ARAŞTIRMA MAKALESİ / *RESEARCH ARTICLE*

Is There an Association between First Trimester 25-Hydroxy Vitamin D Levels and Gestational Diabetes Mellitus?

Birinci Trimester 25-Hidroksi D Vitamini Düzeyleri ile Gestasyonel Diabetes Mellitus Arasında İlişki Var mı?

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ABSTRACT

Aim: *Pregnant women have high Vitamin D deficiency rates. Some studies have suggested that vitamin D deficiency is associated with gestational diabetes mellitus (GDM). This study aimed to investigate the association between first trimester 25-hydroxy vitamin D levels and the risk of developing GDM.*

Material and Method: *A retrospective analysis was conducted on 409 pregnant women aged 18–50 years with singleton pregnancies who had their 25(OH) vitamin D levels checked in the first trimester and underwent an oral glucose tolerance test (OGTT) between 24–28 weeks of gestation. Demographic data, 25(OH) vitamin D levels, and OGTT results were recorded. Gestational diabetes mellitus was diagnosed according to the criteria of the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria. Vitamin D levels were categorized into deficiency (<20 ng/ml), insufficiency (20–30 ng/ml), and adequacy (>30 ng/ml).*

Results: *The median age of the participants was 33 years, and 24.6% (n=101) had GDM. The median 25(OH) vitamin D level was 18 ng/ml, and deficiency was found in 57.2% (n=234), insufficiency in 34.2% (n=140), and adequate level in 8.6% (n=35). The median age (32 vs 34 years; p=0.008), smoking rate (18.8% vs. 8.4%; p=0.007), and median 25(OH) vitamin D level (10(4–30) ng/ml vs 20 (3–151) ng/ml; p<0.001) were significantly lower in patients with GDM than in those without GDM. 25(OH) vitamin D <12 ng/ml (aOR: 0.086, 95% C. I.: 0.51–0.144, p<0.001) and 25(OH) vitamin D <20 ng/ml (aOR: 0.073, 95% C. I.: 0.034–0.155, p<0.001) were strongly associated with GDM in logistic regression analysis.*

Conclusion: *The risk of GDM can be minimized by regular vitamin D supplementation at prophylactic doses before pregnancy.*

Key words: *vitamin D deficiency; gestasyonel diabetes mellitus; oral glucose tolerance test*

ÖZET

Amaç: *Gebe kadınlarda yüksek oranda D Vitamini eksikliği görülmektedir. Bazı çalışmalar D vitamini eksikliğinin gestasyonel diabetes mellitus (GDM) ile ilişkili olduğunu öne sürmektedir. Bu çalışmanın amacı, ilk trimester 25-hidroksi D vitamini düzeyleri ile GDM gelişme riski arasındaki ilişkiyi araştırmaktır.*

Materyal – Metod: *İlk trimesterde 25(OH) D vitamini düzeylerini kontrol ettiren ve 24–28. gebelik haftaları arasında oral glukoz tolerans testi (OGTT) yapılan 18–50 yaş arası tekil gebeliği olan 409 gebe kadın üzerinde retrospektif bir analiz yapılmıştır. Demografik veriler, 25(OH) D vitamini düzeyleri ve OGTT sonuçları da kaydedilmiştir. Gestasyonel diyabetes mellitus tanısı Uluslararası Diyabet ve Gebelik Çalışma Grupları Birliği (IADPSG) kriterlerine göre konulmuştur. D vitamini düzeyleri eksiklik (<20 ng/ml), yetersizlik (20–30 ng/ml) ve yeterlilik (>30 ng/ml) olarak kategorize edilmiştir.*

Bulgular: *Katılımcıların ortanca yaşı 33'tür ve %24,6'sında (n=101) GDM vardır. Toplam kohortun 25(OH) D vitamini düzeyi ortancası 18 ng/ml olup, %57,2'sinde (n=234) eksiklik, %34,2'sinde (n=140) yetersizlik ve %8,6'sında (n=35) yeterli düzey saptanmıştır. GDM'si olanlarda yaş ortancası (32 yaş ~ 34 yaş; p=0,008), sigara içme oranı (%18,8 ~ %8,4; p=0,007) ve 25(OH) D vitamini düzeyi ortancası (10(4–30) ng/ml ~ 20 (3–151) ng/ml; p<0,001) GDM'si olmayanlara göre anlamlı derecede düşüktü. 25(OH) D vitamini <12 ng/ml (aOR: 0,086, %95 C. I.: 0,51–0,144, p<0,001) ve 25(OH) D vitamini <20 ng/ml (aOR: 0,073, %95 C. I.: 0,034–0,155, p<0,001) lojistik regresyon analizinde GDM ile güçlü bir şekilde ilişkili bulunmuştur.*

Sonuç: *Folik asit takviyesine benzer şekilde, GDM riski de gebelikten önce başlanan profilaktik dozda düzenli D vitamini takviyesi ile en aza indirilebilir.*

Anahtar kelimeler: *D vitamini eksikliği, gestasyonel diabetes mellitus, oral glukoz tolerans testi*

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Introduction

Cholecalciferol (vitamin D3) synthesized from cholesterol in the skin under the influence of sunlight, and ergocalciferol (vitamin D2) absorbed from the intestines through dietary products are transported to the liver by vitamin D-binding protein (DBP) and converted first into 25 hydroxy vitamin D and then into its active form, 1.25-dihydroxy vitamin D, in the kidneys[1]. Vitamin D is involved in hormone secretion, regulation of immune function and regulation of cell proliferation and differentiation. Deficiency is also associated with obesity, diabetes, hypertension, cancer, infections, and cardiovascular diseases[2].

The global consensus recommendation panel on the prevention and management of rickets defines vitamin D levels as follows: deficiency is indicated by levels below 30 nmol/L (<12 ng/mL), insufficiency by levels between 30–50 nmol/L (12–20 ng/mL), and adequacy by levels above 50 nmol/L (>20 ng/mL). These thresholds have been widely accepted as a reference for evaluating vitamin D status[3]. During pregnancy, the daily requirement for vitamin D increases owing to the mother's and developing fetus' s additional needs. However, despite its critical role in maternal and fetal health, particularly in bone and skeletal development, studies report that vitamin D deficiency is highly prevalent among pregnant women, ranging from 18% to 84% in different populations[4].

According to the American Diabetes Association (ADA), Gestational Diabetes Mellitus (GDM) is defined as carbohydrate intolerance of varying degrees, characterized by dysfunction of β-cells and insulin resistance that begins or is first recognized during pregnancy[5]. Women with GDM are at an increased risk for cesarean delivery, type 2 DM, hypoglycemia, congenital anomalies, fetal macrosomia, shoulder dystocia, and antenatal death. Furthermore, GDM can lead to long-term metabolic complications in offspring, such as childhood obesity and impaired glucose tolerance. Early diagnosis and appropriate management are crucial for minimizing these maternal and fetal risks and improving pregnancy outcomes[6].

The development of GDM is associated with well-defined risk factors such as advanced maternal age, family history of diabetes, ethnicity, and obesity. Recent studies have suggested that vitamin D deficiency may constitute a risk factor for GDM by increasing insulin resistance and causing hyperinsulinemia[7]. In this study, we aimed to evaluate the relationship between 25(OH) vitamin D levels measured in the first trimester and the development of GDM and to contribute to the literature on the potential role of vitamin D in the pathophysiology of GDM.

Materials and Methods

Patients and Data Collection

Between January 2019 and December 2023, 409 pregnant women aged 18–50 with singleton pregnancies who were admitted to the Department of Obstetrics and Gynecology at Kafkas University had their 25(OH) vitamin D levels measured during the first trimester and underwent an oral glucose tolerance test (OGTT) between 24 and 28 weeks of gestation were included in this study.

Pregnant women with a history of multiple pregnancies, additional systemic diseases before pregnancy, those who did not undergo OGTT for various reasons, and those who did not have 25(OH) vitamin D levels in the first trimester were excluded from the study.

Demographic data, including age, gravidity, parity, number of abortions, smoking history, year of delivery, week of delivery, birth weight, and neonatal intensive care unit (NICU) hospitalization indication, were obtained retrospectively from medical records. 25(OH) Vitamin D levels and OGTT results were also recorded.

Terms and Definitions

In the 75 g oral glucose loading test, GDM is diagnosed if fasting blood glucose is ≥92 mg/dl, 1st hour is ≥180 mg/dl, 2nd hour is ≥153 mg/dl, and at least two values are higher[8]. For 25(OH) vitamin D levels, <20 ng/ml (50 nmol/L) was accepted as deficiency, 20–30 ng/ml (50–75 nmol/L) as insufficient, and >30 ng/ml (75 nmol/L) as adequacy[9].

Ethics Committee Approval

This study was approved by the Non-Interventional Clinical Research Ethics Committee of the Kafkas University Faculty of Medicine (30/04/2024, 80576354–050–9). This study complied with the recommendations of the Declaration of Helsinki for human biomedical research.

Statistical Analysis

The Windows SPSS program (version 24.0) was used for statistical analyses. The Kolmogorov-Smirnov test

evaluated whether the continuous variables were normally distributed. The data showing abnormal distribution as a result of the test are expressed as median (minimum-maximum), and the data showing normal distribution are expressed as mean ± standard deviation. Categorical variables are presented as numbers (n) and percentages (%). The chi-square test was used to compare pregnant women with and without GDM. Since it is a 2×2 table, the Pearson chi-square test was used if the theoretical minimum frequency was >25, the Yates chi-square test between 5 and 25, Fisher's exact test was used if it was <5, and the p result was written. The Kruskal-Wallis test was used to make comparisons according to 25(OH) vitamin D levels. Statistical significance was set at p<0.05. Prism software (version 8, GraphPad Software, San Diego, California, USA) was used for data analysis and graphs.

Results

Demographic, 25(OH) Vitamin D level and newborn data

The median age of the 409 pregnant women was 33 (19–50). Median gravida was 2 (1–8), median parity was 1 (0–5), and median abortion was 0 (0–4). Among the women, 11 % (n=45) smoked during pregnancy. A double screening test was performed in 46% (n=188) of the patients, triple screening tests in 5.6% (n=23), and detailed ultrasonography (USG) in 8.3% (n=34). The median 25(OH) vitamin D level was 18 (3–151) ng/ml. The 25(OH) vitamin D level was <20 ng/ml in 57.2% (n=234) of pregnant women, 20–30 ng/ml in 34.2% (n=140), and >30 ng/ml in 8.6% (n=35). GDM was present in 24.6 % (n=101) of women.

Of the babies born to these pregnant women, 48.2 % (n=197) were female and 51.8% (n=212) were male. In total, 9.5% (n=39) of the babies were born at <37 weeks and 90.5% (n=370) at 37–42 weeks. Birth weight was 1500–2500 grams in 5.4% (n=22), 2500–4000 grams in 92.4% (n=378) and >4000 grams in 2.2% (n=9). The median 1st minute APGAR score was 8 (2–9), and the median 5th minute APGAR score was 9 (7–10). Among the infants, 8.8 % (n=36) were admitted to the neonatal intensive care unit (NICU) with a diagnosis of transient tachypnea of the newborn (TTN), 2.2% (n=9) sepsis, and 0.7% (n=3) respiratory distress syndrome (RDS). Detailed data are presented in Table 1.

Table 1. *Demographic, 25(OH) Vitamin D level and newborn data*

	Total Cohort (n=409)
Age (years) (Median (Min-Max))	33 (19–50)
Smoking history (n, %)	45 (11%)
Number of Gravida (Median (Min-Max))	2 (1–8)
Number of Parities (Median (Min-Max))	1 (0–5)
Number of Abortions (Median (Min-Max))	0 (0–4)
Screening Tests	
Double screening test (n, %)	188 (46%)
Triple screening test (n, %)	23 (5%.6)
Detailed ultrasonography (USG) (n, %)	34 (8%.3)
Gestational diabetes mellitus (GDM) (n, %)	101 (24%.6)
25(OH) Vitamin D level (Median (Min-Max))	18 (3–151)
<20 ng/ml (n, %)	234 (57%.2)
20–30 ng/ml (n, %)	140 (34%.2)
>30 ng/ml (n, %)	35 (8%.6)
Baby Sex (n, %)	
Female	197 (48%.2)
Male	212 (51%.8)
Birth Week (n, %)	
<37 weeks	39 (9%.5)
37–42 weeks	370 (90%.5)
>42 weeks	0 (0%)
Infant Birth Weight (n, %)	
1500–2500 gram	22 (5%.4)
2500–4000 gram	378 (92%.4)
>4000 gram	9 (2%.2)
1st minute APGAR score (Median (Min-Max))	8 (2–9)
5th minute APGAR score (Median (Min-Max))	9 (7–10)
Neonatal Intensive Care Unit (NICU)	
Transient Tachypnea of the Newborn (TTN) (n, %)	36 (8%.8)
Sepsis (n, %)	9 (2%.2)
Respiratory Distress Syndrome (RDS) (n, %)	3 (0%.7)

Comparison of pregnant women with and without GDM

The median age of patients with GDM was 32 years (19–44), and the median age of patients without GDM was 34 years (22–50) (p=0.008). The smoking rate during pregnancy was significantly higher in those with GDM than in those without GDM (n=19, 28.8% vs. n=26, 8.4%; p=0.007). The number of gravida and abortions were similar in both groups, but parity was significantly higher in those without GDM than in those with GDM (n=1 (0–5) vs. n=1 (0–3); p=0.05). The rates of the double screening test (n=58, 57.4% vs. n=130, 42.2%; p=0.008) and detailed USG (n=16, 15.8% vs. n=18, 5.8%; p=0.003) were significantly higher in those with GDM than in those without GDM.

The median 25(OH) vitamin D level was 10 (4–30) ng/ml in patients with GDM and 20 (3–151) ng/ml in those without GDM (p<0.001). Vitamin 25(OH) D <12 ng/ml (n=71, 70.3% vs. n=52, 16.9%; p<0.001)

and vitamin 25(OH) D <20 ng/ml (n=93, 92.1% vs. n=141, 45.8%; p<0.001) were significantly higher in patients with GDM compared to those without GDM. 25(OH) vitamin D levels of 20–30 ng/ml (n=132, 42.9% vs. n=8, 7.9%; p<0.001) and 25(OH) vitamin D levels of >30 ng/ml (n=35, 11.4% vs. n=0, 0%; p<0.001) were significantly in those without GDM higher than in those with GDM. 25(OH) vitamin D <12 ng/ml (aOR: 0.086, 95% C. I.: 0.51–0.144, p<0.001) and 25(OH) vitamin D <20 ng/ml (aOR: 0.073, 95% C. I.: 0.034–0.155, p<0.001) were strongly associated with GDM in logistic regression analysis. The distribution of 25(OH) vitamin D levels in the patients with and without GDM is shown in Figure 1.

NICU admissions with a diagnosis of TTN were significantly higher in patients with GDM than in those without GDM (n=15, 14.9% vs. n=21, 6.8%; p=0.023). Table 2 provides detailed data.

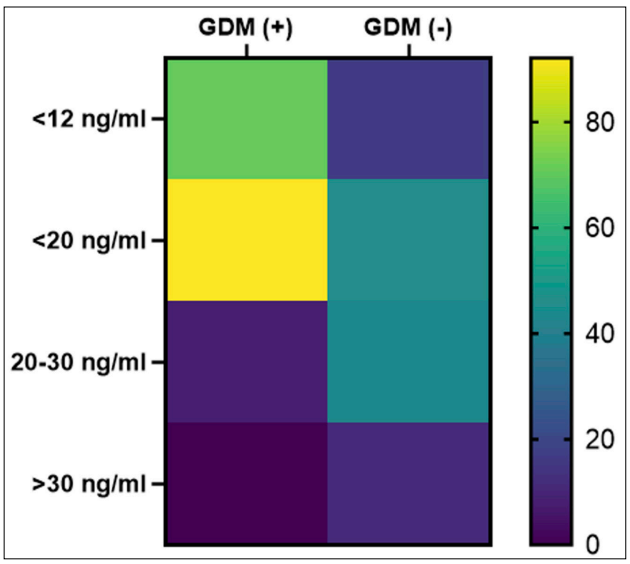

Figure 1. *25(OH) vitamin D levels in patients with and without GDM.*

Table 2. *Comparison of pregnant women with and without GDM*

	Those with GDM (n=101)	Those without GDM (n=308)	p
Age (years) (Median (Min-Max))	32 (19–44)	34 (22–50)	0.008
Smoking history (n, %)	19 (18%.8)	26 (8%.4)	0.007
Number of Gravida (Median (Min-Max))	2 (1–6)	2 (1–8)	0.266
Number of Parities (Median (Min-Max))	1 (0–3)	1 (0–5)	0.050
Number of Abortions (Median (Min-Max))	0 (0–3)	0 (0–4)	0.116
Screening Tests			
Double screening test (n, %)	58 (57%.4)	130 (42%.2)	0.008
Triple screening test (n, %)	8 (7%.9)	15 (4%.9)	0.365
Detailed ultrasonography (USG) (n, %)	16 (15%.8)	18 (5%.8)	0.003
25(OH) Vitamin D level (Median (Min-Max))	10 (4–30)	20 (3–151)	<0.001
<12 ng/ml (n, %)	71 (70%.3)	52 (16%.9)	<0.001
<20 ng/ml (n, %)	93 (92%.1)	141 (45%.8)	<0.001
20–30 ng/ml (n, %)	8 (7%.9)	132 (42%.9)	<0.001
>30 ng/ml (n, %)	0 (0%)	35 (11%.4)	<0.001
Baby Sex (n, %)			
Female	52 (51%.5)	145 (47%.1)	0.442
Male	49 (48%.5)	163 (52%.9)	0.442
Birth Week (n, %)			
<37 weeks	8 (7%.9)	31 (10%.1)	0.659
37–42 weeks	93 (92%.1)	277 (89%.9)	0.659
>42 weeks	0 (0%)	0 (0%)	0.659
Infant Birth Weight (n, %)			
1500–2500 gram	6 (5%.9)	16 (5%.2)	0.360
2500–4000 gram	91 (90%.1)	287 (93%.2)	0.360
>4000 gram	4 (4%)	5 (1%.6)	0.360
1st minute APGAR score (Median (Min-Max))	8 (5–9)	7 (2–9)	0.006
5th minute APGAR score (Median (Min-Max))	9 (7–10)	9 (7–10)	0.776
Neonatal Intensive Care Unit (NICU)			
Transient Tachypnea of the Newborn (TTN) (n, %)	15 (14%.9)	21 (6%.8)	0.023
Sepsis (n, %)	3 (3%)	6 (1%.9)	0.695
Respiratory Distress Syndrome (RDS) (n, %)	1 (1%)	2 (0%.6)	0.728

Table 3. *Comparison of groups according to 25(OH) vitamin D level*

	25(OH) D <20 ng/ml (n=234)	25(OH) D 20–30 ng/ml (n=140)	25(OH) D >30 ng/ml (n=35)	p value
Age (years) (Mean ± SD)	33.36±5.26	33.56±5.48	35.49±5.51	0.096
Smoking history (n, %)	27 (11%.5)	16 (11%.4)	2 (5%.7)	0.579
Number of Gravida (Median (Min-Max))	2 (1–8)	2 (1–7)	3 (1–5)	0.085
Number of Parities (Median (Min-Max))	1 (0–4)	1 (0–5)	1 (0–4)	0.300
Number of Abortions (Median (Min-Max))	0 (0–4)	0 (0–4)	0 (0–3)	0.470
Screening Tests				
Double screening test (n, %)	117 (50%)	49 (35%)	22 (62%.9)	0.002
Triple screening test (n, %)	15 (6%.4)	5 (3%.6)	3 (8%.6)	0.376
Detailed ultrasonography (USG) (n, %)	20 (8%.5)	11 (7%.9)	3 (8%.6)	0.971
Gestational diabetes mellitus (GDM)	93 (39%.7)	8 (5%.7)	0 (0%)	<0.001
Baby Sex (n, %)				
Female	114 (48%.7)	63 (45%)	20 (57%.1)	0.423
Male	120 (51%.3)	77 (55%)	15 (42%.9)	0.423
Birth Week (n, %)				
<37 weeks	20 (8%.5)	17 (12%.1)	2 (5%.7)	0.375
37–42 weeks	214 (91%.5)	123 (87%.9)	33 (94%.3)	0.375
Infant Birth Weight (n, %)				
1500–2500 gram	16 (6%.8)	4 (2%.9)	2 (5%.7)	0.441
2500–4000 gram	213 (91%)	132 (94%.3)	33 (94%.3)	0.441
>4000 gram	5 (2%.1)	4 (2%.9)	0 (0%)	0.441
1st minute APGAR score (Median (Min-Max))	8 (2–9)	7 (5–9)	8 (3–9)	0.828
5th minute APGAR score (Median (Min-Max))	9 (7–10)	9 (8–10)	9 (8–10)	0.550
Neonatal Intensive Care Unit (NICU)				
Transient Tachypnea of the Newborn (TTN) (n, %)	24 (10%.3)	7 (5%)	5 (14%.3)	0.108
Sepsis (n, %)	5 (2%.1)	3 (2%.1)	1 (2%.9)	0.962
Respiratory Distress Syndrome (RDS) (n, %)	2 (0%.9)	1 (0%.7)	0 (0%)	0.858

Comparison of groups according to 25(OH) vitamin D level

Age, number of gravida, parity, number of abortions, smoking rate, rate of screening tests, infant sex, infant birth week, infant birth weight, 1st and 5th minute APGAR scores, NICU hospitalization rates with TTN, sepsis, and RDS were similar in all three groups. However, the number of GDM patients was significantly higher in those with 25(OH) vitamin D <20 ng/ml than in those with 25(OH) vitamin D 20–30 ng/ml and 25(OH) vitamin D >30 ng/ml (n=93, 39.7% vs. n=8, 5.7% vs. n=0, 0%; p=0.002). Detailed data are presented in Table 3.

Discussion

Our study analyzed demographic data, 25(OH) vitamin D levels, and neonatal data of women with and without GDM. 25(OH) vitamin D levels were significantly lower in pregnant women with GDM than in those without GDM (10[4–30] ng/mL vs 20 [3–151] ng/mL; p<0.001). It was found that 92.1% of pregnant women with GDM and 45.8% of those without GDM had 25(OH) vitamin D levels <20 ng/mL (p<0.001). In addition, the GDM rate was 70.3% in pregnant women with 25(OH) vitamin D levels <12 ng/mL. Multivariate logistic regression analysis revealed that 25(OH) vitamin D levels <12 ng/mL (aOR: 0.086, 95% CI: 0.051–0.144) and <20 ng/mL (aOR: 0.073, 95% CI: 0.034–0.155, p<0.001) were strongly associated with GDM.

Human and animal studies have shown that vitamin D deficiency can lead to marked changes in insulin concentration and sensitivity[10]. Vitamin D plays a critical role in glucose metabolism and may have direct effects on insulin resistance and beta cell dysfunction via its receptor and indirect effects through calcium homeostasis regulation[11]. Alterations in calcium levels have been reported to influence insulin secretion and may impair pancreatic beta cell function[12]. These mechanisms collectively suggest that vitamin D deficiency may adversely affect glucose metabolism and the insulin response. These findings underline the importance

of vitamin D in metabolic processes and its potential role in metabolic disorders, such as diabetes[13].

Studies in healthy individuals have shown an inverse relationship between serum 25(OH) vitamin D levels, glucose concentration and insulin resistance[14–17]. However, studies evaluating the relationship between vitamin D levels in pregnancy, glucose metabolism, and GDM present conflicting findings. In studies conducted in Türkiye, low 25(OH) vitamin D levels during pregnancy were significantly associated with GDM risk[18]. In the study by Zhang et al., 25(OH) vitamin D levels measured at 16 weeks of gestation were compared between 24–28 weeks of gestation in pregnant women with GDM and healthy women; vitamin D levels were significantly lower in pregnant women with GDM. These findings suggest that maternal vitamin D deficiency detected in early pregnancy may be associated with the development of GDM[19].

Maghbooli et al. found that pregnant women with severe vitamin D deficiency (<12.5 nmol/L=5 ng/mL) were significantly more likely to be diagnosed with GDM[20]. Similarly, in a prospective cohort study of 655 pregnant women, low 25(OH) vitamin D levels in the first trimester were strongly correlated with the incidence of GDM between 24–28 weeks of gestation[21]. In a case-control study by Soheilykhah et al., 25(OH) vitamin D deficiency was significantly higher in patients with GDM (83.3% vs. 71.2%; p=0.007), which increased the risk of GDM 2.02 times (95% CI: 0.88–4.6)[22]. In a meta-analysis of 12 studies evaluating the association between GDM and vitamin D deficiency, it was reported that the risk of GDM was 1.38 times (95% CI: 1.12–1.70) higher when maternal 25(OH) vitamin D levels were <50 nmol/L and 1.55 times (95% CI: 1.21–1.98) higher when levels were <75 nmol/L[23].

However, some studies do not support this relationship. In a case-control study by Baker et al., first trimester 25(OH) vitamin D deficiency (<50 nmol/L=20 ng/mL) was found to be similarly low among pregnant women with and without GDM (8.3% vs. 6%; p=0.95)[24]. Similarly, in a study by Park et al. on Korean pregnant women, no significant association was found between vitamin D levels in the first trimester and GDM risk[25]. These conflicting findings suggest that further comprehensive and standardized studies are needed better to understand the association between vitamin D deficiency and GDM[26].

Studies have also been conducted to determine whether vitamin D supplementation during the antenatal period prevents GDM development. Similar rates of GDM development were found in the two groups (n=257) that received 2000 IU and 4000 IU vitamin D supplements at 12–16 weeks of gestation[22,27]. In a randomized controlled trial in which low-dose (400 IU/day) and high-dose (5000 IU/day) vitamin D supplements were administered to two groups with low 25(OH) vitamin D levels before the 20th week of gestation and the effects on glucose metabolism were evaluated, the OGTT results at 26–28 weeks of gestation were found to be similar in both groups[28]. It has been reported that high-dose vitamin D treatment has no protective effect against GDM but significantly increases neonatal vitamin D levels[28].

This study had some limitations. Its retrospective design, the fact that it was conducted in only one center, and the fact that extrinsic factors (e.g., sun exposure and diet) could not be assessed may have limited the extent of the results. However, the strengths of the study are also noteworthy. In particular, the fact that it was based on a large sample group increases the generalizability of the findings. In addition, the categorical classification of vitamin D levels and detailed statistical analyses significantly strengthened the reliability and scientific value of the results.

Conclusion

This study revealed that low vitamin D levels during pregnancy are strongly associated with the development of GDM. In particular, severe deficiency levels of <12 ng/mL significantly increased the risk of GDM. These findings emphasize the impact of vitamin D deficiency on metabolic processes and its potential importance in pregnancy. In the future, larger prospective and multicenter studies will contribute to a better understanding of the relationship between vitamin D deficiency and GDM. Furthermore, examining the effect of different doses and durations of vitamin D supplementation on GDM may provide more specific guidance for clinical practice. Like folic acid supplementation, we believe the likelihood of GDM can be minimized with regular prophylactic vitamin D supplementation starting from the pre-pregnancy period, especially in areas with low sunlight, such as Eastern Anatolia.

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