Original Article

BONE PROFILE AND NUTRITIONAL PARAMETERS IN NORMAL AND β-THALASSEMIA MAJOR CHILDREN

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ABSTRACT

Objectives: To compare and correlate bone density parameters and nutritional status parameters in 5-11 years old normal and β-thalassemia major children.

Material and Methods: In this cross-sectional comparative study, 65 apparently healthy children from govt. schools and 65 β-thalassemia major children from thalassemia departments of local hospitals were included. Their age was 5-11 years. All children were examined for nutritional data. Height, weight, BMI, midarm circumference, subscapular and triceps skinfold thickness were calculated and recorded using Herpenden caliper and anthropometric measurements. Quantitative ultrasound bone dimensions i.e. Z-score, Amplitude dependent swiftness of sound (Ad-SOS) and bone transduction time (BTT) were used to assess bone health of both groups of children i.e. subjects and healthy controls.

Results: A total of 130 children (65 healthy and 65 β-thalassemia major) were assessed for bone health (Quantitative ultrasound) and nutritional status (weight, height, BMI, triceps, subscapular and midarm circumference). It was observed that bone profile and nutritional parameters were significantly reduced in β-thalassemia major children. Noteworthy positive association of Ad-SOS was detected with height and weight. Similarly, substantial encouraging connection of BTT was noticed with weight, height and midarm circumference in β-thalassemia major children.

Conclusion: This study highlights the role of nutrition in improving the health of β-thalassemia major children. It is the need of the hour to improve the quality of life of thalassemia children by providing adequate nutrition.

Key Words: β-thalassemia major, Bone health, Nutrition.

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INTRODUCTION

Disorders of Hemoglobin are the most common clinically serious single gene disorders in the world [1]. β-thalassemia major is a group of congenital autosomal recessive disorders. They are caused by reduced (β+) or absent (β_0) synthesis of β chains of hemoglobin tetramers. This leads to imbalanced α/non-α globin chain synthesis that results in variable product ranging from severe anemia to clinically asymptomatic individuals [2]. Thalassemia patients are linked with several other disorders. This is due to ineffective erythropoiesis and accelerated red cell turnover due to the short life span of red blood cell and ultimately causes iron overload that deposit in bone marrow, liver, heart and endocrine glands [3].

It also marks an accelerated demand of energy and nutrients to uphold normal erythropoiesis [4, 5]. Therefore, the nutritional status is becoming progressively significant. Patients with thalassemia commonly exhibit poor growth, decreased bone mineralization, reduced immune function and an increased oxidative stress. All these indispositions link to poor nutritional status [6, 7, 8]. Hansen *et al*. (1991) reported that the important determinants of osteoporosis later in life are peak bone mass at the end of puberty and subsequent bone loss [9]. Bone mass increase in boys at the age of 13 to 17 years and in girls at the age of 11 to 13 years [10]. Studies done by Voskaridou *et al*. (2001) and Lasco *et al*. (2002) have also demonstrated that increase resorption phase and decrease or normal bone formation phase led to imbalance in bone turn over in thalassemia [11,12]. So, alteration in peak bone mass due to growth retardation may lead to development of low bone mineral density (BMD) in thalassemia [13].

MATERIAL AND METHODS:

This cross-sectional comparative study was done at Department of Physiology and Cell Biology, University of Health Sciences (UHS), Lahore. In the present study, a total of 130 children were recruited. Out of 130, 65 β-thalassemia major children from thalassemia departments of local hospitals and 65

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apparently healthy children from govt. schools, age 5-11 years, were selected. Written informed consent was taken from the parents. The study protocol was approved by ethical review committee of the University.

All children were examined for nutritional data. Height, weight, BMI, midarm length, triceps and subscapular skinfold thickness were recorded using herpenden caliper and standard anthropometric measurements.

Bone profile dimensions i.e. BTT, Z-score, Ad-SOS were used to assess bone health of children (subjects and healthy controls). These parameters were automatically calculated by the device.

Amplitude dependent speed of sound (Ad-SOS): The finger width in meter by time of flight in seconds. The reading is documented when the signal is beyond 2mV of amplitude. Bone density increase with the value of Ad-SOS [14].

Z-Score: It is calculated by subtracting measured speed from normal average speed divided by value of standard deviation in m/sec. Z-score less than or equal to -2.0 indicate low bone density for gender, age and body size [15].

Bone transmission time (BTT): BTT (µsec) tends to reduce the confounding soft tissue effect. It is calculated by subtracting the arrival time of the ultrasound pulse through soft tissue and the receiving probe's arrival time of the fastest ultrasound pulse, through bone tissue. BTT increases, as the cortical area of bone increases [14].

Statistical analysis: The data were analyzed by means of Package for Social Sciences (SPSS) version 20.0 and Anthroplus WHO software. Mean ± Standard Deviation (SD) was used for parametric variables and Median ± Inter Quartile Range (IQR) was used for non-parametric variables. Shapiro-Wilk's test checks the normality of data. If *p*-value was $\leq$ 0.05, data is distributed non-normally. Student "t" test was applied to normally distributed variables. Mann-Whitney U test was used in non-normal distribution in two groups. Significant results were noted when *p*-value was $\leq$ 0.05.

RESULTS

The result of the comparison of Bone Profile parameters are given in Table 1. Comparison of nutritional parameters are given in Table 2. The correlation matrix of bone profile with nutritional parameters in β-thalassemia major children is given in Table 3.

1. Weight, height, triceps, subscapular and midarm circumference were significantly reduced in β-thalassemia major children (p< 0.001).
2. BTT is also reduced significantly in β-thalassemia major children as compared to normal children (p=0.012).
3. Significant positive correlation of Ad-SOS with weight (r = 0.332) and height (0.553) was observed in β-thalassemia major children.
4. Similarly, positive correlation of BTT with weight (r = 0.576), height (0.716) and midarm circumference (0.271) was observed in β-thalassemia major children.

Table-1: Comparison of Bone Profile parameters in apparently healthy and β-thalassemia major children.

Bone Profile Parameters (n=65)	Healthy children	β-thalassemia major children
	Mean ± SD	Mean ± SD
Ad-SOS (m/sec)	1906.86 ± 49.53	1893.62 ± 57.88
BTT (µsec)	0.79 ± 0.20	0.70 ± 0.20
Bone Profile z-Score	-0.44 ± 1.22	-0.11 ± 1.62

[a] p-value created by Mann-Whitney U Test; [b] p-value created by Independent Sample "t"-Test

Table-2: Relationship of nutritional factors in apparently healthy and β-thalassemia major children.

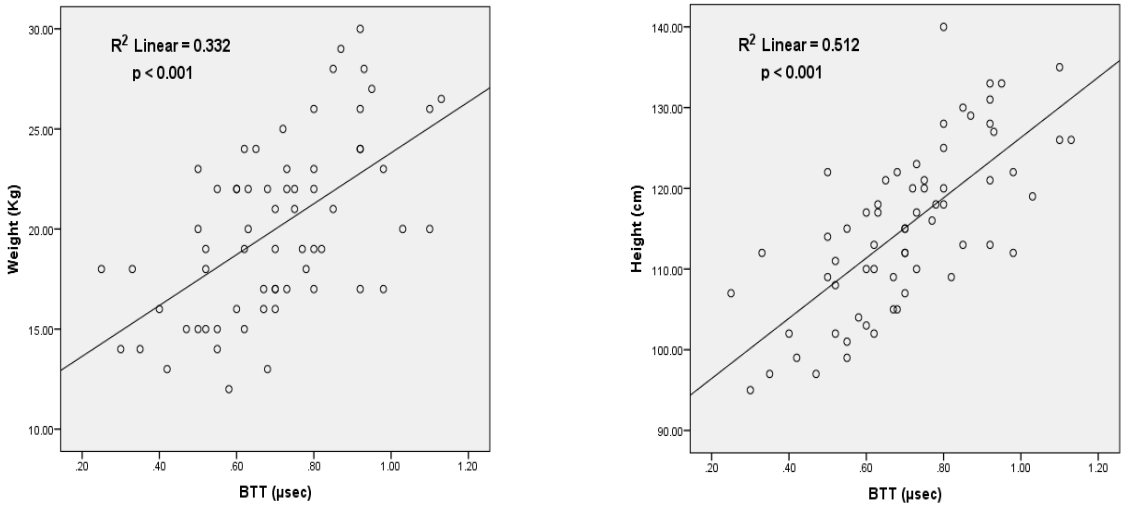
Nutritional Parameters (n=65)	Apparently healthy children	β-thalassemia major children	p-value
	Mean ± SD	Mean ± SD	
Weight (kg)	25.83±6.12	20.04±4.35	<0.001[b]
Height (cm)	130.45±11.26	115.23±10.29	<0.001[b]
BMI	14.95±1.68	14.94±1.76	0.951[b]
Triceps Skin Fold Thickness (mm)	6.56±2.44	11.35±5.06	<0.001[a]
Subscapular Skin Fold Thickness (mm)	5.10±1.93	6.13±1.94	0.001[a]
Midarm Circumference (cm)	17.82±2.09	11.45±6.06	<0.001[a]

[a]p-value observed by Mann-Whitney U Test; [b]p-value generated by Independent Sample "t"-Test

Table-3: Correlation matrix of bone profile with nutritional parameters in β-thalassemia major children.

Parameters		Nutritional Parameters					
Bone Profile Parameters		**Weight (kg)**	**Height (cm)**	**BMI**	**Triceps Skinfold (mm)**	**Subscapular Thickness (mm)**	**Midarm Boundary (cm)**
Ad-SOS (m/sec)	r / rho	0.332[a]	0.553[a]	-0.202[a]	-0.002[b]	0.087[b]	0.155[b]
	p-value	0.007	<0.001	0.107	0.989	0.493	0.217
BTT (µsec)	r / rho	0.576[a]	0.716[a]	-0.007[a]	-0.089[b]	0.069[b]	0.271[b]
	p-value	<0.001	<0.001	0.956	0.482	0.587	0.029
Bone Profile Z-Score	r / rho	0.060[a]	0.159[a]	-0.132[a]	-0.090[b]	-0.050[b]	0.053[b]
	p-value	0.637	0.207	0.293	0.478	0.695	0.676

[a] Correlation (r) and p-values by Pearson coefficient; [b] Coefficient (rho) and p-values are produced by Spearman's Rho



Weight Height

Figure-1: Significant positive correlation of BTT with weight and height in β-thalassemia major children.

DISCUSSION

Thalassemia is the most common genetic blood disorders of the world. Nearly, 4.83 percent of the world's population carry globin variants [16], and nearly 200,000 thalassemia major patients were registered with Thalassemia International Federation [17].

The present study included 130 children (65 apparently healthy and 65 β-thalassemia major children). These children were studied for bone status and nutritional parameters i.e. Ad-SOS, BTT, bone profile Z-score and weight, height, BMI, triceps, subscapular and midarm circumference.

Bone transmission time is significantly reduced in β-thalassemia major children in our study. Baroncelli *et al*. (2003) have also shown lower Bone mineral density in patients with bone and mineral disorders [18]. Karimi et al. (2007) also demonstrated decline in Bone mineral density in thalassemia as compared to normal controls [19]. Work done by Meena et al. (2015) have shown significant decrease in Bone density in thalassemics as compared to normal controls [20]. Increased bone marrow erythropoiesis leads to bone changes in thalassemia. Extensive iron deposition leads to expansion of marrow cavities and reduced trabecular bone volume. This leads to decreased bone tissue and ultimately osteoporosis [21].

In the current study, we noticed a significant reduction in nutritional parameters in β-thalassemia cases. Moiz et al 2017. also observed delayed growth in cases of transfusion-dependent thalassemia. This impairment results from iron overload. The growth impairment increased with increasing age [22]. An Egyptian study reported, height and weight z-scores of <−2 in 49 and 47% patients, respectively [23]. While stunting of growth initiates in early age it progresses as the years advance [24]. MRI studies of pituitary gland revealed that iron accumulation may start as early as four years of age in patients of thalassemia major [25, 26].

Hence growth failure is a noteworthy challenge in β-thalassemia major children which needs to be simultaneously addressed as it negatively affects their quality of life. There is scarcity of data from Asian countries which highlights the

issue of growth failure in peadiatric population with thalassemia major.

CONCLUSION:

Our study concluded that thalassemic children have poor nutrition and growth stunting. Malnutrition affects the growth, development, efficacy of management, treatment and quality of life in children suffering from thalassemia.

AUTHORS CONTRIBUTION

Hira Sohail: Literature Review, Final review and approval, Data collection

Aamenah Malik: Statistical and result analysis.

Khalid Parvez Lone: Proof Reading and overall supervision.

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