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ORIGINAL PAPER

Correlation between body mass index and 25(OH)D levels in pregnant women

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Abstract

Background: Vitamin D is a vitamin that has a positive effect on maternal and infant health. The mother's nutritional status affects vitamin D levels, where one of nutritional status is expressed in body mass index (BMI). It has been assumed that BMI has the potential to influence the mother's vitamin D levels.

Objective: This study analyzes the correlation between BMI and 25(OH)D levels in pregnant women.

Methods: This observational analytical study examines data from the medical records of pregnant women who underwent antenatal examinations at the AMS Clinic Kemang from January 2022 to December 2023. The data analyzed were maternal age, gestational age at the time of vitamin D examination, gestational age at delivery, 25(OH)D levels, and maternal BMI. The Pearson correlation or Spearman Rank test was used in bivariate analysis, with a significance level of p<0.05.

Results: The mean maternal age was 33.45±6.24 years, with the median gestational age at the time of vitamin D examination being 6.5 mg. The median gestational age at birth was 39 weeks, with vitamin D levels of 20.8 ± 7.8, and a median BMI of 24.22 kg/m2. Based on the results of the Spearman statistical test analysis, there is a strong negative significant correlation between body mass index and levels of 25(OH)D in pregnant women (r -0.747; p=0.008).

Conclusion: Pregnant women's body mass index correlates negatively with levels 25 (OH)D. Therefore, it is recommended that pregnant women maintain a BMI within the normal range.

Keywords: body mass index, vitamin D, pregnancy

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Introduction

Vitamin D is a vitamin that has recently received attention because of its effects on health. Vitamin D's primary role is to maintain calcium and phosphorus homeostasis. However, nearly all human cells and tissues contain vitamin D receptors, suggesting that this vitamin has extraskeletal effects, particularly on the immune and cardiovascular systems.[1] Many studies show a high prevalence of vitamin D deficiency globally, including in Indonesia.[2]

Several factors influence vitamin D levels, including sun exposure, ethnicity, altitude, season, use of sun protection, and body mass index (BMI).[3] Serum concentrations of 25(OH)D can be used for both D2 and D3 to evaluate an individual's vitamin D nutritional status. Research reports show that 25–55% of pregnant women experience vitamin D deficiency.[4] The fetus is dependent on the mother's 25(OH)D concentration level, which affects the transfer of calcium, phosphorus, hormones, and immune balance, all of which are critical for bone growth processes and fetoplacental integrity.[5] Observational studies have found a link between low levels of 25(OH)D during pregnancy and more problems for the mother, such as pre-eclampsia, gestational diabetes[6], bacterial vaginosis, osteomalacia[7], and needing a primary cesarean section. Similarly, the fetus will also experience complications, such as impaired fetal growth, increased risk of allergies, premature birth, abortion, neonatal hypocalcaemia, and obesity over the long term.[8]

Although the number of studies is limited, observational studies show that obese pregnant women (BMI >30 kg/m^2) have significantly lower vitamin D levels than non-obese pregnant women.[9] Andersen et al.[10] reported that every 5 kg increase in BMI/m^2 is associated with a decrease in vitamin D levels of 1.48 ng/mL in pregnant women. Karlsson et al.[9] reported that despite consuming higher vitamin D levels in the diet and using the same vitamin D supplements, obese pregnant women had lower vitamin D levels than normal-weight pregnant women in the first trimester. Among women, the obese group exhibited decreased mean vitamin D levels compared to both the overweight and normal weight groups during winter and summer, frequently attaining vitamin D insufficiency status (<10 ng/mL).[11]

Other studies revealed different and conflicting results. Study in West Sumatra indicating a higher prevalence of vitamin D deficiency in pregnant women with low pre-pregnancy weight.[12] Similarly, Shen et al.'s study in southeast China at the first-trimester phase revealed a correlation between a higher pre-pregnancy BMI and higher 25(OH)D levels, a pattern that continues into the second and third trimesters.[13] Some studies show there is no relationship between pre-pregnancy BMI and vitamin D deficiency, as seen in the research of Woon et al.[14] The differences in results from these studies were caused, among other things, by different subject populations, differences in vitamin D calcification based on 25 (OH)D levels, and differences in sampling times, especially in the study area with four seasons.

Even though maintaining optimal levels of vitamin D in the body is important in theory, research has not shown conclusive results. Only a few publications in Indonesia describe vitamin D levels in pregnant women, specifically in West Sumatra[11]. Jakarta is the province with the highest prevalence of obesity among women aged over 18, namely 38.8%.[15] This can put women in the Jakarta area at risk of experiencing high pre-pregnancy BMIs and weight gain during pregnancy. This study aims to determine the correlation between BMI and 25(OH)D levels. The data can be used to recommend that pregnant women maintain BMI to improve vitamin D levels.

Methods

The Trisakti University Faculty of Medicine Ethics Committee no. 036/KER/FK/I/2024 granted ethical approval for the research. This research is an observational analytical study. Secondary data was collected from the medical records of pregnant women who had antenatal visits at AMS Kemang Clinic, South Jakarta, from January 2022 to December 2023. Inclusion criteria: medical records of pregnant women who underwent antenatal examinations from January 2022 to December 2023, maternal age between 21- and 35-years during pregnancy, data on body mass index before pregnancy in the medical record, and data on 25(OH)D examination results in medical records during pregnancy. Exclusion criteria: medical records of pregnant women with kidney disorders or hyperparathyroidism, taking atorvastatin and thiazide diuretics. Samples were selected based on consecutive sampling.

All data will be edited, coded, and entered into the computer. SPSS for Windows version 20.0 will be used for data analysis. Univariate analysis will be carried out to determine the distribution of all variables. The normality test will be carried out using the Kolmogorov-Sminov test with a p-value >0.05 as normally distributed data. For continuous data, it will be presented in mean ± standard deviation, and for categorical data, data will be presented in n (%) for those that are normally distributed and geometric data median (min, max) for those that are not normally distributed. For bivariate analysis, the Pearson correlation test will be used if the data is normally distributed or the Spearman Rank test if the data is not normally distributed with a significance if p-value <0.05.

Results

This study obtained data from 155 respondents who met the inclusion criteria in accordance with the minimum sample size required. The characteristics of the subject can be seen in **Table 1.**

Table 1. Subject characteristics

Variables	Mean±SD /median (min, max)	95% CI
Mother's age (age)	33.45±6.24	29.27 – 37.95
Gestational age at Vitamin D examination (weeks)	6.5 (5, 22)	6.26 – 13.03
Gestational age at labor (weeks)	39 (37, 40)	38.09 – 39.18
25(OH)D level (mg/dL)	20.8±7.8	15.56 – 26.04
Body mass index (kg/m^2)	24.22 (20.22, 41.62)	21.9 – 30.4

The mean maternal age is 33.45±6.24 years, with the median gestational age at the time of vitamin D examination being 6.5 mg. Gestational age during pregnancy with a median of 39 weeks, vitamin D levels 20.8±7.8 with a median BMI of 24.22 kg/m^2.

Table 2 shows the correlation of variables with 25(OH)D levels. Based on the Spearman statistical test analysis results, a strong negative significant correlation exists between body mass index and 25(OH)D levels in pregnant women (r -0.747; p = 0.008).

Table 2. Correlation of independent variables with 25(OH)D levels in pregnant women

Variables	25(OH)D level (mg/dL)	
	r	p
Mother's age	0.132	0.652^p
Gestational age at Vitamin D examination	-0.163	0.579^s
Gestational age at labor	0.038	0.897^s
Body mass index	-0.747	0.008*^{s}

p, Pearson correlation test; s, Spearman correlation test; *p<0,05

Discussion

The mean age of mothers in this study was 33.45±6.24; this age was in the range of 20-35 years, which corresponds to the ideal pregnancy age. WHO recommends that women be between 20 and 35 years old when experiencing pregnancy and childbirth. Pregnant women who are less than 20 years old or older than 35 years old are particularly vulnerable because their uterus and pelvis have not yet reached adult size, making pregnancy and childbirth more prone to complications, including miscarriage. As the uterus gets older (more than 35 years old), pregnancy complications will easily occur, and the incidence of chromosomal abnormalities will also increase.[16]

The gestational age at the time of vitamin D examination in this study was a median of 6.5 weeks, with a minimum gestational age of 5 weeks and a maximum of 22 weeks. According to the literature, increasing gestational age will affect vitamin D levels, and early pregnancy is an essential window for preventing vitamin D deficiency in pregnancy, which affects perinatal outcomes, including preeclampsia and spontaneous premature birth.[17] There are no recommendations for when is the best time to check vitamin D levels in pregnant women. However, maternal 25(OH)D levels progressively decrease during pregnancy due to the fetus' increased physiological needs.[18] However, there is insufficient evidence to support the recommendation to screen all pregnant women for vitamin D deficiency.

The median gestational age is 39 mg; this shows that the gestational age at parturition is within normal limits, namely 37-40 weeks. These new gestational age categories were suggested by the American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine in 2012. They are early term (37 0/7 weeks of gestation to 38 6/7 weeks of gestation), full term (39 0/7 weeks of gestation to 40 6/7 weeks of gestation), late-term (41 0/7 weeks of gestation to gestational age 41 6/7 weeks), and post-term (gestational age 42 0/7 weeks and beyond) to more accurately describe births that happen at or after 37 0/7 weeks of gestation.[19]

The 25(OH)D level is in an insufficiency condition, namely 20.8±7.8 mg/dL. Several studies show that pregnant women worldwide have a high prevalence of vitamin D deficiency in each trimester of pregnancy.[20] Factors determining 25(OH)D concentrations in pregnant women include skin pigmentation, UV radiation, extensive use of skin coverings due to religious or cultural reasons, and, more significantly, social deprivation. Several studies link low 25(OH)D levels with an increased risk of preeclampsia (PE), gestational diabetes mellitus (GDM), indications for cesarean section, premature birth, low birth weight (LBW), and small for gestational age (SGA). Vitamin D status is also critical for the fetus in pregnant women. Early in pregnancy, 25(OH)D crosses the placenta from mother to fetus, and levels measured in cord blood at birth depend on maternal status, averaging 80% of maternal values.[21] If the mother is deficient, the same happens to the fetus.[22] The placenta and fetal tissues express 1α-hydroxylase, which produces bioactive vitamin D in the fetal circulation.

Late hypocalcemia and nutritional rickets are the classic effects of vitamin D deficiency during pregnancy and in the neonate. Some studies suggest that prenatal vitamin D status affects offspring's susceptibility to developing asthma later in life.[23] It may also contribute to destroying pancreatic beta cells due to its action on lymphocytes and type 1 helper cytokines.[24] Vitamin D deficit during maternal pregnancy may also be a risk factor. Early brain development, which plays a relevant role in neuronal differentiation and synaptic function, causes multiple sclerosis in adulthood. The Body Mass Index (BMI) during vitamin D examination showed a median of 24.22 kg/m^2, which indicates that the mother was already overweight at the start of pregnancy. Bivariate analysis showed that of the various variables, only BMI showed a significant, strong negative correlation with 25(OH)D levels. This is in accordance with the theory, which states that an individual's body fat can influence vitamin D levels. Research from Giacoia et al. shows that obesity (BMI >30 kg/m^2) in pregnant women indicates a severe vitamin D deficit risk.[25] 25(OH)D levels <20 ng/mL are considered an indication of vitamin D deficiency, although the Endocrine Society and another expert group consider vitamin D insufficiency if the 25(OH)D level is 20–29 ng/mL and sufficient if the level is ≥30 ng/mL as sufficient; for non-classical measures, some authors suggest achieving levels >40 ng/mL.

Savard et al.'s research on 79 pregnant women showed that in the first and third trimesters, pregnant women with a pre-pregnancy BMI ≥30 kg/m^2 had lower total serum 25(OH)D concentrations than women with a pre-pregnancy BMI <25 kg/m2.[26] Serum total 25(OH)D concentration was inversely related to pre-pregnancy BMI in all trimesters but more strongly in the first trimester. Vitamin D supplement intake is adequate in improving vitamin D status among pregnant women with a higher pre-pregnancy BMI.[26] In assessing vitamin D status, BMI is important because obesity and adiposity are associated with higher total serum 25(OH)D concentrations, and because most women now enter pregnancy with a long-term BMI in the overweight or obese range. Obese adults also often require larger doses of vitamin D to achieve a serum total of 25(OH)D concentrations, similar to adults with a BMI in the recommended range.[27]

From the results of this study, it can be concluded that the need to maintain normal 25(OH)D levels is useful for preventing pregnancy complications. There was also a significant, strong negative correlation between BMI and 25(OH)D levels. This demonstrates a strong correlation between pregnant women's higher BMI and lower 25(OH)D levels. This study has several limitations. This study utilized secondary data, which may have biases and inaccuracies on pre-pregnancy BMI. Secondly, the sample size of this study is limited, requiring bigger sample sizes in further studies. The evaluation of maternal vitamin D levels occurred primarily during the first trimester of pregnancy, rendering the fluctuations in vitamin D status during early gestation uncertain. These constraints may influence the applicability of the findings to different populations. Additional potential factors influencing vitamin D levels, including skin type, physical activity, season, and genetic background, necessitate more investigation.

Conclusion

The results of this study suggest that women entering pregnancy should maintain their nutritional status in normal conditions, characterized by a normal BMI, in order to maintain 25(OH)D levels. Optimal 25(OH)D levels lead to optimal pregnancy outcomes for both the mother and the baby. Future studies using randomized controlled trials with more subjects and more factors influencing vitamin D are strongly recommended.

Conflict of interest

The authors declared no conflict of interest regarding this article.

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