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Vitamin and mineral levels during pregnancy

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SUMMARY

OBJECTIVE: Numerous physiological changes occur during pregnancy, which affect both the mother and the fetus. The objective of this study was to evaluate the magnesium, calcium, phosphate, parathormone (PTH), and vitamin D levels in each trimester of pregnancy.

METHODS: In this study, 30 pregnant women in the first trimester, 30 pregnant women in the second trimester, 30 pregnant women in the third trimester, and 30 healthy, non-pregnant women (control) in the same age group were included. The serum magnesium, calcium, phosphate, PTH, and vitamin D levels were measured in all the participants.

RESULTS: No statistically significant difference was found in the PTH and phosphate levels within the groups. In contrast, a significant difference was found in the vitamin D, calcium, and magnesium levels ($p<0.001$ for all). By analyzing the differences between the groups, the vitamin D, calcium, and magnesium levels were found to decrease with increase in the gestational weeks.

CONCLUSION: For maintaining a healthy pregnancy and fetus, we recommend vitamin D, calcium, and magnesium levels to be included in routine follow-ups for each trimester and supplemented in case of deficiency.

KEYWORDS: Pregnancy. Minerals. Vitamins.

INTRODUCTION

During pregnancy, many physiological changes occur which have an effect on both the mother and fetus. One such transient parameter is vitamin D. 7-Dehydrocholesterol, which is found in the skin, turns into cholecalciferol (vitamin D3) under the effect of ultraviolet B (UVB) rays and acts as the precursor of vitamin D in the skin. Another vitamin D precursor is ergocalciferol (D2). These forms of vitamin D are converted into 1,25-dihydroxy-cholecalciferol (calcitriol), the active form of vitamin D, via 25-alpha-hydroxylase in the liver and 1-alpha-hydroxylase in the kidney[1]. The most essential function of vitamin D is regulation of the plasma calcium and phosphate levels. Vitamin D is a fat-soluble, antiapoptotic, and anti-inflammatory steroid-structured molecule that facilitates bone development, contributes to the formation of the immune system, and prevents the development of cancer, among other functions[2]. During pregnancy, significant changes occur in the vitamin D and calcium metabolism of the body. For bone development and mineralization, the fetus accumulates 2–3 mg of calcium per day in the first trimester and about twice this amount in the third trimester. Vitamin D deficiency in pregnant women can lead to diseases such as gestational diabetes, preeclampsia, preterm labor, intrahepatic cholestasis, while in children, it can cause low birth weight, premature birth, abnormal skeletal development, immune system deficiency, and diseases such as rickets, asthma, type 1 diabetes, and cardiovascular disorders[3-5].

When the plasma calcium levels decrease, it stimulates PTH secretion, activates 1-alpha-hydroxylase enzyme, and actively forms vitamin D. Vitamin D increases plasma calcium and phosphate levels by increasing intestinal calcium and phosphate absorption and also by regulating osteoclast activity[6]. Hence, the need for PTH increases during pregnancy[7]. In general, PTH concentrations are found to be in the normal range in the first trimester of pregnancy, and then continue to increase and return back to the normal level toward the end of the third trimester[8].

Magnesium is also necessary for vitamin D activation; hence, the need for magnesium increases during pregnancy[9]. Magnesium deficiency can lead to preterm labor in pregnant women as well as developmental retardation in the fetus and metabolic syndrome in the later stages of life[10].

The incidence rate of vitamin D deficiency in pregnant women varies between 20–40% in the world and 18.2–45.9% in Turkey[11,12]. The aim of this study was to determine vitamin D, PTH, magnesium, calcium, and phosphate levels in the first, second, and third trimesters in multiparous pregnant women and to determine whether there is a difference between trimesters and healthy, nonpregnant women in the same age group.

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METHODS

This study included a total of 90 pregnant women and 30 healthy, nonpregnant control who were admitted to the Necip Fazıl City Hospital Gynecology and Obstetrics Department outpatient clinic between March and July 2021. Ethical approval was obtained from the ethics committee of the Kahramanmaraş Sütçü İmam University (decision number: 03-20/04/2022-03). Multiparous pregnant women who did not have any previous risk factors or known diseases, did not smoke, and did not use any vitamin D preparations were included in the study. Patients with metabolic and endocrine diseases were excluded from the study. The study participants were categorized into four groups: Group I comprising 30 pregnant women in their first trimester (8.68±0.57 weeks), Group II comprising 30 pregnant woman in their second trimester (22.72±3.64 weeks), Group III comprising 30 pregnant women in their third trimester (34.66±3.38 weeks), and Group IV comprising 30 nonpregnant women as healthy control. Each group consists of different patients. Fasting venous blood samples were collected from the participants of all the groups. The blood samples were centrifuged to separate the serum and plasma. The resulting serum samples were frozen at −80°C until analysis. The following methods were used in the analysis of the samples. The magnesium, calcium, phosphate, vitamin D, and PTH levels were measured.

The magnesium, calcium, and phosphate levels were measured calorimetrically using Roche Hitachi Cobas C501 (Roche Diagnostics, F. Hoffmann-La Roche Ltd., Japan) autoanalyzer. The vitamin D and PTH levels were measured using Roche Hitachi Cobas e-601 module (Roche Diagnostics, F. Hoffmann-La Roche Ltd.) autoanalyzer device via the electrochemiluminescence immunoassay method.

STATISTICAL ANALYSIS

The SPSS version 25.0 (IBM Statistics for Windows version 25, IBM Corp., Armonk, NY, USA) program was used to analyze the study data. Variance homogeneity was checked with Levene test, and conformity of the data to normal distribution was evaluated by Shapiro-Wilk test. Quantitative data were presented as mean±standard deviation. Categorical data were presented as n (number) and percentage (%). Multiple groups were compared using ANOVA, and Tukey HSD was used for intergroup comparisons. The data were examined at 95% confidence interval and $p<0.05$ was considered statistically significant for all the analyses.

RESULTS

The study included multiparous pregnant women in the first, second, and third trimesters and healthy, nonpregnant controls with similar characteristics. The mean age was 26.83±5.93 years in Group I, 27.03±5.58 years in Group II, 27.43±5.81 years in Group III, and 30.77±7.22 years in Group IV. There was no statistically significant difference between the groups in terms of age. Demographic variables of patients are provided in Table 1. Furthermore, no statistically significant difference was found in the PTH and phosphate levels within the control group (Group IV) and the pregnant groups (Groups I, II, and III) ($p=0.495$, $p=0.173$, and $p=0.149$, respectively). Conversely, vitamin D, calcium, and magnesium levels were found significantly lower in the pregnant groups (Groups I, II, and III) compared to the control group (Group IV) ($p<0.001$ for all). When the differences between the groups were analyzed, it was found that the vitamin D, calcium, and magnesium levels decreased as the gestational weeks increased. The vitamin D, calcium, and magnesium levels of Group I were significantly higher than the other groups ($p<0.05$). There was no statistically significant difference between Groups II and III in terms of the vitamin D, calcium, and magnesium levels ($p>0.05$). All the biochemical variables are presented in Table 2.

DISCUSSION

Vitamin D possesses essential functions such as regulating calcium and phosphorus metabolism, contributing in the development of a strong immune system, and preventing oxidative DNA damage and cancer development by inducing apoptosis in tumor-forming cells[13,14]. Studies in the literature have reported vitamin D deficiency to be a common phenomenon in pregnant women[11,12]. Another study stated that the vitamin D levels increased twofold in pregnant women during the first trimester and decreased 2–3 times during the subsequent trimesters[15]. In contrast, other studies have reported no change or increase in the vitamin D levels between trimesters[16]. Vitamin D deficiency in pregnant women can cause disorders, including gestational diabetes, preeclampsia, preterm labor, and intrahepatic cholestasis, while in children, it can lead to low birth weight, premature birth, abnormal skeletal development, immune system deficiency, and diseases such as rickets, asthma, type 1 diabetes, and cardiovascular disorders[3-5]. In general, the concentration of 25(OH)D in cord blood has been shown to be approximately 50–80% of that of the serum[17]. Some studies have found that vitamin D supplementation in pregnant women prevents hypocalcemia, which can cause the softening of the bones, such as in the disorders craniotabes and rickets, dilated cardiomyopathy, and immune system pathologies[18,19].

In our study, it was determined that there was no statistically significant difference in PTH and phosphate levels between the

Table 1. Demographic variables of patients (Kemal Hansu).

Variables	Group 1 (n=30)	Group 2 (n=30)	Group 3 (n=30)	Group 4 (n=30)	p
Age (years)	26.83±5.93	27.03±5.58	27.43±5.81	30.77±7.22	0.049
Gestational age (weeks)	8.68±0.57	22.72±3.64	34.66±3.38	–	<0.001

Data are expressed as mean±SD or n (%), unless otherwise noted. One-way ANOVA (with Tukey HSD) or Pearson's chi-square test.

Table 2. Comparison of the hematological, biochemical, and hormonal variables of the groups (Kemal Hansu).

Variables	Group 1 (n=30)	Group 2 (n=30)	Group 3 (n=30)	Group 4 (n=30)	p
PTH (mIU/mL)	48.61±63.80	70.77±48.55	73.94±42.44	60.55±32.62	0.173
25(OH)D (ng/L)	16.17±10.04*	8.75±4.75†	9.89±7.61†	19.36±6.8064	<0.001
Calcium (Ca) (mg/dL)	9.44±0.54‡	9.34±0.34§	9.04±0.36†	9.82±0.39	<0.001
Magnesium (Mg) (mg/dL)	1.98±0.14‡	1.95±0.38‡	1.90±0.13‡	2.0 6±0.15	0.021
Phosphate (P) (mg/dL)	3.47±0.64	3.49±0.87	3.69±0.75	3.27±0.45	0.149

Data are expressed as the mean±SD or n (%), unless otherwise noted. One-way ANOVA (with Tukey HSD) or Pearson's chi-square test. *p>0.05 between the control group and the related group; †p<0.001 between the control group and the related group; ‡p<0.05 between the control group and the related group; §p<0.01 between the control group and the related group. PTH: parathormone.

control group and pregnant women. PTH is necessary to increase calcium absorption in pregnant women. Serious complications such as intrauterine growth retardation, neonatal tetany, intrauterine deaths, long bones curvature, low birth weight, spontaneous abortions, and fetal deaths can be seen in fetuses of pregnant women with hypoparathyroidism[20]. Therefore, maternal parathormone levels are important in pregnancy. In various studies, it has been shown that PTH decreases or remains the same in the first trimester of pregnancy, increases in the second trimester, and returns to normal levels in the third trimester[21,22]. It has been determined that phosphate levels increase very little during pregnancy and it is important in fetal bone development, but high phosphate levels cause fetal complications by vascular calcification or muscle calcification[23].

Magnesium is a cation that is required in numerous biological and cellular functions, such as protein synthesis, nucleotide metabolism, ATP production, neuromuscular transmission, increased vitamin D synthesis, and bone mineralization[9,24,25]. Magnesium deficiency in pregnant women can lead to preterm labor and metabolic syndrome, growth retardation in the fetus, and insulin resistance in the future stages of life[10,26]. In the present study, a significant reduction was observed in the magnesium levels in all the trimesters in the pregnant women compared with the control group (p<0.001). Intergroup examination revealed that the magnesium levels decreased with increase in the gestational weeks, albeit not statistically significant.

CONCLUSION

Based on the results of this study, the vitamin D, calcium, and magnesium levels were significantly lower in the pregnant groups compared with the control group. Although not statistically significant, it was determined that the magnesium levels decreased with increasing number of gestational weeks. In terms of maintaining a healthy pregnancy, we think that controlling the levels of the vitamin D, calcium, and magnesium during pregnancy and completing the deficiency may be beneficial for both maternal and fetal health.

AUTHORS' CONTRIBUTIONS

KH: Data curation, Funding acquisition, Investigation, Resources, Software, Validation, Writing – original draft. **IGC:** Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Writing – review & editing, Visualization.

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