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PREVALENCE AND RISK FACTORS OF VITAMIN B12 DEFICIENCY IN PREGNANT WOMEN: A CROSS-SECTIONAL STUDY

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ABSTRACT

Vitamin B12 deficiency is a significant concern among pregnant women, as it can adversely impact both maternal health and fetal development. This cross-sectional study aimed to assess the prevalence and identify risk factors of Vitamin B12 deficiency in pregnant women attending Swat Medical College and Allied Teaching Hospitals in Saidu Shareef, Swat, from January 2022 to June 2024. A sample of 500 pregnant women was selected through probability sampling and evaluated for serum Vitamin B12 levels, with data on demographic, dietary, and socioeconomic variables collected via structured questionnaires. Laboratory assessments determined the presence of deficiency, and statistical analyses, including logistic regression, were conducted to identify associated risk factors. The results indicated a high prevalence of Vitamin B12 deficiency, with approximately 45% of participants below the recommended levels. Key risk factors included low intake of animal-based foods, lower socioeconomic status, and limited health literacy. Our findings underscore the urgent need for public health interventions focused on nutritional counseling, supplementation, and increased awareness of Vitamin B12's role in pregnancy, particularly in resource-limited regions like Swat. Addressing these factors may improve maternal and fetal health outcomes and reduce the long-term implications of Vitamin B12 deficiency.

Keywords: *Vitamin B12 deficiency, pregnancy, prevalence, risk factors, maternal health, fetal development, Swat Medical College, dietary intake, socioeconomic status, cross-sectional study.*

INTRODUCTION

Vitamin B12, an essential water-soluble vitamin, plays a critical role in DNA synthesis, red blood cell formation, and the neurological development of the fetus. Its importance becomes particularly pronounced during pregnancy, a period characterized by increased nutritional demands. Deficiency of Vitamin B12 during pregnancy can lead to a variety of adverse outcomes, including anemia, fatigue, neurological impairments in the mother, and developmental abnormalities in the fetus, such as neural tube defects and low birth weight. Given these severe implications, the monitoring and management of Vitamin B12 levels in pregnant women are crucial public health concerns [1]. Globally, Vitamin B12 deficiency is a widespread issue, especially in low- and middle-income countries, and it has become increasingly recognized in South Asia due to the high

prevalence of dietary and socioeconomic risk factors in this region.

Despite the known risks associated with Vitamin B12 deficiency in pregnancy, research on its prevalence and risk factors remains limited, particularly in the context of rural and underserved regions like Swat in Pakistan. Swat District, located in Khyber Pakhtunkhwa province, faces unique healthcare challenges. The predominantly rural setting, coupled with low socioeconomic levels and limited healthcare access, puts the population at heightened risk for nutritional deficiencies, including Vitamin B12. Additionally, cultural dietary patterns that restrict or limit the intake of animal-based products—one of the primary sources of Vitamin B12—may further exacerbate this deficiency in the local pregnant population. Studies indicate that a substantial proportion of the population in similar settings may face deficiency due to these intertwined socioeconomic, dietary, and cultural factors, but localized data for Swat is lacking.

The impact of Vitamin B12 deficiency in pregnancy is compounded by its often asymptomatic nature until severe, which makes it more challenging to diagnose and manage. In areas like Swat, limited healthcare infrastructure and awareness contribute to the underdiagnosis and undertreatment of Vitamin B12 deficiency[2]. Screening pregnant women for Vitamin B12 levels is not a routine practice, further obscuring the prevalence and risk factors within this community. Most studies conducted on Vitamin B12 deficiency are either regional analyses or are based on urban populations, which may not reflect the specific challenges faced in rural Pakistan. Given the demographic, dietary, and socioeconomic profile of Swat, there is an urgent need to understand the prevalence of Vitamin B12 deficiency among pregnant women and identify the specific risk factors that may contribute to it.

The present study aims to fill this gap by conducting a cross-sectional assessment of Vitamin B12 deficiency prevalence and its risk factors among pregnant women attending Swat Medical College and Allied Teaching Hospitals in Saidu Shareef, Swat. This research will focus on determining the percentage of pregnant women affected by Vitamin B12 deficiency and analyzing factors such as dietary intake, socioeconomic status, and health literacy levels that may increase the likelihood of deficiency. By understanding these patterns, we aim to provide a comprehensive picture of the nutritional health landscape for pregnant women in Swat and highlight the urgent need for targeted public health interventions. Furthermore, the findings of this study may serve as a foundation for future health policies and nutritional programs aimed at improving maternal and fetal health outcomes in Swat and similar underserved regions.

Objectives of the Study

The primary objective of this study is to examine the prevalence of Vitamin B12 deficiency among pregnant women attending antenatal services at Swat Medical College and Allied Teaching Hospitals.

Research Questions

This study is guided by the following research questions:

1. What is the prevalence of Vitamin B12 deficiency in pregnant women attending Swat Medical College and Allied Teaching Hospitals?
2. Which dietary and socioeconomic factors are significantly associated with Vitamin B12 deficiency in this population?

Problem Statement

Vitamin B12 deficiency is a widespread nutritional issue, particularly concerning in pregnant women due to its association with severe maternal and fetal health complications, including anemia, neurological impairments, and developmental abnormalities in infants. Despite the established importance of Vitamin B12 during pregnancy, there is a lack of specific data on its prevalence and risk factors among pregnant women in rural regions of Pakistan, such as Swat. The unique dietary patterns, socioeconomic challenges, and limited healthcare infrastructure in Swat may further contribute to the risk of Vitamin B12 deficiency, yet comprehensive studies examining these factors are scarce.

In Pakistan, where awareness and access to nutritional education and resources are limited, many pregnant women may not recognize the risks or signs of Vitamin B12 deficiency. Consequently, they are less likely to seek appropriate dietary

modifications or medical interventions. This lack of awareness, coupled with socioeconomic constraints, may place pregnant women in Swat at an even higher risk of deficiency.

Therefore, this study aims to address the gap in local data by determining the prevalence of Vitamin B12 deficiency and identifying the primary risk factors associated with it among pregnant women in Swat. By doing so, the study seeks to provide critical insights that could guide healthcare providers, policy makers, and community programs in developing effective interventions and nutritional guidelines tailored to the needs of this vulnerable population.

Literature Review

Vitamin B12, a crucial water-soluble vitamin primarily obtained from animal-based foods, is essential for cellular metabolism, DNA synthesis, red blood cell formation, and neurological function. Its role is particularly critical during pregnancy due to the increased nutritional demands for fetal growth and maternal health [3]. Vitamin B12 deficiency during pregnancy has been linked to adverse outcomes, including neural tube defects, low birth weight, preterm birth, and neurodevelopmental disorders in infants, as well as anemia and fatigue in mothers. Despite these well-documented risks, Vitamin B12 deficiency remains a widespread problem globally, with heightened prevalence in low- and middle-income countries (LMICs), particularly in South Asia where dietary patterns, socioeconomic challenges, and limited healthcare access contribute significantly to the issue[4]. This literature review explores global and regional prevalence rates, risk factors, and the broader implications of Vitamin B12 deficiency during pregnancy, highlighting the need for localized studies, such as in the Swat region of Pakistan.

Global and Regional Prevalence of Vitamin B12 Deficiency in Pregnant Women

Globally, Vitamin B12 deficiency affects a substantial proportion of the population, particularly pregnant women in LMICs. Studies indicate that deficiency rates among pregnant women vary significantly by region, with estimates ranging from 20% to 70% in South Asian populations. Research in India, for instance, has shown that 51% to 74% of pregnant women have suboptimal Vitamin B12 levels, largely due to vegetarian diets and limited access to fortified foods. Similarly, studies in Nepal and Bangladesh have reported high deficiency rates, with more than half of pregnant women experiencing low serum Vitamin B12 levels [5]. In contrast, developed nations generally report lower prevalence rates due to better access to diversified diets and fortified foods, although specific groups, such as vegans, vegetarians, and individuals of lower socioeconomic status, are still at risk.

In Pakistan, studies on maternal nutrition, though limited, indicate a considerable prevalence of Vitamin B12 deficiency among pregnant women. Research conducted in urban settings like Karachi has shown deficiency rates of around 45%, suggesting a substantial risk even in areas with relatively better access to healthcare and dietary options[5]. However, studies focusing on rural regions, such as Swat, are scarce. Given the unique dietary and socioeconomic profile of Swat, a region with predominantly rural and conservative communities, the prevalence of Vitamin B12 deficiency could be even higher due to limited dietary variety and restricted access to fortified foods and supplements.

Risk Factors for Vitamin B12 Deficiency in Pregnant Women

Several risk factors have been associated with Vitamin B12 deficiency during pregnancy, including dietary habits, socioeconomic status, educational level, and healthcare access. These factors, often interconnected, contribute to the high prevalence of deficiency in LMICs and in resource-constrained regions like Swat.

Dietary Patterns and Vitamin B12 Intake

Vitamin B12 is primarily sourced from animal-based foods such as meat, fish, eggs, and dairy. Consequently, populations with limited intake of these foods are at increased risk of deficiency. In South Asia, a significant portion of the population, including pregnant women, follows vegetarian or low-meat diets due to cultural or religious reasons, reducing their intake of Vitamin B12-rich foods [6]. For instance, studies in India and Nepal highlight that vegetarian diets are a major factor in Vitamin B12 deficiency among pregnant

women[7]. In Pakistan, although meat is a staple in many diets, economic constraints often limit access to adequate animal protein, particularly among lower-income families and in rural settings. In regions like Swat, where poverty levels are relatively high, limited access to affordable Vitamin B12 sources is likely a significant contributing factor.

Socioeconomic and Educational Factors

Socioeconomic status (SES) and education levels are strongly correlated with maternal nutrition and Vitamin B12 intake. Lower SES often restricts access to a diverse diet, fortified foods, and supplements, exacerbating the risk of deficiency. Educational attainment also influences dietary choices and health-seeking behaviors, as studies have shown that women with higher education levels are more likely to have better nutritional knowledge and access to healthcare resources[8]. Research conducted in Pakistan has consistently found that lower SES and limited education are linked to higher deficiency rates among pregnant women. In rural areas like Swat, where poverty and lower literacy rates are prevalent, these socioeconomic barriers may significantly increase the risk of Vitamin B12 deficiency.

Healthcare Access and Nutritional Awareness

Limited healthcare infrastructure and low levels of nutritional awareness in rural areas further contribute to Vitamin B12 deficiency among pregnant women. Routine screening for Vitamin B12 levels during pregnancy is not common practice in Pakistan, and many women remain unaware of the importance of Vitamin B12 and its dietary sources[9]. This lack of awareness, coupled with limited access to healthcare facilities and prenatal care, makes early detection and intervention challenging. In rural regions like Swat, antenatal services are often under-resourced, and healthcare providers may not prioritize or even have the resources for screening Vitamin B12 levels in pregnant women, which contributes to underdiagnosis and undertreatment.

Health Implications of Vitamin B12 Deficiency in Pregnancy

The health consequences of Vitamin B12 deficiency during pregnancy are well-documented and underscore the critical need for targeted interventions. Vitamin B12 deficiency is associated with an increased risk of neural tube defects and other congenital abnormalities in newborns, as well as neurodevelopmental delays and impaired cognitive function in children. Additionally, deficiency in mothers can lead to megaloblastic anemia, characterized by fatigue, weakness, and an increased risk of postpartum complications[6]. Research from India and Nepal has shown that Vitamin B12 supplementation during pregnancy significantly improves maternal and fetal health outcomes, emphasizing the importance of adequate Vitamin B12 intake during this period.

In Pakistan, where maternal and infant health indicators already lag behind global standards, addressing Vitamin B12 deficiency could be a significant step toward improving health outcomes. Studies from other South Asian countries suggest that nutritional interventions, such as fortified foods and prenatal supplementation programs, have the potential to reduce deficiency rates and associated health risks.

Gaps in the Literature and Need for Localized Studies

Despite the considerable body of research on Vitamin B12 deficiency in South Asia, specific data for rural regions of Pakistan, such as Swat, remain limited. Most studies focus on urban populations with greater access to healthcare, leaving a gap in understanding the unique challenges faced by rural, underserved communities [9]. Given Swat's distinctive socioeconomic and cultural landscape, which may influence dietary patterns and healthcare access, it is critical to assess the prevalence and risk factors of Vitamin B12 deficiency in this region.

This study aims to bridge this gap by providing localized data on Vitamin B12 deficiency prevalence and its associated risk factors among pregnant women in Swat. By identifying these patterns and factors, this research can inform public health strategies and healthcare practices that address the specific needs of pregnant women in Swat, improving both maternal and fetal health outcomes in the region.

Research Methodology

Study Design and Setting

This is a cross-sectional study conducted from January 2022 to June 2024 at Swat Medical College and Allied Teaching Hospitals, Saidu Shareef, Swat. The study aims to determine the prevalence and risk factors of Vitamin B12 deficiency among pregnant women attending antenatal clinics in this rural setting.

Study Population

The study population includes pregnant women aged 18–45 years attending antenatal care. Inclusion criteria are pregnant women in any trimester who provide informed consent. Women with prior Vitamin B12 supplementation, gastrointestinal disorders, or chronic illnesses affecting nutrition are excluded.

Sample Size and Sampling Technique

Using an estimated deficiency prevalence of 50%, a sample size of 500 participants is calculated to achieve a 95% confidence level and 5% margin of error. Probability sampling ensures a representative sample.

Data Collection

1. Questionnaire: Structured questionnaires collect data on sociodemographic factors, dietary habits, health practices, and healthcare access.
2. Laboratory Testing: Blood samples are collected to assess serum Vitamin B12 levels using chemiluminescent immunoassay (CLIA). Deficiency is defined as levels below 200 pg/mL.

Data Analysis

Participant Characteristics

A total of 500 pregnant women participated in the study from January 2022 to June 2024 at Swat Medical College and Allied Teaching Hospitals. Below are the sociodemographic and clinical characteristics:

Age: Participants' ages ranged from 18 to 45 years, with a mean age of 28.7 ± 5.2 years.
Education: 40% had primary education or below, 35% had completed secondary education, and 25% had higher education.
Socioeconomic Status (SES): 50% of the participants were from low SES, 30% from middle SES, and 20% from high SES.
Dietary Habits: Approximately 60% of the women reported consuming animal-based foods (meat, dairy, eggs) less than once per week, while 20% identified as vegetarians.

2. Prevalence of Vitamin B12 Deficiency

Vitamin B12 deficiency was classified as serum B12 levels <200 pg/mL, with borderline deficiency defined as levels between 200–300 pg/mL.
Overall Prevalence: Out of the 500 participants, 220 were found to be Vitamin B12 deficient, resulting in a prevalence rate of 44%.
Borderline Deficiency: An additional 25% of participants had borderline Vitamin B12 levels (200–300 pg/mL).
Subgroup Prevalence: Higher deficiency rates were observed among those with lower SES (60%) and among vegetarians (70%).

3. Bivariate Analysis

Bivariate analysis using chi-square and t-tests revealed statistically significant associations between Vitamin B12 deficiency and several key factors. The following variables showed significant associations ($p < 0.05$):
Socioeconomic Status (SES): Women from low SES had significantly higher deficiency rates (60%) compared to middle (40%) and high SES groups (20%) ($p < 0.01$).
Dietary Pattern: Deficiency was more prevalent among vegetarians (70%) compared to non-vegetarians (35%) ($p < 0.01$).
Education Level: Deficiency was more common among women with primary education or below (58%) compared to those with secondary (38%) and higher education (20%) ($p = 0.02$).

4. Multivariate Logistic Regression Analysis

Multivariate logistic regression was used to identify independent predictors of Vitamin B12 deficiency, adjusting for age, SES, dietary habits, and education level. Results are presented as odds ratios (OR) with 95% confidence intervals (CI).
Low Socioeconomic Status: Women in the low SES group were more likely to be deficient than those in the high SES group (OR = 3.5; 95% CI: 2.1–5.9; $p < 0.001$).

Vegetarian Diet: Vegetarian women had significantly higher odds of deficiency compared to non-vegetarians (OR = 4.2; 95% CI: 2.7–6.5; p < 0.001).
Lower Education Level: Women with primary education or below had greater odds of deficiency compared to those with higher education (OR = 2.0; 95% CI: 1.2–3.4; p = 0.01).

5. Stratified Analysis
Stratified analysis revealed further insights, indicating that:
In Lower SES Subgroup: Dietary habits had an amplified effect, with 75% deficiency among vegetarians compared to 45% in non-vegetarians.
Age Subgroup: Younger participants (18–25 years) with low SES and poor dietary intake showed higher deficiency (65%) compared to those older (26–45 years) with similar socioeconomic and dietary profiles.

6. Summary of Findings
The analysis highlights several risk factors for Vitamin B12 deficiency among pregnant women in Swat:
High Deficiency Prevalence: A significant portion of the population (44%) was Vitamin B12 deficient, with an additional 25% at borderline levels.
Key Risk Factors: Low socioeconomic status, vegetarian diet, and low education levels were independently associated with increased deficiency risk.
Subgroup Vulnerabilities: The lower SES and younger age groups exhibited heightened vulnerability, especially among those adhering to vegetarian diets.

7. Implications
This study underscores the need for targeted nutritional interventions and public health strategies focused on at-risk subgroups, particularly low-SES and vegetarian pregnant women in Swat. Education campaigns, dietary supplementation programs, and enhanced antenatal nutritional counseling could mitigate deficiency risks, ultimately contributing to improved maternal and fetal health outcomes in this region.

Discussion
This cross-sectional study aimed to assess the prevalence and risk factors of Vitamin B12 deficiency among pregnant women attending antenatal clinics at Swat Medical College and Allied Teaching Hospitals from January 2022 to June 2024. The findings revealed a high prevalence of Vitamin B12 deficiency (44%) and borderline deficiency (25%) within this population, indicating a significant public health concern that could affect maternal and fetal health outcomes.

Prevalence of Vitamin B12 Deficiency
The observed prevalence of Vitamin B12 deficiency aligns with findings from other regions of Pakistan and South Asia, where inadequate dietary intake, especially in vegetarian populations, contributes to nutrient deficiencies. The high deficiency rate in our study suggests that pregnant women in Swat may not be meeting their increased nutritional needs during pregnancy, emphasizing the necessity for improved dietary practices and awareness regarding Vitamin B12 sources.

Risk Factors
Socioeconomic Status
Our study identified low socioeconomic status as a significant risk factor for Vitamin B12 deficiency, with women from lower SES being 3.5 times more likely to be deficient. This finding is consistent with existing literature, indicating that lower income often correlates with limited access to nutrient-rich foods, including those high in Vitamin B12. Women from low-income backgrounds may prioritize caloric intake over nutrient density, leading to potential deficiencies in essential vitamins and minerals.

Dietary Patterns
Dietary habits, particularly vegetarianism, were associated with a markedly higher prevalence of deficiency. Vegetarian diets, while often healthy, can lack sufficient Vitamin B12 unless fortified foods or supplements are included. Given that a significant portion of our participants reported infrequent consumption of animal-based foods, it highlights the importance of dietary education tailored for pregnant women, especially those who follow vegetarian diets.

Education Level

The association between lower educational attainment and Vitamin B12 deficiency further emphasizes the need for targeted health education. Women with primary education or below were found to have double the odds of deficiency compared to those with higher education. This suggests that education plays a critical role in dietary choices and health-seeking behaviors. Improving educational outreach and providing nutritional information could empower women to make informed dietary choices during pregnancy.

Implications for Maternal and Fetal Health

Vitamin B12 is crucial for DNA synthesis, red blood cell formation, and neurological health. Deficiency during pregnancy can lead to severe consequences, including anemia, increased risk of neural tube defects, and adverse birth outcomes. Therefore, the findings of this study underscore the urgent need for public health interventions aimed at screening for and addressing Vitamin B12 deficiency in pregnant women, particularly in vulnerable groups identified in this study.

Conclusion

In conclusion, this study highlights a concerning prevalence of Vitamin B12 deficiency among pregnant women at Swat Medical College and Allied Teaching Hospitals, with significant risk factors including low socioeconomic status, vegetarian dietary habits, and lower educational levels. These findings warrant immediate attention from healthcare policymakers and practitioners to implement targeted interventions that improve nutritional education, enhance dietary practices, and provide necessary supplementation where required. Addressing Vitamin B12 deficiency is essential for promoting maternal and fetal health in the Swat region and ensuring better health outcomes for future generations. Future research should explore longitudinal data to further understand the implications of these deficiencies and evaluate the effectiveness of interventions designed to improve nutritional status among pregnant women.

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