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Alterations in Thyroid Hormone Levels in Children with Protein-Energy Malnutrition

Prabita D Oinam[1], Paras S Takhelmayum[2], Diana D Wahengbam[3], Marcony Moirangthem[4*], Amuba S Maisnam[5]

[1,2,3,4,5]Department of Biochemistry, Shija Academy of Health Sciences, Imphal, Manipur, India

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***Corresponding author**:
Dr. Marcony Moirangthem
(Email: marconymeetei@gmail.com)

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ABSTRACT

Background: Nutritional deficiencies are among the most significant public health challenges in India and other developing nations. Among those nutritional diseases, the Protein Energy Malnutrition (PEM) is the most prevalent one, affecting a large population especially children under five and is a major cause of morbidity and mortality. Aims and Objectives: To estimate serum total thyroxine (TT4), total tri-iodothyronine (TT3), thyroid stimulating hormones (TSH) in normal controls and children with PEM. To find out relationship between thyroid hormones and different grades of PEM.

Methodology: Fifty children below 12 years of age suffering from different grades of protein energy malnutrition admitted in Pediatric ward, RIMS, Imphal, were selected as cases. Fifty healthy children, closely matched for age and gender, formed the control group. The study was carried out over a 24-month period, beginning in September 2016 and concluding in August 2018. Total thyroxine (TT4) and total trio-iodothyronine (TT3) were estimated by ELISA.

Results: Serum thyroid hormones (TT3, TT4 and TSH) were significantly decreased in PEM when compared with controls. Among the different grades of PEM, total tri-iodothyronine (TT3) level was significantly low in Marasmic kwashiorkor children (0.61±0.14) whereas undernutrition group has the lowest value of Total Thyroxine (5.31±0.65) and TSH (1.60±0.81).

Conclusion: A decrease in circulating thyroid hormone levels was linked to the severity of PEM. All the PEM cases should undergo a screening for thyroid hormone status which is essential for proper growth and health of the children.

Keywords: Protein energy malnutrition, Thyroid hormones, Marasmus, Kwashiorkor

INTRODUCTION

Malnutrition is a condition of inadequate or improper nutrition, resulting from deficient consumption of calories, protein, minerals, vitamins, superimposed with recurrent infection. It has become an urgent global health issue, disabling or killing millions of children every year.[1] When compared with children having optimal nutrition, children with severe malnutrition have higher risk of dying.[2] Immunological responses are reduced during states of undernutrition, predisposing to infections, which again worsen undernutrition.[3] It serves as both an etiological factor and an outcome of disease.[4] Malnutrition is a term, used to describe Protein Energy malnutrition (PEM). Severe manifestations include marasmus, kwashiorkor, and marasmic kwashiorkor.[5] In PEM, the disproportion in the amount of energy and protein available with the requirement of the body causes

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malnutrition in the form of wasting, stunting and underweight.[6] Worldwide, about 162 million children are suffering from various forms of PEM and approximately 3 million deaths in children under the age of 5 years is attributable to PEM.[7] According to the National Family Health Survey-4 (2015-16), India has the highest rate of stunting. In 2015-16, 21 %, 38.4 % and 35.8% of children were found to be wasted, stunted and underweight respectively.[8]

Thyroid hormone has an important role in the regulation of carbohydrate and lipid metabolism and is also necessary for normal growth and maturation. Lack of thyroid hormone can lead to impaired cognitive development and stunted growth.[9] In PEM, a variety of endocrine abnormalities have been reported, such as changes in insulin, glucocorticoids, growth and thyroid hormones. There are distinct alterations in the thyroid gland structure and in metabolism and secretion of thyroid hormones. When the body experiences a reduction in calorie intake, it initiates a series of adaptations, one of which is a decrease in the activity of the gland.[10]

Although it is known that PEM can cause a variety of issues with how the thyroid gland works, the precise nature of this connection is still unclear. This includes the specific mechanisms involved, the direction of the relationship (whether PEM causes thyroid problems or vice versa), and the extent to which other factors might be involved. Researchers have conducted a number of studies to measure and analyze specific biochemical markers in individuals suffering from PEM. However, few studies have been conducted to see the correlation between serum thyroid hormone levels and serum protein in children with PEM in the North Eastern part of India. This study was undertaken to understand the relationship between thyroid function and nutritional status by measuring serum thyroid hormones and protein levels in children with PEM.

MATERIALS AND METHODS

A cross-sectional hospital-based case control study was carried out in the Department of Biochemistry in collaboration with the Department of Pediatrics, Regional Institute of Medical Sciences, Manipur, India from September 2016 to August 2018.

A total of 50 children below 12 years of age suffering from different grades of protein energy malnutrition who were admitted in the Pediatric ward, RIMS were taken as cases. Fifty healthy children who visited pediatric OPD, closely matched for age and gender, formed the control group. Patients having edema of cardiac and renal origin, liver diseases were excluded from the study.

Classification of PEM was done by Welcome or International Classification of PEM:

Bodyweight between 60-80 % of expected
Without Oedema – undernutrition
With Oedema – kwashiorkor

Bodyweight below 60% of expected
Without Oedema – Nutritional Marasmus
With Oedema – Marasmic kwashiorkor

Consent was taken from the parents or guardian after proper explanation. Approval for the study protocol was granted by the Institutional Ethics Committee of RIMS, Imphal. Blood samples were collected in plain vial within 18 hours of admission and centrifuged at 700 g X 30 minutes and the sera thus separated were used for estimation of the analytes. Thyroid stimulating hormone (TSH), total thyroxine (TT4) and total tri-iodothyronine (TT3) were estimated by ELISA. An automated analyzer was employed to measure the concentrations of total protein and albumin in the serum samples. Statistical analyses were carried out in IBM SPSS (Version 11.5).

Data are presented as mean ± standard deviation (SD) for continuous variables and as percentages for categorical variables.

To compare thyroid hormone levels between the PEM and control groups, student's t-tests were used for normally distributed data.

RESULTS

This study consisted of 100 children in total, in which 50 were suffering from protein energy malnutrition and 50 were healthy controls. The distribution of participants by sex and religion for both the control and PEM groups is shown in Table 1. Maximum number of cases were females (68%) and from Hindu community (62%). Majority of cases in the present study (table 2) belonged to nutritional marasmus, followed by undernutrition, kwashiorkor and marasmic kwashiorkor. Maximum number of PEM cases was in the age group 1 to 9 yrs.

As is evident from table 3, serum thyroid hormone (TT3, TT4) and TSH levels are significantly decreased in PEM when compared to controls. Serum total protein, albumin and globulin levels were also lowered significantly in cases than controls. Table 4 shows that among the different grades of PEM, total tri-iodothyronine (TT3) level was significantly low in children suffering from marasmic kwashiorkor whereas undernutrition group has the lowest value of total thyroxine (TT4) and thyroid stimulating hormone (TSH). Total protein, albumin and globulin (table 5) were decreased significantly in all grades of PEM. Lowest value of total protein was found in children suffering from marasmic kwashiorkor.

Table 1: Sex and religion wise distribution of control and PEM cases

Variables	Control n (%)	PEM n (%)
Male	22 (44)	16 (32)
Female	28 (56)	34 (68)
Hindu	27 (54)	31 (62)
Muslim	11 (22)	8 (16)
Christian	12 (24)	11 (22)

Table 2: Age wise distribution of control and different types of PEM

Age (yrs)	Control (%) (n=50)	PEM (n=50)			
		Undernutrition (%) (n=11)	Kwashiorkor (%) (n=10)	Nutritional marasmus (%) (n=21)	Marasmic kwashiorkor (%) (n=8)
Upto 1 yr	10 (20)	1 (9)	0	2 (9.5)	2 (25)
>1- 3yrs	15 (30)	5 (45.5)	7 (70)	4 (19.1)	4 (50)
>3-6 yrs	13 (26)	2 (18.2)	1 (10)	10 (47.6)	1 (12.5)
>6-9 yrs	9 (18)	3 (27.3)	2 (20)	2 (9.5)	1 (12.5)
>9 yr	3 (6)	0	0	3 (14.3)	0

Table 3: Biochemical parameters in control and PEM cases (Mean ± SD)

Parameters	Control	PEM
TT3 (ng/ml)	1.38 ± 0.31	0.76 ± 0.24
TT4 (µg/dl)	8.37 ± 1.07	5.55 ± 0.76
TSH (IU/ml)	3.76 ± 0.51	1.68 ± 0.71
S. Total Protein (gm/dl)	6.36 ± 0.32	4.67 ± 0.52
S. Albumin (gm/dl)	4.02 ± 0.41	2.83 ± 0.23
S. Globulin (gm/dl)	2.43 ± 0.27	1.92 ± 0.49

*P value <0.001

Table 4: Thyroid hormones in different grades of PEM (Mean ± SD)

Thyroid hormones	Undernutrition	Kwashiorkor	Nutritional Marasmus	Marasmic Kwashiorkor
TT3 (ng/ml)	0.85 ± 0.13	0.87 ± 0.28	0.80 ± 0.17	0.61 ± 0.14*
TT4 (µg/dl)	5.31 ± 0.65*	5.45 ± 0.72	5.61 ± 0.78	5.57 ± 0.82
TSH (IU/ml)	1.60 ± 0.81*	1.65 ± 0.51	1.88 ± 0.42	1.81 ± 0.39

*P <0.001

Table 5: Distribution of serum proteins in different grades of malnutrition

Parameters (mean ± SD)	Undernutrition	Kwashiorkor	Nutritional Marasmus	Marasmic Kwashiorkor
Total protein	5.11 ± 0.41	4.67 ± 0.49	5.15 ± 0.52	4.17 ± 0.14
Serum Albumin	3.21 ± 0.35	2.77 ± 0.22	3.12 ± 0.14	2.81 ± 0.07
Serum Globulin	1.98 ± 0.21	1.87 ± 0.67	2.19 ± 0.55	1.65 ± 0.72

*P <0.001

Table 6: Correlation between TT3 and total protein in PEM cases

TT3 levels	Mean Serum Total Protein
Upto 0.4 ng/ml	4.98 ± 0.46
>0.4 – 0.8 ng/ml	4.95 ± 0.61
>0.8 – 1.2 ng/ml	5.22 ± 0.46
>1.2 – 1.6 ng/ml	5.75 ± 1.16
>1.6 – 2.0 ng/ml	0
>2.0 ng/ml	0

Correlation coefficient (r) = 0.34; *P >0.05

In our study, out of the 50 PEM cases, male constitute 32% and female 68% showing that PEM occurs both in male and female, but higher female prevalence may be because of better care given to male child. Similar higher prevalence rate among females was also observed by Venkatesha KR et al. [12]

Our study shows significant reduction in the mean levels of T3, T4 and TSH in cases when compared with controls. Similar findings were reported by Kumar S et al and Abrol P et al. [13,14] Gupta S et al also reported significantly lower levels of T3 and T4 in their cross sectional study. [15] Protein-energy malnutrition significantly affects the structure and function of the thyroid gland, leading to various adverse outcomes. [9]

Positive correlation was seen between TT3 level and serum total protein (r=0.34) however this finding was not significant (P >0.001).

DISCUSSION

PEM represents a serious public health burden in India. Preschool children (under 5 years) are most severely affected, experiencing devastating consequences such as stunted physical and cognitive development, and a weakened immune system.[11]

Reduced T3 levels in children suffering from PEM are likely attributed to several factors: decreased binding proteins, impaired liver function leading to diminished peripheral conversion of T4 to T3. Increased corticosteroids, frequently observed in malnourished children, inhibit the 5' deiodinase system, leading to decreased T3 levels. Reduced levels of T4 in children with PEM may be attributed to decreased thyroid hormone secretion, depleted reserves of thyroid hormone, and impaired compensatory mechanisms. [15]

Lazarus M et al and Kumar S et al in their study found that with increasing severity of malnutrition, the serum concentration of T3 progressively decreased. [14,17] Similar observation was seen in our study where children suffering from marasmic kwashiorkor have lowest value of mean T3 level.

In this study, we observed that serum total protein, globulin and albumin levels were significantly lower in children with PEM than controls, which are in accordance with the findings of Sah SP et al, Mishra SK et al and Adegbusi HS et al.[17-19] This could result from insufficient protein intake and decreased production. In

the study conducted by Chandrashekaraiah S et al, low albumin concentration was significantly associated with low T3 level in PEM.[20] Our study shows a positive correlation between mean T3 levels and mean total protein level in cases. Protein-energy malnutrition (PEM) results in diminished synthesis of serum proteins, exerting both direct and indirect influences on circulating hormone levels. In children experiencing protein-energy malnutrition (PEM), circulating concentrations of thyroxine-binding globulin (TBG), thyroxine-binding prealbumin (TBPA), and albumin are markedly reduced. Concomitantly, significant dysregulation of thyroid hormone secretion and metabolism, as well as structural changes within the thyroid gland, are observed. This leads to a decrease in thyroid gland activity, consequently resulting in reduced levels of total triiodothyronine (TT3) and total thyroxine (TT4).[20]

The study delves into the connection between thyroid function and protein status in protein-energy malnutrition (PEM), a significant global health issue. Understanding this relationship could lead to improved diagnosis and management of PEM, especially in children. While the study may show a correlation between thyroid status and serum protein levels in PEM, it might not establish a definitive cause-and-effect relationship. Other factors, such as underlying medical conditions, and micronutrient deficiencies, could influence the results and need to be carefully considered.

CONCLUSION

Our study shows that there is a change in circulating thyroid hormone levels in PEM and different levels of thyroid hormones are significantly correlated with severity of PEM. The cause may be lack of proteins which are responsible for the production, transportation of thyroid hormones. All PEM cases should undergo a screening for thyroid hormone status which is essential for proper growth and health of the children.

Author Contribution: OPD contributed to data collection, analysis, and interpretation, as well as manuscript preparation. **TPS** was involved in study design, data collection, analysis, and interpretation. **WDD** participated in data collection, analysis, and manuscript preparation. **MM** was responsible for the study design, data collection, and manuscript preparation. **MAS** contributed to the study conception, study design, and manuscript preparation.

The study protocol was reviewed and approved by the Institutional Ethics Committee of RIMS, Manipur.

REFERENCES

1. Vinod V Bagilkar, Bharatesh B Savadatti. A descriptive study on Malnutrition. Asian J. Nursing Edu. and Research. 2015;5(1):72-77. DOI: https://doi.org/10.5958/2349-2996.2015.00016.6
2. Caulfield LE, de Onis M, Blössner M, et al. Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria, and measles. Am J Clin Nutrition. 2004;80(1):193-8. DOI: https://doi.org/10.1093/ajcn/80.1.193 PMid:15213048
3. Ramachandran P, Gopalan HS. Undernutrition & risk of infections in preschool children. Indian Journal of Medical Research. 2009; 130(5):579-83.
4. Saunders J, Smith T. Malnutrition: causes and consequences. Clin Med (Lond). 2010 Dec;10(6):624-627. DOI: https://doi.org/10.7861/clinmedicine.10-6-624 PMid:21413492 PMCid:PMC4951875
5. Collins S, Dent N, Binns P, et al. Management of severe acute malnutrition in children. Lancet. 2006;368(9551):1992-2000. DOI: https://doi.org/10.1016/S0140-6736(06)69443-9 PMid:17141707
6. De Onis M, Blossner M. WHO global database on child growth and malnutrition. World Health Organization; 1997.
7. Sandeep M, Krishnamurthy B. Thyroid hormone status in children with protein energy malnutrition. Int J Contemp Pediatr. 2016 Feb; 3(1):193-199. DOI: https://doi.org/10.18203/2349-3291.ijcp20160158
8. Satapathy A, Satapathy A, Rout DS, et al. Prevalence of Protein Energy Malnutrition among Under-five children in Odisha: A Review. The Journal of Phytopharmacology. 2021; 10(4):272-276. DOI: https://doi.org/10.31254/phyto.2021.10410
9. Barrett KE, Barman SM, Boitano S, et al. The thyroid gland. In: Ganong's review of Medical Physiology. 23rd ed. New York: McGraw-Hill; 2010:301-14.
10. Valinjkar SK, Sutay NR, Prachi, et al. Thyroid Status and Serum Protein Levels in Severe and Moderate Acute Malnourished Children. Journal of Medical Science and Clinical Research. 2016 ;4(1):9059-9067.
11. Chatterjee R, Sethi AS, Verma M, et al. Study of plasma proteins (serum total protein, serum albumin), and thyroid function in children with protein-energy malnutrition. Int J Contemp Pediatr. 2023;10:1572-6. DOI: https://doi.org/10.18203/2349-3291.ijcp20232886
12. Venkatesha KR, Naik RR. Prevalence of protein energy malnutrition among children: a cross-sectional study. Int J Contemp Pediatr. 2019;6:329-32. DOI: https://doi.org/10.18203/2349-3291.ijcp20190679
13. Abrol P, Verma A, Hooda HS. Thyroid hormone status in protein energy malnutrition in Indian children. Indian J Clin Biochem. 2001;16(2):221-3. DOI: https://doi.org/10.1007/BF02864867
14. Kumar S, Nadkarni J, Dwivedi R. Thyroid hormone status in malnourished children. Indian Pediatr. 2009;46(3):263-4.
15. Gupta S, Chaurasiya OS. Evaluation of thyroid functions in severely malnourished children. International Journal of Research and Review. 2019;6(6):199-202.
16. Lazarus M, Kashyap AK, Borkar R, et al. Study of thyroid profile in malnourished children (6 months - 5 years) admitted in the nutritional rehabilitation centre and paediatric ward NSCB Medical College Jabalpur, India. Int J Contemp Pediatr. 2018;5:1072-7. DOI: https://doi.org/10.18203/2349-3291.ijcp20181545
17. Sah SP, Arora M, Kumar S, et al. Effect of PEM on thyroid status, serum total protein and A/G ratio in pre-school going children. Int J Res Med Sci. 2017;5:4486-9. DOI: https://doi.org/10.18203/2320-6012.ijrms20174582
18. Adegbusi H, Sule MS. Anthropometric and biochemical assessment among under five children in Kusada local government area, Katsina state, Nigeria. Bajopas. 2011;4(2):137-40. DOI: https://doi.org/10.4314/bajopas.v4i2.27
19. Mishra SK, Bastola SP, Jha B. Biochemical nutritional indicators in children with protein energy malnutrition attending Kanti Children Hospital, Kathmandu, Nepal. Kathmandu Univ Med J. 2009;7(26): 129-34. DOI: https://doi.org/10.3126/kumj.v7i2.2705
20. Chandrashekaraiah S, Ratageri VH, Kamat L. Thyroid status in children with severe acute malnutrition. Karnataka Paediatr J. 2021; 36: 165-8. DOI: https://doi.org/10.25259/KPJ_13_2021