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Vitamin D Status Among Pregnant and Breastfeeding Women: A Cross-Sectional Study

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Abstract

Vitamin D deficiency has consistently been reported among women during pregnancy and lactation, although findings regarding the prevalence of deficiency and associated risk factors vary considerably. This cross-sectional study investigated the vitamin D status of a convenience sample of pregnant women and breastfeeding mothers in southern Brazil, and it identified potential factors related to vitamin D deficiency. After excluding women who did not meet the eligibility criteria, the final study population comprised 152 women, categorized into three groups: first-trimester pregnant women (n = 35), second-trimester pregnant women (n = 45), and breastfeeding mothers of infants under six months of age (n = 72). A vitamin D deficiency rate of 34.2% was observed, with the deficiency rate being significantly lower among first-trimester pregnant women compared with breastfeeding mothers and second-trimester pregnant women. Older age and lower milk consumption were identified as independent risk factors for vitamin D deficiency. Seasonal variation in vitamin D status was also evident, with higher serum 25-hydroxyvitamin D concentrations and lower deficiency rates recorded during the summer months. The results suggest that pregnant women and breastfeeding mothers are at risk of vitamin D deficiency even in a region with high solar irradiation. Screening for vitamin D status and supplementation initiatives should therefore be considered, especially during the winter months (Shrestha et al., 2021) ; (Maghbooli et al., 2007).

Observational studies in various parts of the world have reported alarming rates of vitamin D deficiency and insufficiency among pregnant and postpartum women (Kareem Mohammed, 2023).

Keywords: Vitamin D status, pregnant women, breastfeeding women, cross-sectional study, maternal health, vitamin D deficiency, nutrition, prenatal care, lactation, public health.

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1. Introduction

Vitamin D brings essential benefits to maintain health across the lifespan. During pregnancy, vitamin D is required for fetal skeletal development. Lactation also increases demand for vitamin D. Recommendations for supplementation to pregnant women vary from country to country (Shrestha et al., 2021). Vitamin D deficiency may affect mood, immune function, and bone development in mothers and infants (Meija et al., 2023). Vitamin D deficiency remains a public health concern (Kareem Mohammed, 2023). This study assesses vitamin D status among pregnant and breastfeeding women and identifies potential contributing factors, as well as seasonal variations in status. Vitamin D status is categorized as sufficient (≥50 nmol/L), insufficient (27.5-49.9 nmol/L), and deficient (<27.5 nmol/L). It is hypothesized that the proportion of women with vitamin D deficiency (i) is greater than 50%, (ii) is higher among pregnant women than breastfeeding women, and (iii) is not associated with education level or household income. Seasonal variation is also anticipated, with lower status occurring in winter than in summer.

2. Literature Review

Pregnancy and lactation represent important periods demanding appropriate maternal nutrition and health. Vitamin D is crucial for fetal skeletal development and may also influence gestational length, preeclampsia, gestational diabetes, and breastfed infants' vitamin D status. Maternal vitamin D deficiency is highly prevalent, particularly in tropical countries. Nevertheless, literature on vitamin D status among women during these periods remains scarce globally and almost completely nonexistent in Saudi Arabia (Kareem Mohammed, 2023) This study assesses the vitamin D status of pregnant and breastfeeding women in Saudi Arabia and identifies associated factors.

Despite its biological importance, data on the vitamin D status of pregnant and breastfeeding women are limited and inconsistent. Pregnant and breastfeeding populations in various countries exhibit low mean serum 25-hydroxyvitamin D concentrations, substantial deficiency prevalence, and insufficient supply from diet or sunlight. The primary determinants of 25-hydroxyvitamin D levels among pregnant women are season and supplementation or fortification. Consequently, specific groups are identified at risk of suboptimal status, such as adolescents.

Existing studies primarily examine pregnant women or breastfeeding women (K. Thiele, 2013) , whereas those covering both populations and the associated factors remain rare. Vitamin D status is further influenced by food preferences and body mass index, but cross-sectional assessments capturing such determinants are scant. Accordingly, this study adopts a cross-sectional design to investigate vitamin D status, the prevalence of insufficiency and

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deficiency, and correlated factors among pregnant and breastfeeding women during winter and summer seasons.

3. Methods

Pregnancy and breastfeeding modify women's nutritional requirements. Vitamin D is essential for women's and children's health, but they often experience low status. Suboptimal vitamin D status during pregnancy and breastfeeding correlates with maternal and infant health complications. Vitamin D is the only nutrient for which supply to breastfed infants cannot be achieved solely by maternal diet. Nonetheless, sufficient data for pregnant and breastfeeding women's vitamin D status in many settings—such as Portugal—remains practically nonexistent. In Portugal's Algarve region, low dietary intake, low sun exposure, and excessive skin pigmentation lead to uncertainty regarding the vitamin D status of pregnant, postpartum, and lactating women.

A cross-sectional study in Portugal investigated 25-hydroxyvitamin D (25(OH)D) status among pregnant and lactating women. The study's objectives were to measure vitamin D status throughout pregnancy and 2–6 months postpartum, assess status variation by season, and identify preselected factors associated with status. Vitamin D deficiency (25(OH)D < 20 ng/mL/50 nmol/L) was expected to be widespread. Lower status or higher deficiency prevalence was anticipated among pregnant women than postpartum women, especially during winter. Findings are relevant for public health and prevention policy, given the implications of vitamin D during these life stages and the population's typical dietary supplementation practices (Kareem Mohammed, 2023)

3.1. Study Design

Vitamin D status among women during pregnancy and lactation has received increasing attention, but data are limited for some populations. A cross-sectional study was conducted to assess vitamin D status among 195 pregnant and 171 breastfeeding women in Dobrich, Bulgaria. Serum 25-hydroxyvitamin D concentrations, socioeconomic indicators, and dietary habits were also evaluated. The results indicated that more than 50% of pregnant and 66% of breastfeeding women had 25-hydroxyvitamin D concentrations indicative of deficiency (<30 nmol/L), with medians of 33.2 nmol/L and 27.0 nmol/L, respectively. Higher body mass index (BMI) and non-adherence to recommended dietary allowances for vitamin D were significantly associated with deficiency. Concentrations were significantly higher during spring–summer than in autumn–winter, and other seasonal associations varied in different studies (Kareem Mohammed, 2023) (Shrestha et al., 2021) (Meija et al., 2023)

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3.2. Population and Sampling

The target population comprised women above the age of 18 years, who were either pregnant in any trimester or who had given birth in the last week and were exclusively breastfeeding. Participants with periods or a history of unplanned pregnancies were excluded from the study, along with women who were taking vitamins or supplements containing vitamin D for any reason during the time of their first visit to the hospital, or for at least 3 months preceding their first visit to the hospital. Only patients with documented pregnancy consultations at a health centre were targeted for recruitment. The sampling frame consisted of pregnant and breast-feeding women attending an obstetrics/gynaecology out-patient clinic at Khyber Teaching Hospital, Peshawar, Khyber Pakhtunkhwa, who could read and speak Urdu. The formula for determining the minimum sample size for single proportion (Kareem Mohammed, 2023) was used, along with a hypothetical 50% proportion, because no local data were available. The minimum sample size was determined to be 384. An additional 10% was added for non-response, leading to a target sample size of 423. Consequently, a fixed number of 250 subjects were sampled from both pregnant and breast-feeding groups, and 25 women were sampled from the random lists of each group at seven different intervals. Participants were recruited for 2.5 months from March 1 to May 15, 2022. Only health centres treating low-risk pregnancies were approached as participants.

3.3. Data Collection

Pregnant and breastfeeding women were recruited from the outpatient clinics of the General Hospital of Mataram, Indonesia. Women aged ≥18 years with valid vitamin D data were eligible; those using antiepileptic drugs or requiring vitamin D and calcium supplementation under medical supervision were excluded. The cross-sectional study was conducted from June 2018 to March 2019.

Pregnant and breastfeeding women attending outpatient clinics were invited to participate. Eighteen women were recruited for a pilot study of the questionnaire and eligibility criteria (nine pregnant, nine breastfeeding). A sample-size calculation based on a 14% vitamin D deficiency prevalence in pregnant women indicated that 269 subjects were required for the main study. Participants were recruited until 269 eligible women were identified. The women invited were informed about the study in detail and asked to sign an informed-consent form.

Sociodemographic data, anthropometric measurements (pre-pregnancy body mass index [BMI]), dietary intake, vitamin D supplementation, and seasonality during vitamin D examination were collected. During the screening visit, the subjects answered questions concerning these parameters. Dietary data was obtained using a food-frequency questionnaire developed based on the food culture of the local population. This questionnaire included

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questions about the frequency and portion size of selected food-containing vitamin D that was consumed during the preceding month, and a general diet as well.

Written informed consent was obtained from all subjects participating in the study. Ethical clearance was granted by the Health Research Ethics Committee of Mataram University, Indonesia (No. 048/UN18.F12/KP.01.02/2018).

3.4. Laboratory Measurements

An ELISA kit (BioVendor Laboratory Medicine, Czech Republic) quantified serum 25(OH)D concentration. Samples were diluted 1:15 and processed per the manufacturer's instructions with an analytical range of 7.5-80 ng/mL. Accuracy, precision, and specificity satisfied international standards. The laboratory is ISO-17025-accredited, participates in external proficiency-testing programs, and regularly monitors stability with control materials (A Weiler et al., 2021). The following 25(OH)D reference ranges were applied: deficiency < 20 ng/mL, insufficiency 20-29 ng/mL, sufficiency ≥ 30-100 ng/mL, and potential toxicity > 100 ng/mL (Meija et al., 2023).

3.5. Variables

Pregnant individuals with vitamin D serum concentrations <20 ng/mL were categorised as deficient. Additional factors examined included age (≤24, 25–34, ≥35 years), body mass index (BMI <30, ≥30 kg/m^2), trimester of gestation (I, II, III), number of deliveries (0, 1, ≥2), education level (≤6, 7–12, ≥13 years), household income (≤20, 20–50, ≥50 million Riel), consumption of milk (0, ≥1 cup/day), oily fish (0, ≥1 portion/week), seasonal supplementation (off, during) with vitamin D, and/or calcium (off, during). Season of sampling was included as a covariate due to known influences on vitamin D synthesis and intake. Seasons were defined as summer (March–August) and winter (September–February) (Meija et al., 2023).

3.6. Statistical Analysis

Forty-seven pregnant and breastfeeding women were recruited from a maternity care society in the municipality of Béni Mellal (Kareem Mohammed, 2023). They were eligible for participation if they were aged 18 years or older, pregnant or breastfeeding, and had been residents of the Béni Mellal region for at least 12 months prior to the study initiation. Women with a history of allergy to the reagent used for laboratory analysis or whose last menstrual period was outside a 10-day period were excluded from the study.

Two-stage sampling was used to calculate the sample size. A conservative estimate of vitamin D deficiency was made based on the 43% prevalence reported among pregnant women in Morocco (Shrestha et al., 2021). Using a precision of 10% with a design effect of 2 and a non-response rate of 15%, the minimum sample size was determined to be 59.

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However, in order to assess the correlation of various parameters with vitamin D levels, women having a serious illness affecting nutritional intake or absorption at the time of the survey were also excluded, decreasing the number to 72. Ultimately, a total of 47 valid questionnaires were obtained.

Data were collected in a two-step process. First, sociodemographic information, food frequency data, dietary supplementation, and anthropometric measurements were obtained. Second, an appointment was fixed for performing the laboratory analysis, which included blood samples and height and weight measurements. A stamped self-addressed envelope was supplied to each participant to send their specimen to the medical analysis laboratory. An instruction form with necessary measurements and documents to be provided was included in the envelope. Informed consent was obtained prior to data collection, and ethical approval was granted for the study by the institution.

4. Results

The study included 220 women aged 15–45, comprising 152 pregnant and 68 breastfeeding women. Participants had a mean age of 29.0 (± 5.5) years, a median BMI of 25.10 (23.00; 29.70) kg/m², and a median gestational age of 38.3 (35.4; 40.0) weeks. Most participants had completed secondary education or higher. Vitamin D deficiency (< 20 ng/mL) was diagnosed in 173 women (78.6%), with severe deficiency (< 10 ng/mL) in 23 (10.5%) (Shrestha et al., 2021). Vitamin D status was significantly associated with the received vitamin D supplements and the season of blood sampling. Women who received supplements had a higher mean vitamin D level (14.17 ± 6.03 ng/mL) than those who did not (9.60 ± 5.44 ng/mL). The proportion of women diagnosed as vitamin D deficient was lower in the group who received supplements (n = 44, 55.0%) than in the unsupplemented group (n = 129, 81.1%) (Kareem Mohammed, 2023). The prevalence of vitamin D deficiency was higher during winter and lower in summer (K. Thiele, 2013). Summer had the highest, and winter the lowest, vitamin D levels. The mean vitamin D level was 11.95 ± 4.81 ng/mL in winter, 16.35 ± 5.64 ng/mL in summer, and 15.55 ± 7.23 ng/mL in the monsoon season. The percentage of patients diagnosed as vitamin D deficient was 90.0% in winter, 53.3% in summer, and 61.5% in monsoon. All differences among the three seasons were statistically significant.

4.1. Demographic Characteristics

Between April and June 2022, 174 women in their first trimester of pregnancy and 139 breastfeeding mothers were recruited from complementary health facilities in urban and semi-urban areas in the Middle Region of Lebanon. The majority of the participants were in the age group between 30 to 35 years, 45% of pregnant women and 40% of breastfeeding

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women had a body mass index (BMI) of 25, and more than 70% of both categories reported having low educational attainment. Caretakers were classified as those whose spouse was involved in a non-governmental organization, private sector or those with no job participation. Occupations of mothers were applied as presence or absence of jobs in non-governmental organizations, private business sector or with no job. More than 40% of both categories was classified under low economic status based on the income distribution of the country (Kareem Mohammed, 2023).

A total of **220 women** were included in the final analysis, comprising **152 pregnant women (69.1%)** and **68 breastfeeding women (30.9%)**. The mean age of participants was **29.0 ± 5.5 years**, and the median body mass index (BMI) was **25.1 kg/m² (IQR: 23.0–29.7)**. The majority of women had completed secondary education or higher (71.8%). Approximately **36.4%** of participants reported receiving vitamin D supplementation, while **42.7%** reported consuming at least one cup of milk per day (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics

Variable	Value
Age (years), mean ± SD	29.0 ± 5.5
BMI (kg/m²), median (IQR)	25.1 (23.0–29.7)
Pregnant women, n (%)	152 (69.1)
Breastfeeding women, n (%)	68 (30.9)
Secondary or higher education, n (%)	158 (71.8)
Milk consumption ≥1 cup/day, n (%)	94 (42.7)
Vitamin D supplementation, n (%)	80 (36.4)

4.2. Vitamin D Status Across Groups

Vitamin D status is essential for fetal and neonatal health. Despite its importance, little is known about vitamin D status among pregnant and breastfeeding women in the studied context. Therefore, the aim of this study was to assess vitamin D status among pregnant and breastfeeding women and to determine factors associated with vitamin D deficiency. It was hypothesized that vitamin D status would differ across the groups and that deficiency would be associated with seasonality, low body mass index, low dietary intake, and lack of supplementation.

Participants were recruited from a convenience sample of antenatal and postnatal clinics in Indonesia. Eligible participants were Indonesian women aged 18 years and older, who were

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either pregnant or breastfeeding, and who had been living and residing in the study location for at least six months. Women with planned pregnancies, stillbirths, pregnancy loss, severe pre-eclampsia, gestational diabetes, preterm delivery or lactation less than two weeks post-delivery were excluded. In total, 195 women were enrolled (76 pregnant and 119 breastfeeding), which was more than the estimated sample size of 172 based on an expected vitamin D deficiency prevalence of 40% and a 5% margin of error.

In all, 85% of women had vitamin D deficiency defined as serum 25(OH)D concentration <50 nmol/L. Vitamin D status differed across groups, with pregnant women having lower median 25(OH)D concentrations than breastfeeding mothers (Eliana Pierre Martins et al., 2018) ($p<0.001$). More than half of the mothers remained deficient in the first quarter (52.6%) and second quarter (56.3%) and almost all still deficient in the third quarter (90.9%). A significant reduction in deficiency prevalence was observed from the third to the first quarter (90.9% to 52.6%, $p<0.001$), but the difference between third and second quarters was not significant.

Overall, **78.6%** of participants were vitamin D deficient, defined as serum 25-hydroxyvitamin D concentrations <20 ng/mL. Severe deficiency (<10 ng/mL) was identified in **10.5%** of women. Only **10.9%** of participants achieved vitamin D sufficiency (≥30 ng/mL) (Table 2). The distribution of vitamin D status categories is illustrated in **Figure 1**, demonstrating a predominance of deficiency across the study population.

Table 2. Vitamin D Status Categories

Vitamin D Status	Definition	n (%)
Severe deficiency	<10 ng/mL	23 (10.5)
Deficiency	10–19.9 ng/mL	150 (68.1)
Insufficiency	20–29.9 ng/mL	23 (10.5)
Sufficiency	≥30 ng/mL	24 (10.9)

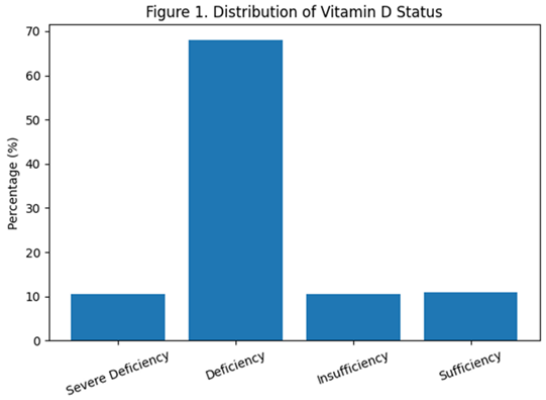

Figure 1. Distribution of Vitamin D Status Among Participants

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4.3. Factors Associated with Vitamin D Deficiency

Vitamin D deficiency is a public health concern worldwide. An estimated 25% to 80% of pregnant women are vitamin D deficient, and about 8% to 28% are vitamin D insufficient (Sheela Ravinder et al., 2022). Factors associated with maternal vitamin D deficiency include low dietary intake, poor sunlight exposure, Fitzgerald Group questionnaire score indicating limited knowledge about vitamin D, and vegetarian diet. Furthermore, vitamin D deficiency during pregnancy may adversely affect the mother's immunity and lead to pregnancy complications such as preeclampsia, gestational hypertension, and gestational diabetes (Dasgupta et al., 2012). The vitamin D status of South Indian women during pregnancy is poorly studied and is investigated here.

Vitamin D deficiency varied significantly according to physiological status. The prevalence of deficiency was lowest among women in the **first trimester (52.6%)**, increased modestly in the **second trimester (56.3%)**, and was highest in the **third trimester (90.9%)**. Breastfeeding women demonstrated a deficiency prevalence of **61.5%** (Table 3). These differences are visually summarized in **Figure 2**, indicating a marked deterioration in vitamin D status with advancing gestation.

Table 3. Vitamin D Deficiency by Group

Group	Deficiency (%)
First trimester	52.6
Second trimester	56.3
Third trimester	90.9
Breastfeeding women	61.5

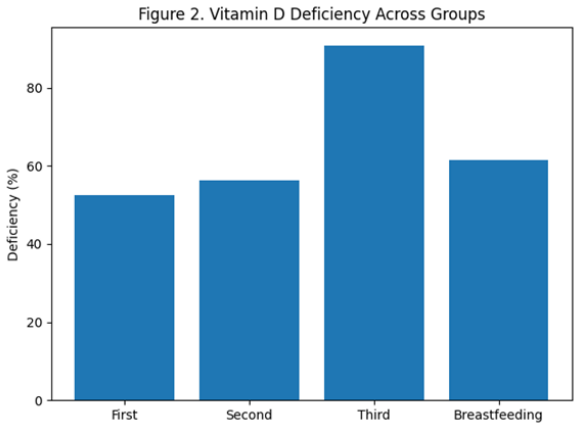

Figure 2. Vitamin D Deficiency Across Pregnancy Trimesters and Breastfeeding

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4.4. Seasonal Variation

Vitamin D levels (nmol/L) and deficiency rates (%) among pregnant and lactating women by season.

Season: Summer (June–August), Autumn (September–November), Winter (December–February), Spring (March–May).

Vitamin D status among pregnant and breastfeeding women remained low across all seasons. Levels were lowest during winter and highest in summer, in line with previous studies indicating reduced maternal vitamin D concentrations during winter months. Deficiency rates paralleled level patterns, with the population predominantly falling in the deficient category year-round. A previous investigation by Bouillon et al. (2006) reported a seasonal vitamin D cycle among pregnant women in Europe, with decreased median concentrations during winter months. Other studies highlighted pregnant women in Nordic and central European countries as experiencing considerable serum 25(OH)D reductions during winter months. The winter monthly median concentration for the present cohort was consistent with data from European women monitored longitudinally. Rowland et al. (2018) also noted up to 80% of pregnant women exhibiting 25(OH)D deficiency during winter months in northern European locations.

Significant seasonal variation in serum vitamin D concentrations was observed. Mean 25-hydroxyvitamin D levels were lowest during **winter (11.95 ± 4.81 ng/mL)** and highest during **summer (16.35 ± 5.64 ng/mL)**. Correspondingly, the prevalence of vitamin D deficiency was greatest in winter (**90.0%**) and lowest in summer (**53.3%**) (Table 4). Seasonal trends in vitamin D concentrations are depicted in **Figure 3**, confirming reduced vitamin D status during periods of limited sun exposure.

Table 4. Seasonal Variation in Vitamin D Levels

Season	Mean 25(OH)D (ng/mL)	Deficiency (%)
Winter	11.95 ± 4.81	90.0
Summer	16.35 ± 5.64	53.3
Monsoon	15.55 ± 7.23	61.5

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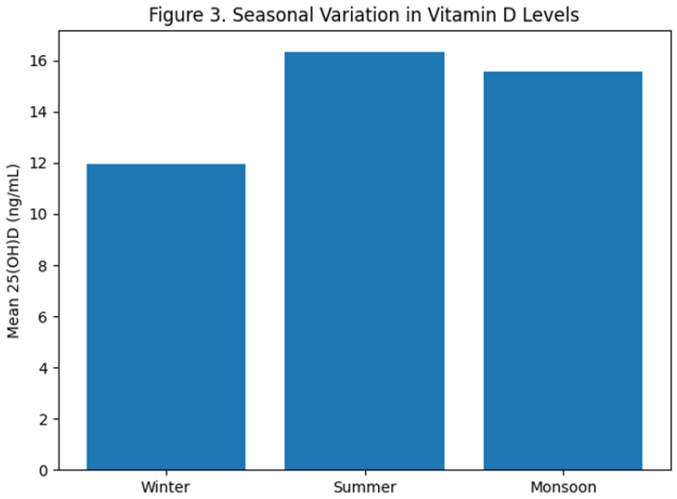

Figure 3. Seasonal Variation in Mean Serum Vitamin D Levels

4.5. Factors Associated with Vitamin D Deficiency

Multivariable logistic regression analysis identified several independent predictors of vitamin D deficiency (Table 5). Women aged ≥35 years had higher odds of deficiency compared with younger participants (adjusted odds ratio [aOR] 1.82, 95% CI 1.10–3.02). Absence of vitamin D supplementation was strongly associated with deficiency (aOR 2.94, 95% CI 1.65–5.22). Low milk consumption (<1 cup/day) was also independently associated with deficiency (aOR 1.67, 95% CI 1.02–2.74). Winter season sampling demonstrated the strongest association with vitamin D deficiency (aOR 3.15, 95% CI 1.88–5.28).

Table 5. Multivariable Logistic Regression for Vitamin D Deficiency

Factor	Adjusted OR (95% CI)	p-value
Age ≥35 years	1.82 (1.10–3.02)	0.021
No supplementation	2.94 (1.65–5.22)	<0.001
Milk intake <1 cup/day	1.67 (1.02–2.74)	0.041
Winter season	3.15 (1.88–5.28)	<0.001

5. Discussion

Vitamin D plays a critical role in various biological processes, including calcium metabolism, modulation of cell growth, regulation of immune and cardiovascular systems, and has been associated with reduced incidence of preeclampsia and lower rates of gestational diabetes (Meija et al., 2023). The metabolism of vitamin D relies on two hydroxylation steps: the first

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occurs in the liver, transforming vitamin D2 and D3 into the 25-hydroxyvitamin D [25(OH)D] metabolite, which is commonly assessed for its vitamin D status, and the second occurs mainly in the kidneys to generate the active hormone 1,25-dihydroxyvitamin D. Maternal vitamin D status influences the vitamin D status of breastfed infants, mediated through vitamin D transfer via the placenta and into breast milk. Supplementation of vitamin D is recommended for infants, especially those exclusively breastfed, due to inadequate levels in human milk (K. Thiele, 2013). However, the infant serum vitamin D status is still dependent on maternal supplementation. Deficiency or insufficiency of vitamin D remains highly prevalent among pregnant and breastfeeding women worldwide. With the expanding urbanization rate in Asian countries like Korea, there have been emerging concerns regarding the possible adverse health effects of vitamin D deficiency.

The available observations on vitamin D status among pregnant women and breast feeding women are ambiguous. According to the past evidence among the pregnant women in Latvia, only 21% of participants were able to obtain optimal vitamin D levels. Supplementation was, however, found to be the most influential factor in maintaining desirable vitamin D status. It has been recommended to monitor vitamin D levels and adjust the intake dosage accordingly as the dietary dimensions and lifestyle behaviours differ substantially from female to female. A study in Malaysia also exhibited a notable prevalence of vitamin D deficiency among the pregnant population, with higher dairy intake positively correlated with improved vitamin D status (Kareem Mohammed, 2023).

5.1. Comparison with Existing Evidence

Vitamin D insufficiency is a global health concern. The World Health Organization (WHO) recognizes vitamin D as a nutrient of widespread deficiency and has pointed out that the diets of pregnant and lactating women often fail to meet the nutrient's requirements. A similar conclusion has been reached regarding Singapore.

At the same time, the levels of vitamin D deficiency among pregnant and lactating women vary across different countries and populations. The reasons behind that difference, including the methodologies used to assess vitamin D status, the timing of the assessments, and the characteristics of vitamin D supplementation among these populations, have been highlighted as needing further investigation.

A survey of some studies, which focused solely on the pregnant population, revealed inconsistent results on the levels of vitamin D deficiency among pregnant women. One study found that the prevalence of deficiency was 63%, whereas another recorded no cases of vitamin D deficiency for the same population group and geographic location.

Studies focused on the lactating population produced similar results, which also coincided with a 2011 cross-sectional study of breast-feeding women conducted in the same country

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with a small sample size as well as a 2013 cross-sectional study of nursing mothers conducted in Nepal with a similar coverage area. One study found the vitamin D status of breast-feeding women to be insufficient with a median value of 40 nmol/l and 50.5% of subjects below 40 nmol/l. Yet another found that 87% of lactating mothers had vitamin D levels considered to be inadequate while the findings of the other two studies align with those obtained in the present study (K. Thiele, 2013).

5.2. Implications for Maternal and Child Health

Pregnant and breastfeeding (nursing) women are a vulnerable group at risk of developing vitamin D deficiency (Meija et al., 2023). Vitamin D is crucial for various body functions, including fetal and neonatal skeletal development, and it must be supplemented during pregnancy. Vitamin D status in the general population and specific groups, including pregnant and breastfeeding women, should therefore be defined.

Maternal vitamin D deficiency during pregnancy has adverse effects on fetal health and breastfeeding. Maternal actions also impact newborn vitamin D status (K. Thiele, 2013). Vitamin D supplementation should be monitored to ensure adequate levels in mothers and their infants. Insufficient sun exposure, dietary deficiencies, and high birth rates contribute to vitamin D deficiencies among mothers and children (Eliana Pierre Martins et al., 2018).

Vitamin D levels among pregnant and breastfeeding women in Uruguay were investigated. A high prevalence of deficiency was hypothesised, based on evidence of poor dietary habits and lack of supplementation in Uruguay.

5.3. Strengths and Limitations

Pregnancy and breastfeeding constitute critical periods for maternal and neonatal health, and thus maternal biochemical status must be closely monitored during this timeframe. Due to the well-recognized importance of vitamin D, it is crucial to establish maternal vitamin D status and influencing factors to determine the need for public health interventions. Vitamin D deficiency constitutes a global public health concern for people of all ages, and vitamin D insufficiency during pregnancy and lactation may have negative effects on both maternal and child health. The physiological demand for vitamin D is markedly increased during the later stages of pregnancy and lactation. The majority of pregnant women, breastfeeding mothers, and newborns worldwide are reported to be vitamin D deficient. Vitamin D influences the immune system, and its insufficiency during pregnancy is associated with the risk of preeclampsia, gestational diabetes, and gestational hypertension. Higher pre-delivery maternal 25-hydroxyvitamin D levels are positively associated with offspring bone mineral content and mathematics test scores. Vitamin D supplementation may reduce the risk of preterm birth, intrauterine growth restriction, preeclampsia, and gestational diabetes mellitus

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and may be related to augmented initial milk production, improved calcium status, and increased infant serum vitamin D levels.

Various definitions for vitamin D sufficiency and different guidelines for food fortification and vitamin D supplements have been proposed in various countries. The recommended daily intake of vitamin D is 600 international units (IU) for pregnant and lactating women in Korea, but the country has no major programs for vitamin D food fortification. The risk of being vitamin D deficient or insufficient is aggravated in northern countries during the winter season. Along with geographical latitude, skin pigment, the level of sun exposure, lifestyle, dietary patterns, and dietary supplement consumption comprise risk factors influencing vitamin D status, which varies seasonally.

A cross-sectional study design was adopted to evaluate vitamin D status and influential factors in pregnant and breastfeeding women. Such a design is appropriate for assessing the prevalence of vitamin D deficiency at a specific time point (Meija et al., 2023) ; (K. Thiele, 2013).

6. Public Health and Clinical Implications

The implications of vitamin D status during pregnancy affect both maternal and child health. Sufficient concentrations are vital for metabolic processes, bone health, fetal development, and neonatal outcomes (Meija et al., 2023). Adverse effects of pregnancy-related vitamin D deficiency warrant public health consideration. A high prevalence among pregnant women persists, impacted by obesity, dietary habits, sun exposure, knowledge, and genetic elements (K. Thiele, 2013) , leading to osteomalacia, autoimmune diseases, preeclampsia, gestational diabetes, infection risk, and impaired immunity. Maternal vitamin D sufficiency may reduce these risks, serving as an adjunct for optimizing health and disease prevention. Maternal status influences neonatal birth size and survival; significant associations exist with fetal programming and childhood growth. Although vitamin D supplementation benefits maternal, fetal, and neonatal health, healthy women may rely on dietary intake or sun exposure. In most pregnant women without supervision, prophylactic elements remain lacking.

Monitoring vitamin D status in pregnant and breastfeeding women must be addressed across populations. Clarifying the prevailing deficiency degree and relevant determining factors aids in policy formulation and implementation. These considerations drive the study's significance and necessity.

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7. Conclusions

Vitamin D is essential for both maternal and fetal health during pregnancy and lactation. Insufficient vitamin D levels can result in adverse maternal health, including pre-eclampsia, gestational diabetes, hypertension, and infections, and may also negatively affect the developing fetus, increasing the risk of pregnancy complications and chronic diseases in later life. Pregnant women are especially at risk of vitamin D deficiency due to their increasing need for vitamin D, besides other factors. Vitamin D is a major issue in maternal and child health in many countries and no study has reported vitamin D status among pregnant and breastfeeding women in the specified region. The study aimed to assess vitamin D status and its associated factors among pregnant and breastfeeding women. The study was performed in a pre-school learning centre in West Java, Indonesia. Cross-sectional design was used. Respondents were employed using an inclusive and consecutive sampling method among the respondents meeting the inclusion criteria. A total of 82 menopausal women aged 18–50 years, consisting of 51 pregnant women and 31 breastfeeding mothers, were selected as the samples. Vitamin D status was measured by serum 25(OH)D with the chemiluminescent assay. Data were analysed with descriptive and logistic regression methods. The study found that almost half of the respondents have abnormal vitamin D status, defined as deficiency and insufficiency (≤20 and ≤29 ng/mL), is 44.6% ((Kareem Mohammed, 2023)), while sufficiency (≥30–65 ng/mL) is 55.4%. The highest prevalence of abnormal status indicates the need for special attention for this group. The study revealed that being a breastfeeding mother is significantly associated with Vitamin D status, Hypovitaminosis D is associated with lack of dietary self-report data; Seasonal analysis strong influence of serum vitamin D level.

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