International Journal of Research in Medical Sciences
*Paul AR et al. Int J Res Med Sci. 2024 Dec;12(12):4439-4443*
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20243687

**Original Research Article**

# Comparison of plasma calcium, albumin, and total cholesterol in severely malnourished vs. healthy children in Bangladesh: a case-control study

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**Received:** 07 October 2024
**Accepted:** 16 November 2024

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## ABSTRACT

**Background:** Malnutrition poses a significant threat to the health and development of children in developing countries. The purpose of the study was to compare plasma calcium, albumin, and total cholesterol levels between severely malnourished and healthy children in Bangladesh. The aim of the study was to compare plasma calcium, albumin, and total cholesterol levels between severely malnourished and healthy children in Bangladesh.
**Methods:** This cross-sectional study included 120 subjects, consisting of 60 severely malnourished children aged 18 months to 5 years in Group I (Case) and 60 healthy children in Group II (Control), conducted at Mymensingh Medical College & Community Based Medical College Bangladesh from July 2008 to June 2009. Serum calcium, albumin, and total cholesterol levels were measured and analyzed using SPSS version 22.0, applying descriptive statistics and Student's unpaired t-test for group comparisons.
**Results:** In this study, Group I (severely malnourished children) had a significantly lower mean weight (10.70±2.20 kg) compared to Group II (healthy children) at 14.30±2.30 kg ($p<0.001$). Group I also exhibited significantly lower serum calcium (7.3±1.5 mg/dl vs. 8.6±0.55 mg/dl; $p<0.001$), albumin (3.1±0.32 g/dl vs. 4.5±0.22 g/dl; $p<0.001$), and cholesterol levels (117.0±17.0 mg/dl vs. 127.0±17.6 mg/dl; $p = 0.004$).
**Conclusions:** The study found significantly lower levels of plasma calcium, albumin, and total cholesterol in severely malnourished children compared to healthy controls, indicating critical nutritional deficiencies that require targeted interventions.

**Keywords:** Children, Malnutrition, Plasma calcium, Serum albumin, Total cholesterol

## INTRODUCTION

Malnutrition is a widespread nutritional challenge in developing countries and is a major contributor to childhood mortality and morbidity, resulting in long-term impairments in both physical and mental development.[1] Protein-energy malnutrition (PEM) is a serious condition that can be fatal and occurs in children and adults whose protein and energy intake falls short of the body's nutritional requirements.[2] This disorder is characterized by a deficiency or imbalance in energy and nutrient consumption, leading to symptoms such as wasting, stunting, or being underweight.[3,4] The prevalence of malnutrition among school-aged children in South Asia is alarmingly high, with nearly 60% of both boys and girls classified as underweight. Furthermore, Southeast Asia has the highest rate of stunting among adolescents aged 5 to 19, at 12%.[5]

The nutritional status of severely malnourished children is frequently evaluated through serum protein measurements, as levels of serum total protein and albumin are usually diminished in these cases.[6-8] Micronutrients, vital components of a healthy diet, significantly influence overall health and are needed in small amounts, yet they play essential roles in forming healthy body tissues, including the brain and bones.[9] The concentration of transport proteins, especially albumin, is commonly used to assess protein deficiency, underscoring the importance of monitoring nutritional parameters such as plasma calcium, albumin, and cholesterol levels as indicators of children's overall health and nutritional status.[10]

Protein-energy malnutrition is a serious concern that greatly affects children's health, often leading to reduced serum total protein and albumin levels, conditions referred to as hypoproteinemia and hypoalbuminemia.[11] These deficiencies contribute significantly to childhood illnesses, increasing vulnerability to infections such as diarrhea, pneumonia, and malaria, which, in turn, further worsen malnutrition.[12] Inadequate levels of trace elements like zinc, selenium, iron, vitamin A, and iodine are particularly troubling in developing countries, where young children are the most affected by poor nutrition.[9,13] Such deficiencies not only impede physical growth but also adversely impact cognitive development, immune function, and overall health, resulting in severe long-term health implications.

Research has consistently demonstrated that malnourished children exhibit significantly lower serum total protein and albumin levels compared to their well-nourished counterparts, underscoring the value of these markers in evaluating nutritional status.[14] National surveys have reported distressing malnutrition rates among children aged 6-71 months, with nearly 49% experiencing stunting, 12% being wasted, and 52% classified as underweight.[2] While much of the research has concentrated on deficiencies in iodine, iron, and vitamin A, there has been limited exploration into calcium and cholesterol deficiencies, despite their essential roles in growth, development, and maintaining overall health. This gap emphasizes the need for more comprehensive studies to better understand how malnutrition affects children and the broader impact of various nutrient deficiencies on health outcomes.

Given the high prevalence of malnutrition among children in developing countries, understanding the impact of nutrient deficiencies is crucial for improving health outcomes. Therefore, this study aims to compare plasma calcium, albumin, and total cholesterol levels between severely malnourished and healthy children in Bangladesh, to better understand the nutritional disparities and their potential health implications in this vulnerable population. The aim of the study was to compare plasma calcium, albumin, and total cholesterol levels between severely malnourished and healthy children in Bangladesh.

## METHODS

This cross-sectional study was conducted at the Department of Biochemistry, Mymensingh Medical College in collaboration with the Department of Paediatrics, Mymensingh Medical College, and the Community Based Medical College Bangladesh, over a 1-year period from July 2008 to June 2009. A total of 120 subjects were included, with 60 in Group I (Case) and 60 in Group II (Control).

### *Inclusion criteria*

*For group I (case)*

Inclusion criteria were severely malnourished children aged 18 months to 5 years, defined as those with a weight-for-age Z-score less than -3 or a percentage of desired body weight for age and sex below 60%. Age distribution: 60% aged 4-5 years, 18% aged 3-4 years, 10% aged 2-3 years, and 12% below 2 years. Z-score calculations were based on the CDC growth chart (USA, 2000).

*For group II (case)*

Inclusion criteria were apparently healthy children aged 18 months to 5 years, defined as those with a weight-for-age Z-score greater than -1 or a percentage of desired body weight above 90%. Age distribution: 70% aged 4-5 years, 22% aged 3-4 years, 4% aged 2-3 years, and 4% below 2 years. Z-score calculations were based on the CDC growth chart (USA, 2000).

### *Exclusion criteria*

*For group 1 (case)*

Exclusion criteria were children with clinically diagnosed renal, liver, or cardiac diseases and children with known endocrinological or genetic disorders.

The study protocol was approved by the Ethical Review Committee of Mymensingh Medical College, and all participants were informed of their right to withdraw from the study at any time. Data were collected using a structured questionnaire after obtaining informed consent from the guardians of the subjects, which included relevant variables for the study. Blood samples (4 ml) were drawn under aseptic conditions using a 5 ml sterile disposable syringe with a butterfly needle, immediately transferred to dry screw-capped test tubes, allowed to clot, and then centrifuged. The separated serum was stored in labeled Eppendorf tubes at -20°C for subsequent analysis. The separated serum was stored in labeled Eppendorf tubes at -20°C for subsequent analysis. Laboratory investigations focused on serum calcium, albumin, and total cholesterol levels, measured using the Colorimetric method, the Bromcresol green method, and the CHOD-PAP method, respectively. Data analysis was performed using SPSS version 22.0, employing descriptive statistics and

Student's unpaired t-test for group comparisons, with a significance threshold set at p<0.05.

## RESULTS

The mean weight of Group I (case) was significantly lower (p<0.001) compared to Group II (control). The mean±SD for Group I (case) was 10.70±2.20 kg, while for Group II (control), it was 14.30±2.30 kg (Table 1).

**Table 1: Comparison of weight between groups.**

| Clinical characteristics | Group | | P value |
|---|---|---|---|
| | Group-I (Case) | Group-II (Control) | |
| | (n=60) | (n=60) | |
| **Weight (Kg)** | 10.70±2.20 | 14.30±2.30 | <0.001 |

The status of nutritional parameters demonstrated that Group I (case) had significantly lower levels of serum calcium, albumin, and cholesterol compared to Group II (control). The mean±SD of serum calcium for Group I was 7.3±1.05 mg/dl, compared to 8.6±0.55 mg/dl for Group II (p<0.001). Serum albumin levels in Group I were 3.1±0.32 g/dL, significantly lower than the 4.5±0.22 g/dl observed in Group II (p<0.001). Similarly, serum cholesterol was 117.0±17.0 mg/dl in Group I, compared to 127.0±17.6 mg/dL in Group II (p=0.004) (Table 2).

**Table 2: Comparison of nutritional parameter between groups.**

| Nutritional parameter | Group | | P value |
|---|---|---|---|
| | Group-I (Case) | Group-II (Control) | |
| | (n=60) | (n=60) | |
| **Calcium** | 7.3±1.5 | 8.6±0.55 | <0.001 |
| **Albumin** | 3.1±0.32 | 4.5±0.22 | <0.001 |
| **Cholesterol** | 117.0±17.0 | 127.0±17.6 | 0.004 |

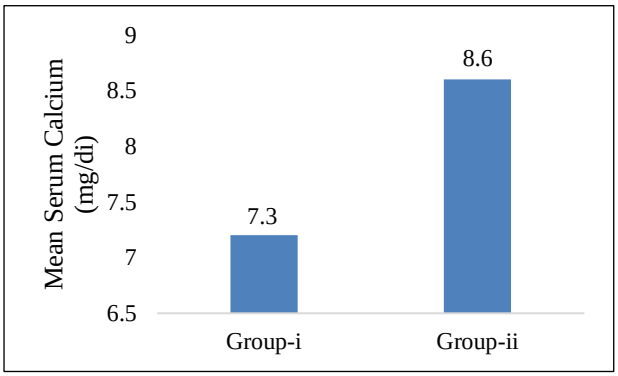


**Figure 1: Comparison of mean serum calcium between groups.**

This Figure 1 shows that the mean serum calcium level in Group I (case) was significantly lower than in Group II (control).

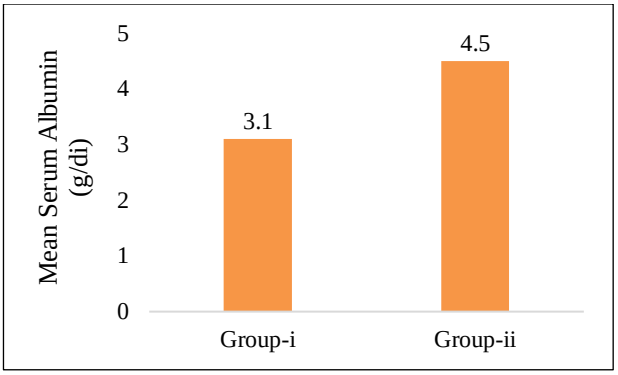


**Figure 2: Comparison of mean albumin between groups.**

This Figure 2 illustrates that the mean serum albumin level in Group I (case) was significantly lower than in Group II (control).

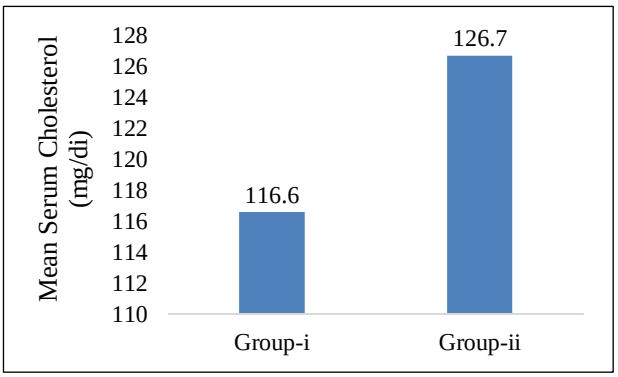


**Figure 3: Comparison of mean serum cholesterol between groups.**

This Figure 3 demonstrates that the mean serum cholesterol level in Group I (case) was significantly lower than in Group II (control).

## DISCUSSION

This cross-sectional study aimed to compare plasma calcium, albumin, and total cholesterol levels between severely malnourished and healthy children in Bangladesh. conducted at the Department of Biochemistry, Mymensingh Medical College, in collaboration with the Departments of Pediatrics at Mymensingh Medical College & Hospital and Community Based Medical College Bangladesh, the study drew participants from the local community of Mymensingh Sadar. A total of 120 subjects were included in this investigation, providing a comprehensive overview of the nutritional status of children in the region.

Our findings indicate that the mean weight of Group I (case) was significantly lower (p<0.001) compared to Group II (control). Specifically, the mean weight for Group I was 10.70±2.20 kg, while Group II had a mean weight of 14.30±2.30 kg. This substantial difference

underscores the impact of malnutrition on the growth and development of children in the case group, suggesting a correlation between malnutrition and reduced body weight. The results imply that children in Group I may be experiencing significant nutritional deficiencies, which could adversely affect their overall health and growth outcomes.

In our study, the serum albumin level in the study group was significantly ($p<0.05$) lower than in the control group. This finding aligns with the work of Rahman et al, Chowdhury et al, Frenk et al, and Kalra et al, who reported that serum albumin values in all grades of Protein Energy Malnutrition (PEM) are significantly lower than in normal children, attributing this reduction to generalized protein deficiency and inadequate dietary intake.[15-18] Our results also support findings from Kumer et al, who suggested that low plasma albumin concentrations in the final stages of PEM can arise due to a protein-deficient diet.[19] Additionally, Osifo et al reinforced that the reduction of serum albumin and total protein in PEM results from decreased protein synthesis due to inadequate intake.[20] Conversely, Iputo et al noted that intestinal protein loss does not significantly contribute to edema in severe PEM, with hypoalbuminemia possible in PEM children without edema.[21] Another study showed marked hypoalbuminemia in severe PEM, with total albumin mass potentially reduced by 50%.[22]

Moreover, our study revealed that the mean serum calcium level in the case group was significantly ($p<0.05$) lower than in the control group. This result is consistent with findings from Frenk et al and Mishra et al, who reported hypocalcemia in children with PEM.[17,23] Said et al found that calcium levels decrease in plasma but may be elevated in red blood cells.[24] Other studies have noted that hypocalcemia occurs in both kwashiorkor and marasmus, particularly in cases of kwashiorkor, with total calcium concentrations decreased but ionized serum calcium levels remaining normal.[25] This suggests that the protein-bound fraction of calcium is significantly affected in malnourished children. Nakamoto et al emphasized that the calcium complex fraction, which includes calcium bound to proteins and inorganic salts, is the primary compartment altered in the malnourished group.[26] However, our findings contradict those of Rao et al, who reported no significant changes in calcium levels in malnourished children compared to controls.[27]

These findings highlight the critical need for targeted nutritional interventions to address the deficiencies observed in severely malnourished children. By improving dietary intake and monitoring key nutritional parameters, we can enhance the overall health and developmental outcomes of vulnerable populations in Bangladesh.

This study had several limitations. Small sample size due to time constraints. Limited resources affecting the scope of the study. Findings may not be generalizable due to the specific population studied. Lack of advanced techniques and technologies in the analysis.

## CONCLUSION

This study compared plasma calcium, albumin, and total cholesterol levels between severely malnourished and healthy children in Bangladesh. The results showed that mean serum calcium, albumin, and total cholesterol levels were significantly lower ($p<0.05$) in severely malnourished children compared to healthy controls. These findings highlight the nutritional deficiencies faced by malnourished children, suggesting the need for targeted interventions to address these deficits and support their growth and development.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethics Committee*

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**Cite this article as:** Paul AR, Shahidullah ASM, Sen B, Tumpa MP, Farzana S, Suny NS. Comparison of plasma calcium, albumin, and total cholesterol in severely malnourished vs. healthy children in Bangladesh: a case-control study. Int J Res Med Sci 2024;12:4439-43.