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Socioeconomic and Demographic Determinants of Maternal Vitamin D Status in Pregnancy

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KEYWORDS

Vitamin D deficiency, socioeconomic status, pregnancy, maternal nutrition.

ABSTRACT:

Background: Vitamin D deficiency during pregnancy is common in South Asia and may be influenced by socioeconomic and demographic factors. Understanding these determinants is essential for targeted preventive strategies. This study aimed to evaluate the socioeconomic and demographic characteristics associated with maternal vitamin D status among pregnant women delivering at a tertiary care hospital.

Methods: A comparative cross-sectional study was conducted in the Department of Obstetrics and Gynaecology at Bangabandhu Sheikh Mujib Medical University, Dhaka, from July 2023 to December 2024. Sixty pregnant women delivering term neonates were included. Maternal age, education, occupation, socioeconomic status, pre-pregnancy body mass index and parity were recorded using a structured questionnaire. Serum 25-hydroxyvitamin D was measured using chemiluminescence immunoassay. Data were analyzed using SPSS version 26. Statistical significance was set at $p<0.05$.

Results: Mean maternal vitamin D level was 12.50 ± 4.73 ng/ml in one group and 16.15 ± 5.01 ng/ml in the other, with an overall high prevalence of deficiency. Maternal age differed significantly between groups ($p=0.04$). Socioeconomic status showed a statistically significant association ($p=0.02$). Educational status, occupational profile, body mass index and parity did not demonstrate significant differences.

Conclusion: Maternal vitamin D deficiency was highly prevalent and appeared to be influenced by socioeconomic context within this cohort. Strengthening antenatal nutritional assessment and targeted interventions may help address micronutrient deficiencies in pregnancy.

Introduction

Vitamin D deficiency has emerged as a global public health concern affecting populations across diverse geographic regions. Pregnant women represent a particularly vulnerable group because of increased physiological demands and the critical role of vitamin D in maternal and fetal health [1]. Serum 25-hydroxyvitamin D is the accepted biomarker of vitamin D status and reflects both endogenous synthesis and dietary intake [2]. Suboptimal vitamin D levels during pregnancy have been associated with adverse maternal and neonatal outcomes, including impaired fetal growth and metabolic disturbances [3].

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Globally, vitamin D deficiency is highly prevalent among women of reproductive age, including in regions with ample sunlight. For example, widespread hypovitaminosis D has been reported throughout South Asia, the Middle East and parts of Africa, where factors such as cultural clothing that limits skin exposure, reduced outdoor activities and poor dietary intake contribute significantly to the deficiency burden despite environmental conditions favoring synthesis [4,5]. In Bangladesh, several recent studies document a high proportion of pregnant women with deficient serum vitamin D concentrations, often asymptomatic, underscoring a public health need for focused interventions [4].

Socioeconomic and demographic factors critically influence nutritional status during pregnancy by affecting dietary diversity, health behaviors and access to antenatal care. Maternal age, education level, occupation and socioeconomic status can shape exposure to health information and availability of nutrient-rich foods. Lower socioeconomic strata are particularly vulnerable to micronutrient deficiencies due to limited economic resources and health literacy [6,7]. Pre-pregnancy body mass index (BMI) also affects vitamin D bioavailability, given adipose tissue's capacity to sequester vitamin D, thus reducing circulating levels [5,7]. Additionally, parity plays a role, as repeated pregnancies without adequate recovery time may deplete maternal micronutrient reserves, especially in low-resource environments [4]. Variations in occupational sun exposure can further modify endogenous vitamin D synthesis [5].

While the link between maternal vitamin D deficiency and adverse birth outcomes (such as preeclampsia, gestational diabetes, low birth weight and neonatal intensive care unit admissions) has been well-documented, fewer studies have concentrated on the upstream determinants of vitamin D status in pregnant women, particularly in low- and middle-income countries [8,9]. This knowledge gap limits the development of targeted interventions addressing modifiable socioeconomic and demographic risk factors, which is crucial for settings undergoing nutritional transition alongside persistent inequities in healthcare access [4,5].

In Bangladesh specifically, research has largely emphasized the neonatal consequences of maternal vitamin D deficiency rather than elucidating determinants such as maternal age distribution, educational attainment, occupation, parity and socioeconomic status in relation to biochemical vitamin D status during pregnancy. Identifying these determinants would enable early recognition of high-risk groups and inform antenatal supplementation and nutrition strategies [4].

This study aims to investigate socioeconomic and demographic factors influencing maternal vitamin D status among pregnant women delivering in a tertiary care hospital. By exploring variables including maternal age, education, occupation, socioeconomic condition, pre-pregnancy BMI and parity alongside serum 25(OH)D measurements, the study seeks to generate context-specific evidence to guide interventions and improve maternal nutritional programs.

Materials & Methods

This comparative cross-sectional study was conducted in the Department of Obstetrics and Gynaecology at Bangabandhu Sheikh Mujib Medical University, Dhaka, from July 2023 to December 2024. The study population comprised 60 pregnant women who delivered term neonates during the study period. Participants were categorized based on neonatal birth weight into two equal groups of 30 each; however, the present analysis focused exclusively on maternal socioeconomic and demographic characteristics in relation to measured serum vitamin D levels. Eligible participants were mothers of term singleton neonates who provided written informed consent. Mothers receiving vitamin D supplementation during pregnancy, those with multiple gestations, congenital fetal anomalies, chronic systemic diseases, endocrine disorders, renal disease, or medications affecting vitamin D metabolism were excluded. After delivery, maternal demographic data including age, education, occupation, socioeconomic status, parity and pre-pregnancy body mass index were collected using a pretested structured questionnaire. Socioeconomic status was classified according to household income categories used in the thesis dataset. Neonatal birth weight and APGAR scores were recorded from hospital records, although neonatal outcomes were not considered primary variables in this analysis. Three

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milliliters of maternal venous blood were collected under aseptic conditions for measurement of serum 25-hydroxyvitamin D. Laboratory analysis was performed in the Department of Biochemistry using a standardized direct competitive chemiluminescence immunoassay following manufacturer protocols. Internal quality control procedures were maintained to ensure the reliability and reproducibility of laboratory results. Ethical approval was obtained from the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University. Confidentiality of participant information was strictly preserved and data were anonymized before statistical analysis. Statistical analysis was performed using SPSS version 26. Continuous variables were expressed as mean and standard deviation and categorical variables as frequency and percentage. Associations between maternal characteristics and vitamin D levels were assessed using chi-square tests and independent t-tests where appropriate. A p-value less than 0.05 was considered statistically significant.

Results

Table I. Age distribution of study population (n=60)

Age (years)	Low Birth Weight (n=30)	Normal Birth Weight (n=30)	p value
≤ 20	4 (13.30%)	4 (13.30%)	
21-30	16 (53.30%)	23 (76.70%)	
> 30	10 (33.30%)	3 (10.00%)	
Mean ± SD	28.20 ± 4.10	25.77 ± 3.51	0.04

Table I shows the age distribution of the study population. Among the three age groups, mothers aged 21- 30 years were proportionately higher in both groups. On the other hand, the least number of women in both groups was ≤ 20 years. The mean maternal age was significantly higher in the low-birth-weight group compared with the normal birth weight group.

Table II. Educational and occupational status of mothers

Variable		Low Birth Weight (n=30)	Normal Birth Weight (n=30)	p value
Education	Below SSC	9 (30.0%)	6 (20.0%)	0.22
	SSC	6 (20.0%)	12 (40.0%)	
	HSC	11 (36.7%)	6 (20.0%)	
	Graduate	4 (13.3%)	6 (20.0%)	
Occupation	Housewife	22 (73.3%)	21 (70.0%)	0.7
	Non-government employee	7 (23.3%)	6 (20.0%)	
	Business	1 (3.3%)	2 (6.7%)	
	Others	0 (0.0%)	1 (3.3%)	

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Table II presents the educational and occupational status of mothers. Educational attainment and occupational distribution were comparable between groups and no statistically significant differences were observed.

Table III. Pre-pregnancy BMI of the study population

Pre-pregnancy BMI (kg/m^2)	Low Birth Weight (n=30)	Normal Birth Weight (n=30)	p value
< 18.5 (Underweight)	2 (6.70%)	1 (3.30%)	
18.5 to 24.9 (Normal)	28 (93.30%)	25 (83.30%)	
25.0 to 29.9 (Overweight)	0 (0%)	1 (3.30%)	
30.0 to 39.9 (Obese)	0 (0%)	3 (10.00%)	
Mean ± SD (kg/m^2)	20.72±1.87	21.75±3.81	0.19

Table III shows the pre-pregnancy BMI of the study population. Normal pre-pregnancy BMI mothers were proportionately higher in both groups and mean pre-pregnancy BMI were 20.72±1.87 kg/m2 and 21.75±3.81 kg/m2, respectively and statistically non-significant (p = 0.19).

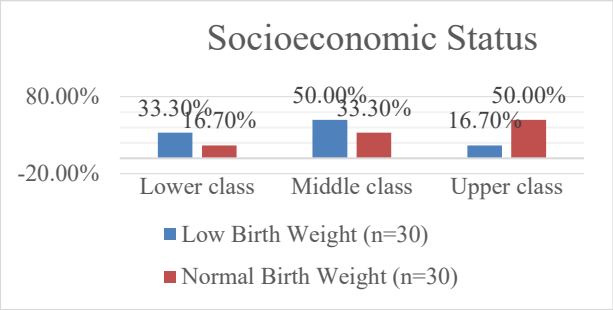

Figure 1: Distribution of socioeconomic status of study population

Figure 1 presents the socioeconomic condition of the study population. Middle-class 15 (50.00%) mothers were proportionately higher in the low-birth-weight group but the same proportion of mothers were in the higher class in the normal birth weight group and it was statistically significant (p=0.02)

Table IV. Parity distribution of mothers

Parity	Primipara	8 (26.70%)	11 (36.70%)	0.41
	Multipara	22 (73.30%)	19 (63.30%)	

Table IV shows the parity distribution of the study population. Multipara mothers were proportionately higher in both groups, with no significant difference between them (p=0.41).

Table V. Maternal serum vitamin D levels

Serum vitamin D	Low Birth Weight (n=30)	Normal Birth Weight (n=30)	p value
Deficient (<20 ng/ml)	26 (86.7%)	21 (70.0%)	0.12
Insufficient (21–30 ng/ml)	4 (13.3%)	6 (20.0%)	0.49
Sufficient (≥31 ng/ml)	0 (0%)	3 (10.0%)	0.24
Mean ± SD (ng/ml)	12.50 ± 4.73	16.15 ± 5.01	0.01

Table V presents the maternal serum vitamin D levels among the study population. A high prevalence of vitamin D deficiency was observed across the study population. Mean serum vitamin D concentration was significantly lower among mothers in the low-birth-weight group.

Discussion

This study examined the socioeconomic and demographic profile of pregnant women in relation to measured serum vitamin D levels within a tertiary care

setting. A high prevalence of maternal vitamin D deficiency was observed across the study population, with mean serum concentrations remaining below optimal levels in both groups. These findings underscore the widespread burden of hypovitaminosis D among pregnant women in this context.

The overall prevalence of vitamin D deficiency in the present cohort is consistent with regional data. Zamal et al. reported that a substantial proportion of Bangladeshi pregnant women had serum vitamin D levels below recommended thresholds [10]. Similarly, Mithal et al. documented pervasive vitamin D deficiency across South Asia despite adequate sunlight availability [11]. The persistence of deficiency in sun-rich environments suggests that sociocultural practices, limited dietary sources and reduced outdoor exposure may significantly influence maternal vitamin D status.

Maternal age differed significantly between groups defined by neonatal birth weight, with older mothers more frequently represented in the low-birth-weight group. Although this analysis focused on determinants of vitamin D status, maternal age may indirectly influence micronutrient reserves through cumulative lifestyle factors and health behaviors. Harvey et al. emphasized that maternal biological and environmental factors collectively shape vitamin D status during pregnancy [3]. However, the age distribution observed in this study remained within the typical reproductive range, suggesting that age alone may not fully explain the high prevalence of deficiency.

Educational attainment did not differ significantly between groups. Nevertheless, education remains a critical determinant of nutritional awareness and health-seeking behavior. Black et al. highlighted that maternal education strongly influences dietary practices and utilization of antenatal care services [12]. The absence of a statistically significant difference in education within this relatively small sample does not negate its broader public health relevance. It may reflect limited variability in educational exposure within the study population.

Occupational status was predominantly characterized by housewives in both groups. Limited occupational diversity may reduce variability in sunlight exposure, particularly in urban settings where indoor confinement is common. van der Mei et al. demonstrated that lifestyle patterns affecting ultraviolet B exposure substantially influence vitamin D synthesis [13]. In settings where women spend considerable time indoors, endogenous production may be insufficient despite geographic advantage.

Socioeconomic status demonstrated a statistically significant difference between groups. Mothers from lower socioeconomic strata were more commonly represented among those with adverse neonatal outcomes and lower mean vitamin D levels. Victora et al. described socioeconomic disadvantage as a central determinant of maternal undernutrition and micronutrient deficiencies in low-income countries [14]. Reduced purchasing power may limit access to vitamin D–rich foods such as fortified dairy products and fatty fish. Socioeconomic constraints may also affect access to preventive supplementation during pregnancy.

Pre-pregnancy body mass index did not differ significantly between groups, with most women classified within the normal range. However, obesity and higher adiposity have been associated with lower circulating vitamin D due to volumetric dilution and sequestration in adipose tissue. Wortsman et al. demonstrated reduced bioavailability of vitamin D among individuals with higher fat mass [15]. Although the present study population showed limited BMI variability, future investigations in more heterogeneous cohorts may clarify the interaction between adiposity and maternal vitamin D status.

Parity distribution was comparable between groups. King reported that repeated pregnancies in resource-limited settings may contribute to maternal nutritional depletion [16]. In this study, most participants were multiparous, which may partly explain the uniformly high prevalence of deficiency. However, the absence of statistical significance suggests that parity alone may not be a dominant determinant within this specific cohort.

The mean serum vitamin D level was significantly lower among mothers in the low-birth-weight group. While neonatal outcome was not the primary focus of this manuscript, the observed pattern reinforces the interconnection between socioeconomic context, maternal nutrition and fetal health. Palacios and Gonzalez emphasized that vitamin D deficiency during pregnancy is frequently intertwined with broader nutritional inadequacies linked to social determinants [17]. The convergence of socioeconomic disadvantage

and micronutrient deficiency may amplify vulnerability to adverse outcomes.

The strength of this study lies in the biochemical assessment of vitamin D using standardized laboratory techniques and the systematic documentation of maternal demographic variables. The use of structured data collection tools and uniform laboratory methodology enhances internal validity. However, interpretation must consider the institutional setting and sample size constraints.

Collectively, these findings highlight that maternal vitamin D deficiency is not merely a biochemical abnormality but is embedded within socioeconomic and demographic realities. Addressing hypovitaminosis D in pregnancy therefore requires multidimensional strategies that integrate nutritional counseling, targeted supplementation and broader social support mechanisms.

Limitations of the study

The study was conducted in a single tertiary care hospital with a modest sample size, which may limit the generalizability to the wider population. The cross-sectional design precludes causal inference regarding determinants of vitamin D deficiency.

Conclusion

Maternal vitamin D deficiency was highly prevalent among pregnant women in this study. Socioeconomic status demonstrated a significant association with maternal characteristics linked to vitamin D status, while age distribution differed between groups. Educational level, occupation, body mass index and parity did not show significant variation within the study sample. These findings suggest that socioeconomic context plays a central role in shaping maternal vitamin D status during pregnancy. Public health strategies focusing on nutritional education, equitable access to supplementation and targeted antenatal screening may contribute to improved maternal micronutrient status.

Conflicts of interest: There are no conflicts of interest.

Ethical Approval: Ethical approval was obtained from the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University (BSMMU)

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