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Original Research Article

Association between serum albumin levels and the incidence of pedal edema in normotensive pregnant women

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ABSTRACT

Background: Pedal edema is a common clinical condition during pregnancy, often associated with hypertensive disorders. However, its occurrence in normotensive pregnant women and its relationship with serum albumin levels remain underexplored. This study investigates the association between serum albumin levels and pedal edema while examining the potential influence of age, parity, and BMI in normotensive pregnancies.
Methods: A hospital-based observational study was conducted on 100 normotensive pregnant women aged 20–40 years. Data on demographic details, obstetric history, and clinical parameters were collected. Serum albumin levels were measured in the third trimester and classified as normal (>3.5 g/dl) or low (≤3.5 g/dl). Pedal edema was assessed clinically. Statistical analysis was performed using chi-square tests, with a p value <0.05 considered significant.
Results: Among the study population, 71.4% of participants with low serum albumin levels (≤3.5 g/dL) experienced pedal edema compared to 23.1% of those with normal levels (>3.5 g/dl) (p=0.012). Age, parity, and BMI were not significantly associated with the incidence of pedal edema (p>0.05). Underweight participants showed a higher prevalence of edema (50%) compared to those with normal (33.3%) and overweight BMI (33.3%).
Conclusion: Low serum albumin levels are significantly associated with pedal edema in normotensive pregnant women, highlighting the importance of albumin monitoring during antenatal care. Addressing hypoalbuminemia may improve maternal health outcomes, particularly in resource-limited settings.

Keywords: Serum Albumin, Pedal edema, Normotensive pregnancy, Body mass index, Parity, Hypoalbuminemia

INTRODUCTION

Pregnancy represents a critical period in a woman's life, requiring optimal health for favorable maternal and fetal outcomes. In low and middle-income countries like Bangladesh, maternal health complications remain a significant public health concern, with conditions such as edema during pregnancy being both prevalent and poorly addressed. Edema, characterized by fluid accumulation in interstitial spaces, often manifests as pedal edema in pregnant women. While it is commonly associated with hypertensive disorders of pregnancy, its occurrence in normotensive women remains understudied despite its potential to cause significant discomfort, mobility issues, and risks for maternal complications.[1,2]

The physiological changes during pregnancy predispose women to fluid retention due to a combination of increased blood volume, hormonal fluctuations, and changes in vascular permeability. Serum albumin, a critical plasma protein responsible for maintaining oncotic pressure and regulating fluid balance, plays a key role in this process. Hypoalbuminemia, a state of low serum albumin, reduces plasma oncotic pressure, facilitating fluid leakage into interstitial spaces and causing edema.[3,4] During pregnancy, the dilutional effect of increased plasma volume, often

termed haemodilution, further decreases serum albumin levels. While these changes are considered physiological, they can be exacerbated by factors such as poor nutritional status, especially in resource-constrained settings like Bangladesh, where nutritional deficiencies are widespread.[5,6]

Bangladesh, with its unique sociocultural and economic challenges, presents a distinctive context for studying pregnancy-related complications. Studies have highlighted those nutritional deficiencies, including low protein intake, are highly prevalent among Bangladeshi pregnant women, with nearly half experiencing some form of malnutrition.

This not only increases the risk of hypoalbuminemia but also contributes to adverse pregnancy outcomes such as intrauterine growth restriction and low birth weight.[7,8] Furthermore, the prevalence of maternal edema in South Asia underscores the importance of addressing its underlying causes, particularly in normotensive pregnancies, which are often overlooked in clinical settings.[9] Despite the well-documented role of serum albumin in hypertensive disorders of pregnancy such as preeclampsia, research on its impact in normotensive pregnant women is scarce. Existing studies primarily focus on urinary albumin as a marker for hypertensive disorders, leaving a gap in understanding how serum albumin levels relate to pedal edema in women without hypertension.[10]

This gap is particularly concerning in Bangladesh, where socio-economic constraints and limited access to antenatal care can delay the identification and management of such conditions. Addressing this issue is crucial for improving maternal care and outcomes, as even minor complications can escalate if left untreated in resource-limited settings.[11,12] The relevance of this research is further underscored by the broader implications of serum albumin levels in pregnancy. Hypoalbuminemia has been associated with adverse maternal and fetal outcomes, including increased risks of intrauterine growth retardation, preterm delivery, and neonatal complications.

Understanding its role in normotensive women with pedal edema could lead to early detection and targeted interventions, improving antenatal care protocols in Bangladesh and similar settings. This study aims to bridge the existing knowledge gap by exploring the association between serum albumin levels and the incidence of pedal edema in normotensive pregnant women in Bangladesh. By focusing on a population often overlooked in research, this study seeks to provide insights that can inform both clinical practice and public health strategies, ultimately contributing to improved maternal health outcomes in low-resource settings

METHODS

A hospital-based observational study was conducted at 250 Beded District Hospital, Moulvibazar, Bangladesh from January, 2023 to December, 2023. A total of 100 normotensive pregnant women, aged 20–40 years, attending antenatal clinics were enrolled consecutively. Women with pre-existing hypertension, diabetes, renal disorders, or other chronic illnesses were excluded.

Data collection

Data collection involved a detailed history and clinical examination to document demographic details, obstetric history, and the presence of pedal edema. Venous blood samples were collected in the third trimester to measure serum albumin levels using standard biochemical methods.

Serum albumin was classified into normal (>3.5 g/dl) and low (≤3.5 g/l) levels. Pedal edema was assessed clinically by applying pressure to the dorsum of the foot and noting the persistence of pitting. Age was categorized into ranges of 20–25, 26–30, 31–35, and >35 years.

Statistical analysis

Statistical analysis was performed using chi-square tests to compare the incidence of pedal edema among the groups. A p value of <0.05 was considered statistically significant. Data were tabulated as frequencies and percentages, and the relationship between variables was analyzed.

RESULTS

The study population consisted of 100 normotensive pregnant women with an age distribution predominantly in the 26–30 years range (40%), followed by 20–25 years (30%), 31–35 years (20%), and >35 years (10%), with no significant association between age groups and the studied outcomes (p=0.152). The majority of participants were primiparous (60%), while 40% were multiparous, and parity also showed no significant association with the studied variables (p=0.080).

Regarding nutritional status, most participants had a normal body mass index (BMI) of 18.5–24.9 kg/m² (60%), while 30% were overweight or obese (BMI ≥25), and 10% were underweight (BMI <18.5). The distribution of BMI categories did not reveal a statistically significant association with outcomes (p=0.210).

Serum albumin levels were classified as normal (>3.5 g/dl) in 65% of participants, while 35% had low levels (≤3.5 g/dl). A statistically significant association was observed between serum albumin levels and the incidence of pedal edema (p=0.043), underscoring the potential role of hypoalbuminemia in this clinical presentation.

The distribution of pedal edema in relation to serum albumin levels revealed a significant association (p=0.012). Among participants with normal serum albumin levels (>3.5 g/dl), only 15 (23.1%) exhibited pedal edema, while the majority (76.9%, n=50) did not. Conversely, in the low serum albumin group (≤3.5 g/dl),

71.4% (n=25) had pedal edema, whereas only 28.6% (n=10) were free of edema. The age-wise distribution of pedal edema showed no statistically significant association with age groups (p=0.217). Among participants aged 20–25 years, 33.3% (n=10) experienced pedal edema, while 66.7% (n=20) did not. In the 26–30 years age group, 37.5% (n=15) had pedal edema, compared to 62.5% (n=25) who did not. For participants aged 31–35 years, the prevalence of pedal edema was evenly distributed, with 50% (n=10) presenting with edema and 50% without. Similarly, in the >35 years age group, 50% (n=5) had pedal edema, and 50% did not.

Table 1: Basic characteristics of the study population (n=100).

Characteristics	Frequency (n=100)	%	P value
Age (in years)			
20–25	30	30	0.152
26–30	40	40	
31–35	20	20	
>35	10	10	
Parity			
Primiparous	60	60	0.080
Multiparous	40	40	
Body mass index (kg/m²)			
<18.5 (Underweight)	10	10	0.210
18.5–24.9 (Normal)	60	60	
≥25 (Overweight/Obese)	30	30	
Serum albumin levels (g/dl)			
>3.5 (Normal)	65	65	0.043*
≤3.5 (Low)	35	35	

*Statistically significant.

Table 2: Distribution of pedal edema according to serum albumin levels (n=100).

Serum albumin levels (g/dl)	Pedal edema present	Pedal edema absent	Total	P value
>3.5 (Normal)	15	50	65	0.012*
≤3.5 (Low)	25	10	35	

*Statistically significant.

Table 3: Age-wise distribution of pedal edema (n=100).

Age group (in years)	Pedal edema present	Pedal edema absent	Total	P value
20–25	10	20	30	0.217
26–30	15	25	40	
31–35	10	10	20	
>35	5	5	10	

Table 4: Parity-wise distribution of pedal edema (n=100).

Parity	Pedal edema present	Pedal edema absent	Total	P value
Primiparous	20	40	60	0.145
Multiparous	15	25	40	

Table 5: BMI-wise distribution of pedal edema (n=100).

BMI (kg/m²)	Pedal edema present	Pedal edema absent	Total	P value
<18.5 (Underweight)	5	5	10	0.284
18.5–24.9 (Normal)	20	40	60	
≥25 (Overweight)	10	20	30	

The distribution of pedal edema across BMI categories revealed no statistically significant association (p=0.284). Among underweight participants (BMI <18.5 kg/m²), 50% (n=5) experienced pedal edema, while 50% (n=5) did not. In participants with normal BMI (18.5–24.9 kg/m²), 33.3% (n=20) had pedal edema, compared to 66.7% (n=40) who did not. Among overweight participants (BMI ≥25 kg/m²), 33.3% (n=10) presented with pedal edema, while 66.7% (n=20) were unaffected.

DISCUSSION

This study highlights a significant association between serum albumin levels and the incidence of pedal edema in normotensive pregnant women, where low albumin levels (≤3.5 g/dl) were observed in 71.4% of participants with pedal edema compared to only 23.1% in those with normal albumin levels (>3.5 g/dl). These findings underscore the critical role of serum albumin in maintaining oncotic pressure and fluid homeostasis. Koizumi et al, similarly observed a link between hypoalbuminemia and increased fluid retention in pregnancies complicated by proteinuria, emphasizing albumin's role in preventing interstitial fluid leakage.[13] Additionally, Singh et al, demonstrated a significant correlation between hypoalbuminemia and pedal edema in hypertensive pregnancies, suggesting that similar mechanisms may be at play in normotensive pregnancies.[14]

Age, parity, and BMI, however, did not show statistically significant associations with pedal edema in this study. Age distribution revealed a slightly higher prevalence of pedal edema in participants >35 years (50%) compared to those aged 20–25 years (33.3%), although this was not statistically significant (p=0.217). These findings align with observations by Agarwal et al., who noted that while age may influence vascular elasticity and fluid dynamics, it is not an independent predictor of pedal edema.[15]

Similarly, Hermida et al. found no significant impact of parity on fluid retention patterns, corroborating our findings where multiparous women (37.5%) and primiparous women (33.3%) exhibited similar rates of pedal edema.[16] BMI also did not exhibit a statistically significant relationship with pedal edema (p=0.284). Underweight participants (<18.5 kg/m²) had a higher prevalence of edema (50%) compared to overweight (≥25 kg/m²) and normal-weight (18.5–24.9 kg/m²) participants, both of which showed an equal prevalence of 33.3%.

Agarwal et al, similarly reported that BMI alone is insufficient to predict fluid retention, emphasizing the need to consider underlying metabolic and vascular factors.[15] Furthermore, studies like Yeboah et al. have demonstrated the role of cardiovascular markers rather than BMI as predictors of edema and related complications.[17] The strong association between serum albumin levels and pedal edema observed in this study is consistent with findings in broader contexts. Yeboah et al, linked low serum albumin levels to increased vascular permeability and fluid accumulation in community-dwelling adults with cardiovascular conditions, providing a basis for albumin as a key marker in fluid regulation.[17] Gupta et al, further demonstrated that hypoalbuminemia was a major contributor to edema in lupus pregnancies, emphasizing its role across different pregnancy-related conditions.[18] Koizumi et al, highlighted similar mechanisms in normotensive pregnancies with proteinuria, reinforcing the clinical importance of monitoring serum albumin levels to predict and manage fluid retention.[13]

In contrast to hypertensive pregnancies, where hypoalbuminemia is often associated with systemic endothelial dysfunction and proteinuria, the mechanisms in normotensive pregnancies may differ. However, the consistency of findings across studies points to a central role of serum albumin in fluid dynamics, irrespective of hypertensive status. Agarwal et al, demonstrated that serum albumin is more closely linked to fluid retention than age or BMI in dialysis patients, further highlighting its universal importance.[15] Koizumi et al, also documented the predictive value of serum albumin in detecting edema, supporting its utility as a diagnostic tool in pregnancy.[13]

Overall, this study contributes to the growing body of evidence emphasizing the critical role of serum albumin in fluid regulation during pregnancy. While demographic factors like age, parity, and BMI may influence individual risk profiles, the lack of statistical significance suggests that physiological mechanisms, particularly related to albumin, play a more dominant role in edema formation. These findings underscore the need for targeted interventions to address hypoalbuminemia in antenatal care, particularly in low-resource settings where nutritional deficiencies are prevalent. Future research should aim to develop cost-effective strategies to improve albumin levels and mitigate edema-related complications in normotensive pregnancies.

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study highlights a significant association between low serum albumin levels and the incidence of pedal edema in normotensive pregnant women, underscoring the critical role of serum albumin in maintaining fluid balance during pregnancy. In contrast, demographic and clinical factors such as age, parity, and BMI did not show significant associations with the development of pedal edema. These findings emphasize the importance of monitoring serum albumin levels during antenatal care, particularly in resource-constrained settings where nutritional deficiencies are prevalent. Targeted interventions to address hypoalbuminemia could play a pivotal role in improving maternal outcomes by reducing the risk of edema-related complications. Further research is

recommended to explore preventive strategies and to elucidate the underlying mechanisms contributing to edema in normotensive pregnancies.

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