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Correlation of Thyroid Hormone Profile with Severity of Malnutrition among Children Admitted to a Tertiary Care Hospital

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ABSTRACT

Background: Malnutrition remains a major public health problem among children in developing countries and is associated with significant metabolic and endocrine alterations. Thyroid hormones play a vital role in growth, development, and energy metabolism, and their levels may be influenced by the severity of malnutrition. This study aimed to assess the thyroid hormone profile and its correlation with the severity of malnutrition among children admitted to a tertiary care hospital.

Methods: A prospective observational study was conducted among 110 malnourished children aged 6 months to 5 years admitted to the Department of Pediatrics, S.N.R. District Hospital, Kolar, Karnataka. Demographic details, clinical features, and anthropometric measurements were recorded. Serum triiodothyronine (T3), thyroxine (T4), thyroid-stimulating hormone (TSH), total protein, and albumin levels were estimated using standard laboratory methods. Pearson's correlation coefficient was used to determine the association between the severity of malnutrition and biochemical parameters.

Results: The majority of children belonged to the 2–4 years age group (46.36%), with a nearly equal distribution of males (50.91%) and females (49.09%). Moderate malnutrition was observed in 56.36% of participants, while 43.64% had severe malnutrition. Psychomotor changes were the most common clinical feature (82.73%). The mean serum T3, T4, and TSH levels were 100.01 ± 12.72 ng/dL, 5.57 ± 1.90 µg/dL, and 1.99 ± 0.88 mIU/L, respectively. Mean total protein and serum albumin levels were 4.44 ± 0.63 g/dL and 2.73 ± 0.47 g/dL. A significant positive correlation was observed between the severity of malnutrition and serum T3 ($r = 0.661$, $p < 0.001$), total protein ($r = 0.677$, $p < 0.001$), and serum albumin ($r = 0.545$, $p < 0.001$), whereas T4 and TSH showed no significant correlation.

Conclusion: Malnutrition is associated with significant alterations in serum T3, total protein, and albumin levels. Serum T3 appears to be the thyroid hormone most closely associated with the severity of malnutrition and may serve as a useful biochemical marker for evaluating metabolic adaptation in malnourished children.

Keywords: *Malnutrition.*

INTRODUCTION

Malnutrition remains one of the most important public health challenges affecting children worldwide and is a leading contributor to childhood morbidity and mortality, particularly in low- and middle-income countries. According to the World Health Organization (WHO), malnutrition encompasses deficiencies, excesses, or imbalances in energy and nutrient intake. In children, undernutrition manifests as wasting, stunting, underweight, and micronutrient deficiencies, all of which adversely affect growth, cognitive development, immune function, and survival. Globally, an estimated 149 million children under five years of age were stunted, 45 million were wasted, and nearly half of all deaths among children under five were associated with undernutrition.[1 2]

India continues to bear one of the highest burdens of childhood malnutrition despite significant improvements in maternal and child health services. Malnutrition predisposes children to recurrent infections, delayed psychomotor development, impaired physical growth, and poor neurocognitive outcomes. The adverse consequences extend beyond childhood, resulting in reduced educational attainment, diminished work productivity, and an increased risk of chronic non-communicable diseases later in life.[1 2]

The endocrine system undergoes several adaptive changes during prolonged nutritional deprivation to conserve energy and maintain essential physiological functions. Among these adaptations, alterations in thyroid hormone metabolism are particularly important because thyroid hormones regulate basal metabolic rate, thermogenesis, protein synthesis, tissue growth, and neurological development. During starvation and protein-energy malnutrition, peripheral conversion of thyroxine (T4) to the biologically active triiodothyronine (T3) decreases due to reduced activity of type I deiodinase, resulting in the characteristic "low T3 syndrome" or non-thyroidal illness syndrome. This adaptive response lowers energy expenditure and helps preserve body protein stores during periods of nutritional stress.[3 4]

Several clinical studies have demonstrated altered thyroid hormone concentrations in malnourished children. The most consistent biochemical abnormality is a reduction in serum T3 concentration, whereas serum T4 may remain normal or show only a mild decline and thyroid-stimulating hormone (TSH) generally remains within the normal reference range. These hormonal changes are considered adaptive rather than indicative of primary thyroid gland dysfunction. Nevertheless, persistent reductions in circulating thyroid hormones may adversely influence linear growth, skeletal maturation, neurodevelopment, immune competence, and metabolic homeostasis in growing children.[3–5]

Protein-energy malnutrition is also associated with reduced serum total protein and albumin concentrations owing to inadequate dietary intake, impaired hepatic protein synthesis, increased protein catabolism, and recurrent infections. Since more than 99% of circulating thyroid hormones are protein-bound, hypoalbuminemia and hypoproteinemia may influence thyroid hormone transport and metabolism. Previous investigators have reported positive correlations between serum T3 concentrations and serum protein or albumin levels, suggesting that deterioration in nutritional status is accompanied by progressive endocrine and biochemical alterations.[5–7]

Although thyroid function abnormalities in malnutrition have been investigated in different populations, published data remain limited and variable, particularly from Indian tertiary care hospitals. Regional differences in dietary practices, socioeconomic status, infection burden, and severity of malnutrition may influence endocrine responses, highlighting the need for locally generated evidence. Understanding the relationship between thyroid hormone profile and the severity of malnutrition may improve knowledge of the metabolic adaptations occurring during nutritional deprivation and contribute to comprehensive clinical evaluation of malnourished children. Therefore, the present study was undertaken to determine serum T3, T4, and TSH levels, estimate serum total protein and albumin concentrations, and evaluate their correlation with the severity of malnutrition among children admitted to a tertiary care hospital.

METHODOLOGY

A prospective observational study was conducted in the Department of Pediatrics, S.N.R. District Hospital, Kolar, Karnataka, over a period of 18 months after obtaining approval from the Institutional Ethics Committee. A total of 110 malnourished children aged 6 months to 5 years admitted during the study period were enrolled after obtaining written informed consent from their parents or legal guardians.

Children diagnosed with moderate acute malnutrition (MAM) or severe acute malnutrition (SAM) according to the World Health Organization (WHO) criteria were included. Children with known thyroid disorders, congenital hypothyroidism, chronic systemic illnesses, or those receiving medications affecting thyroid function were excluded.

Demographic details and clinical findings were recorded using a predesigned proforma. Anthropometric assessment was performed according to WHO guidelines, and children were categorized based on the severity of malnutrition. Venous blood samples were collected before initiation of nutritional rehabilitation for estimation of serum triiodothyronine (T3), thyroxine (T4), thyroid-stimulating hormone (TSH), total protein, and serum albumin using standard laboratory methods.

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 22.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean ± standard deviation. Pearson's correlation coefficient was used to assess the relationship between the severity of malnutrition and biochemical parameters. A p value of <0.05 was considered statistically significant.

RESULT

Table 1. Demographic characteristics of the study participants (n = 110)

Variable	Category	n	%
Age (years)	<2	18	16.36

	2–4	51	46.36
	>4	41	37.27
Gender	Male	56	50.91
	Female	54	49.09

Table 2. Distribution of patients according to clinical features (n = 110)

Clinical feature	n	%
Psychomotor changes	91	82.73
Tremors	25	22.73
Skin changes	15	13.64
Coldness of extremities	15	13.64
Hypotonia	14	12.73
Constipation	3	2.73

Table 3. Severity of malnutrition and thyroid profile among the study participants (n = 110)

Variable	Value
Severity of malnutrition	
Moderate malnutrition	62 (56.36%)
Severe malnutrition	48 (43.64%)
Biochemical parameters (Mean ± SD)	
Serum T3 (ng/dL)	100.01 ± 12.72
Serum T4 (µg/dL)	5.57 ± 1.90
Serum TSH (mIU/L)	1.99 ± 0.88
Total protein (g/dL)	4.44 ± 0.63
Serum albumin (g/dL)	2.73 ± 0.47

Table 4. Correlation between severity of malnutrition and biochemical parameters (n = 110)

Parameter	Correlation coefficient (r)	p value
Serum T3	0.661	<0.001*
Serum T4	-0.161	0.094
Serum TSH	-0.075	0.436
Total protein	0.677	<0.001*
Serum albumin	0.545	<0.001*

Significant at $p < 0.05$.

The majority of the study participants belonged to the 2–4 years age group, and the distribution of males and females was nearly equal, indicating a balanced representation of both sexes among malnourished children included in the study.

Psychomotor changes were the most common clinical manifestation observed among the study participants, while constipation was the least frequent. Tremors, skin changes, coldness of extremities, and hypotonia were observed in a smaller proportion of children, reflecting the diverse clinical presentation of malnutrition.

Moderate malnutrition was more prevalent than severe malnutrition in the study population. The thyroid hormone profile and biochemical parameters demonstrated alterations consistent with the metabolic adaptations associated with malnutrition, with reduced serum protein and albumin levels reflecting compromised nutritional status.

A significant positive correlation was observed between the severity of malnutrition and serum T3, total protein, and serum albumin levels, whereas serum T4 and TSH showed no statistically significant correlation. These findings suggest that serum T3, total protein, and albumin are more closely associated with the severity of malnutrition than T4 and TSH.

DISCUSSION

Malnutrition remains a significant public health concern in developing countries, particularly among children under five years of age, owing to its adverse effects on growth, immunity, metabolism, and neurodevelopment.[1,2] The present study evaluated the thyroid hormone profile and its correlation with the severity of malnutrition among children admitted to a tertiary care hospital. More than half of the participants had moderate malnutrition, while the remaining children had severe malnutrition, highlighting the substantial burden of undernutrition requiring hospital-based management.

The majority of the study participants belonged to the 2–4 years age group, with an almost equal distribution of males and females. Similar demographic findings have been reported by Chandrashekaraiah et al. and Mehta et al., who also observed that malnutrition commonly affects preschool-aged children without a significant gender predominance.[6,7] This age group

is particularly vulnerable because of rapid growth, increased nutritional requirements, recurrent infections, and inappropriate complementary feeding practices.[1,2]

Psychomotor changes were the predominant clinical manifestation observed in the present study, followed by tremors, skin changes, coldness of extremities, and hypotonia. These findings reflect the multisystem effects of prolonged nutritional deficiency and are consistent with the well-recognized clinical manifestations of protein-energy malnutrition. Chronic undernutrition affects the nervous system, skeletal muscles, and skin, resulting in delayed development, muscle weakness, and impaired neurological function.[3,8]

The present study demonstrated altered thyroid hormone levels among malnourished children. The mean serum T3 level was reduced, whereas T4 and TSH remained within relatively preserved ranges. These findings support the concept of the "low T3 syndrome" or non-thyroidal illness syndrome, which represents an adaptive physiological response to nutritional deprivation. During starvation, peripheral conversion of T4 to T3 decreases due to reduced deiodinase activity, thereby lowering basal metabolic rate and conserving energy.[3,4] Similar observations have been reported by Chandrashekaraiah et al., Mehta et al., and Sultan et al., who demonstrated significantly lower T3 concentrations among children with severe acute malnutrition compared with controls or moderately malnourished children.[6,7,9]

Serum total protein and albumin concentrations were also reduced in the present study, reflecting impaired protein synthesis and inadequate nutritional intake. Protein deficiency is a characteristic feature of malnutrition and contributes to edema, impaired immune function, delayed wound healing, and altered transport of circulating hormones. Because thyroid hormones circulate predominantly bound to plasma proteins, hypoalbuminemia may further influence thyroid hormone transport and metabolism.[3,5] Previous investigators have similarly reported significantly lower serum protein and albumin concentrations in children with severe acute malnutrition, supporting the present findings.[6,9]

Correlation analysis demonstrated a significant association between the severity of malnutrition and serum T3, total protein, and albumin levels, whereas serum T4 and TSH did not show statistically significant correlations. These observations suggest that serum T3 is more sensitive to worsening nutritional status than T4 or TSH. Similar findings have been reported by Meena et al. and Chandrashekaraiah et al., who observed significant correlations between declining T3 concentrations and reduced serum protein or albumin levels in malnourished children.[6,10] The absence of a significant relationship between T4 or TSH and malnutrition severity further supports the hypothesis that thyroid gland function is generally preserved and that alterations primarily occur at the level of peripheral hormone metabolism.

The findings of the present study emphasize that thyroid function abnormalities observed in malnutrition are predominantly adaptive rather than indicative of primary thyroid disease. Recognition of these biochemical alterations is important because unnecessary thyroid hormone replacement should be avoided in the absence of true hypothyroidism. Instead, correction of nutritional deficiencies through appropriate nutritional rehabilitation remains the cornerstone of management.[3,4] Assessment of thyroid hormone profile, together with serum protein and albumin levels, may provide useful information regarding the metabolic response to severe malnutrition and the overall nutritional status of affected children.

CONCLUSION

The present study demonstrated that malnutrition is associated with significant alterations in thyroid hormone profile, particularly reduced serum T3 levels, along with decreased serum total protein and albumin concentrations. A significant correlation was observed between the severity of malnutrition and serum T3, total protein, and albumin, whereas serum T4 and TSH did not show significant associations. These findings suggest that serum T3 is the thyroid hormone most closely related to the severity of malnutrition and reflects the adaptive metabolic response to nutritional deprivation. Assessment of thyroid function, especially serum T3, along with nutritional biomarkers may aid in the comprehensive evaluation of malnourished children. Early identification and appropriate nutritional rehabilitation remain essential for improving clinical outcomes and minimizing the long-term consequences of childhood malnutrition.[1,3,6]

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