages that are considered safe for pregnant women have not been clearly defined. The World Health Organization (WHO) recommends a daily intake of 200 IU of vitamin D.[12-14]

The average maternal vitamin D level in this study was 17.4 ng/mL, and the fetal vitamin D

level was 17.6 ng/mL. A serum 25(OH)D level of less than 20 ng/mL (50 nmol/L) indicates vitamin D deficiency. If it is adjusted to the definition of vitamin D deficiency, it is known that the average sample of the study has this condition. The statistical correlation between maternal vitamin D levels and neonatal vitamin D levels was moderate (p = 0.004, R = 0.462). These results are consistent with several studies that have been previously conducted in various countries.

The results of a study in Nepal found that the average vitamin D level in pregnant women was 14.6 ng/mL and 25.7 ng/mL in neonates. Linear regression analysis revealed a linear relationship between maternal vitamin D levels and neonatal vitamin D levels (p 0.001).[15] A study in Turkey discovered that the mean serum vitamin Dllevels in pregnant women were 14.82 ng/mL and 13.16 ng/mL in neonates.[16] Another, the average serum vitamin D in pregnant women was 68.11 mol/L and 28% of the samples hadi vitamin D deficiency.17

Prenatal complications such as gestational diabetes, preeclampsia, preterm delivery, and low birth weight have been linked to low vitamin Di levels.[18] The lack of vitamin D in pregnant women can also be found in their neonates and can affect the development of these neonates. Complications that can occur in children include rickets disease, susceptibility to respiratory tract disorders, and autoimmune diseases such as Crohn's disease or type I diabetes mellitus. The most severe complication that may occur is cancer.19 Various risks of this disease can occur due to the function and role of vitamin D in the body. The placenta is an organ that has the ability to convert 25(OH)D into its active form, 1,25-dihydroxyvitamin D. This active form of vitamin D has the ability to modify histones, leading to immunomodulation.[20]

The various complications that can arise are an important point in studying vitamin D levels in pregnant women and neonates. The correlation between maternal serum vitamin D levels and neonatal vitamin D levels was established in this study. These outcomes are consistent with another study that determines the serum vitamin D level of the neonate, which is known to correlate with that of the mother in the first 8 months, and endogenous synthesis only starts to play a role afterwards.[15] The study found that a deficiency of vitamin D in the mother increases the risk of vitamin D deficiency in placental blood by 2.765 times higher compared to mothers with normal vitamin D levels.[21] Several studies have also found that pregnant women's 25(OH) D levels are positively correlated with serum vitamin D levels in the placenta. For that reason pregnant women must have sufficient vitamin D levels so that they can supply the vitamin D needed by the fetus.[22,23]

A study looking at maternal and neonatal vitamin D status in South Africa found that mean maternal and cord vitamin D levels were 29.7 ng/mL and 21.0 ng/mL. Predictors of vitamin D deficiency in neonates include maternal age (OR 16.5 95% CI 1.82-149), birth in winter (OR 3.68 95% CI 2.05-6.61), birth by section cesarean delivery (OR 4.92 95% CI 1.56-15.57) and low birth weight (OR 1.99 95% CI 1.13-3.50).[24] Another study in Southeast Asia found mean maternal vitamin D levels and umbilical cord of 25.42 ng/mL and 14.85 ng/mL and there is a positive correlation between the two (r=0.86 and p<0.001). Vitamin D deficiency is thought to be caused by low maternal vitamin D levels and vitamin D supplementation, which also affects umbilical cord vitamin D levels.[25]

Additionally, this study also obtained the result that the average birth weight of the fetus was 3,100 grams, where the vitamin D levels of third trimester mothers did not correlate with the birth weight of the fetus (p > 0.05). The results of this study have similarities with the study by Lee et al. in 2022, assessing the relationship between maternal and neonatal vitamin D deficiency on neonatal anthropometry. The study found an average fetal birth weight of 3,064 grams and found no association between maternal vitamin D deficiency and infant birth weight.[26] Studies in China investigating the association between maternal vitamin D levels, pregnancy conditions, and infant growth found no correlation between maternal vitamin D deficiency and preterm labor, low or small birth weight for gestational age, as well as neonatal anthropometry (weight, length, and BMI) at ages 0 to 3 years. The studies concluded that there was no relationship between maternal vitamin D levels and infant growth.[27]

The findings of this study differ from several previous researches. In another study, samples with maternal vitamin D deficiency had lower neonatal anthropometric measurements. Vitamin D insufficiency, defined as levels below 50 nmol/L, was associated with the risk of small babies for gestational age and preterm labor. [28] Another study by Shakeri found a significant relationship between vitamin D deficiency or insufficiency and

low birth weight babies. The study suggested that this link may be due to the role of vitamin D in bone mineralization, leading to decreased fetal bone growth. [29] A systematic review study also obtained different results, showing a positive correlation between vitamin D deficiency and low birth weight (OR=2.45; 95% CI=1.91-3.13).[30]

CONCLUSION

The study revealed an average maternal vitamin D level of 17.4 ng/mL in the third trimester, and neonates had an average vitamin D level of 17.6 ng/mL. The findings indicate a moderate positive correlation between maternal and neonatal vitamin D levels. However, maternal vitamin D levels in the last trimester did not show any correlation with the baby's birth weight. Maintaining sufficient levels of vitamin D during pregnancy is essential to ensure an adequate supply for the developing fetus.

SUGGESTION

Further research is warranted to investigate the changes in maternal serum vitamin D levels throughout each trimester of pregnancy. Additionally, more studies are needed to explore the relationship between maternal vitamin D levels and other markers of fetal growth and development during pregnancy, as well as its impact on fetal physiology during childbirth. Maintaining adequate vitamin D levels in pregnant women is crucial for providing sufficient vitamin D to the developing fetus. One major limitation of our study is the inability to monitor sun exposure in the participating mothers. As the cultural practice of wearing cloth in Aceh may limit sun exposure, all mothers included in our study were likely vitamin D deficient, and their lifestyles may not have changed during the study period.

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CONFLICT of INTEREST

There are no conflicts of interest in this report..

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