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The Effect of Anthropometry on Refractive Error and Ocular Biometry in Children with β-Thalassemia Major

Aryani Atyatul Amra[1]*, Fithria Aldy[1], Bidasari Lubis[2], Elyani Rahman[1]

[1]*Department of Ophthalmology, Faculty of Medicine, University of Sumatera Utara, Medan, Indonesia;* [2]*Department of Paediatrics, Faculty of Medicine, University of Sumatera Utara, Medan, Indonesia*

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***Correspondence:** Aryani Atiyatul Amra, Department of Ophthalmology, Faculty of Medicine, University of Sumatera Utara, Indonesia. E-mail: aryani@usu.ac.id
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Abstract

AIM: The objective of the study was to evaluate the effect of anthropometry on refractive error and ocular biometry in children with β-thalassemia major.

METHOD: This study was an analytical observational with a cross-sectional design which conducted in 1 day care thalassemia pediatric Department and Ophthalmology Department of North Sumatera University Hospital from February to April 2019. The study included 44 children with β-thalassemia major.

RESULTS: Anthropometric analysis of refractive errors did not show a significant correlation, whereas anthropometric analysis on biometry showed a significant correlation between height and axial length of the right eye ($p = 0.004$) and left eye ($p = 0.043$), then showed significant correlations between height and anterior chamber depth of the right eye ($p = 0.027$) and left eye ($p = 0.016$).

CONCLUSION: Height affects the axial length and anterior chamber depth, but there are no anthropometric variables that affect refractive errors in this study.

Introduction

Thalassemia is a hemoglobinopathy characterized by impaired production of α-chains and β-globin chains. Epidemiologically, β-thalassemia is the most common type of thalassemia (with an incidence of up to 14% in some populations) that is inherited in an autosomal recessive [1]. It has been recorded that around 56,000 babies are born every year in the world with β-thalassemia major [2]. The career thalassemia frequency in Indonesia ranges 3–10% [3].

Patients with β-thalassemia major are always accompanied by growth disorders. This condition causes a characteristic growths disorder in the craniofacial bones and long bones. Ocular growth is closely related to orbital bone growth [4]. A study conducted in Australia involving 1765 children in the age group between 6 and 13 years explained that there was a significant difference between height and axial length, where the taller children had eyes with longer axial lengths [5]. An observational study conducted in Medan involving 34 children with β-thalassemia major and 34 normal children showed a significant difference regarding anterior chamber depth and lens thickness, whereas children with β-thalassemia major had a shallower anterior chamber depth and thicker lens thickness. However, there was no significant difference in axial length [6]. Biometric differences found in children with β-thalassemia major became the basis for researchers to assess the presence or absence of accompanying refractive errors.

Methods

This was an observational analytic with a cross-sectional study comprising 44 pediatric patients. This study was performed in 1 Day Care Thalassemia Pediatric Department and Ophthalmology Department of North Sumatera University Hospital, from February 2019 to April 2019. This research was approved by the PPKRM ethics committee meeting, Faculty of Medicine, University of Sumatera Utara. The inclusion criteria in this study were children aged between 6 and 18 years who received repeated blood transfusions. The exclusion criteria were pediatric patients with the other blood disorder besides thalassemia, anterior segment disorder, and posterior segment diseases and uncooperative pediatric patients. All participants underwent bodyweight measurement, height measurement, body mass index, and then plotting curves to CDC charts and head circumference and also plotting curves to Nellhaus charts. All participants underwent ophthalmic examination, including visual acuity (VA) examination using Snellen charts and assessment of the subjective refractive abnormalities by trial and error, assessment of anterior segment and posterior segment, and assessment of axial length, anterior chamber depth, and lens thickness using Tomey AL-100 biometry. The data were analyzed using the Chi-square test. If the expected count <5 was not found, the Fisher's exact test was to be used.

Results and Discussion

Demographic data (Table 1) showed 23 subjects (52.3%) within 6–11 years old, 23 subjects (52.3%) were male, and 30 subjects (68.2%) were Javanese. There were 38 right eyes (86.4%) and 36 left eyes (81.8%) with VA 6/9.5–6/19.

Table 1: Subject characteristics

Characteristics	Total	%
Age		
6–11 years old	23	52.3
12–18 years old	21	47.7
Gender		
Male	23	52.3
Female	21	47.7
Ethnic group		
Javanese	30	68.2
Acehnese	4	9.1
Minangkabau	3	6.7
Malays	1	2.3
Tionghoa	1	2.3
Karo	3	6.8
Mandailing	1	2.3
Sundanese	1	2.3
Visual acuity OD (VOD)		
6/3.8–6/7.5	5	11.3
6/9.5–6/19	38	86.4
6/24–6/48	1	2.3
Visual acuity OS (VOS)		
6/3.8–6/7.5	7	15.9
6/9.5–6/19	36	81.8
6/24–6/48	1	2.3
Diagnosis of the right eye		
Emmetropia	5	11.3
Myopia	28	63.7
Hypermetropia	3	6.8
Astigmatism	8	18.2
Diagnosis of the left eye		
Emmetropia	7	15.9
Myopia	23	52.3
Hypermetropia	2	4.5
Astigmatism	12	27.3

Based on the diagnosis, the most common diagnosis was myopia in both eyes, which was found in 28 subjects (63.7%) in the right eye and 23 subjects (52.3%) in the left eye. Table 2 shows a significant correlation between height and axial length of the right eye (p = 0.004) and the left eye (p = 0.043). However, there was no significant correlation between bodyweight, head circumference, and body mass index with axial length.

The previous studies have explained a significant difference in β-thalassemia major children's weight compared to normal children, but this difference does not necessarily affect axial length in β-thalassemia major children [5]. A study conducted by Amini *et al*. in Iran explained that β-thalassemia major children found significant cephalometric changes when compared to normal children, following the pattern of Class II malocclusion. However, the study did not compare the orbital space dimensions, so the changes in orbital space volume in β-thalassemia major children cannot be assessed [7]. Table 3 shows a significant correlation between height and anterior chamber depth of the right eye (p = 0.027) and the left eye (p = 0.016). However, no significant correlation found between bodyweight, head circumference, and body mass index to anterior chamber depth in β-thalassemia major children. The study by Jonas *et al.* in India found a significant correlation between height and anterior chamber depth. They found the deeper anterior chamber depth in adult populations [8]. The study by Rahman *et al*. in Medan also found no significant difference in head circumference size in two populations. Head circumference was an anthropometric part that did not change in children with β-thalassemia major and that did not affect the anterior chamber depth [6]. Table 4 shows that there was no significant correlation between weight, height, head circumference, and body mass index with a lens thickness. It is similar with a study by Wahidiyat *et al*. weight and height in β-thalassemia major children did not have a significant correlation with a lens thickness [3]. Shih *et al*. found that lens thickness was strongly related to axial length, where axial length growth is only related to height [9]. Table 5 shows that there was no significant correlation between

Table 2: Relationship of anthropometry to axial length of the right eye and left eye in β-thalassemia major children

Anthropometry	Axial length OD		p-value	Axial length OS		p-value
	Normal	Abnormal		Normal	Abnormal	
	n (%)	n (%)			n (%)	
Weight						
Normal	7 (70)	3 (30)	0.133	8 (80)	2 (20)	0.068
Abnormal	16 (47)	18 (53)		16 (47.1)	18 (52.9)	
Height						
Normal	8 (100)	0 (0)	0.003*	7 (87.5)	1 (12.5)	0.043*
Abnormal	15 (41.7)	21 (58.3)		17 (47.2)	19 (52.8)	
Head circumference						
Normal	22 (52.4)	20 (47.6)	0.733	23 (54.8)	19 (45.2)	0.708
Abnormal	1 (50)	1 (50)		1 (50)	1 (50)	
BMI						
Normal	16 (66.7)	8 (33.3)	0.073	14 (58.3)	10 (41.7)	0.804
Abnormal	7 (35)	13 (65)		10 (50)	10 (50)	

Table 3: Relationship of anthropometry to anterior chamber depth of the right eye and left eye in β-thalassemia major children

Anthropometry	Anterior chamber depth OD		p-value	Anterior chamber depth OS		p-value
	Normal	Abnormal		Normal	Abnormal	
	n (%)	n (%)		n (%)	n (%)	
Weight						
Normal	2 (20)	8 (80)	0.415	5(50)	5 (50)	0.063
Abnormal	4 (11.8)	30 (88.2)		6 (17.6)	28 (82.4)	
Height						
Normal	1 (12.5)	7 (87.5)	0.023*	5 (62.5)	3 (37.5)	0.016*
Abnormal	5 (13.9)	31 (86.1)		6 (16.7)	30 (83.3)	
Head circumference						
Normal	5 (11.9)	37 (88.1)	0.257	10 (23.8)	32 (76.2)	0.442
Abnormal	1 (50)	1 (50)		1 (50)	1 (50)	
BMI						
Normal	4 (16.7)	20 (83.3)	0.425	8 (33.3)	16 (66.7)	0.294
Abnormal	2 (10)	18 (90)		3 (15)	17 (85)	

Table 4: Relationship of anthropometry to lens thickness of the right eye and left eye in β-thalassemia major children

Anthropometry	Lens thickness OD		p-value	Lens thickness OS		p-value
	Normal	Abnormal		Normal	Abnormal	
	n (%)	n (%)		n (%)	n (%)	
Weight						
Normal	1 (10)	9 (90)	0.330	4 (40)	6 (60)	0.200
Abnormal	8 (23.5)	26 (76.5)		7 (20.6)	27 (79.4)	
Height						
Normal	0 (0)	8 (100)	0.100	1 (12.5)	7 (87.5)	0.343
Abnormal	9 (25)	27 (75)		10 (27.8)	26 (72.2)	
Head circumference						
Normal	8 (19)	34 (81)	0.371	10 (23.8)	32 (76.2)	0.442
Abnormal	1 (50)	1 (50)		1 (50)	1 (50)	
BMI						
Normal	5 (20.8)	19 (79.2)	0.332	8 (33.3)	16 (66.7)	0.294
Abnormal	4 (20)	16 (80)		3 (15)	17 (85)	

Table 5: Relationship of anthropometry to myopia of the right eye and left eye in β-thalassemia major children

Anthropometry	Myopia OD		p-value	Myopia OS		p-value
	Yes	No		Yes	No	
	n (%)	n (%)		n (%)	n (%)	
Weight						
Normal	8 (80)	2 (20)	0.068	9(90)	1 (10)	0.091
Abnormal	16 (47.1)	18 (52.9)		11 (32.3)	23 (67.7)	
Height						
Normal	5 (62.5)	3 (37.5)	0.461	5 (62.5)	3 (37.5)	0.270
Abnormal	19 (52.8)	17 (47.2)		15 (41.6)	21 (58.4)	
Head circumference						
Normal	23 (54.8)	19 (45.2)	0.708	19 (45.2)	23 (54.8)	0.720
Abnormal	1 (50)	1 (50)		1 (50)	1 (50)	
BMI						
Normal	15 (62.5)	9 (37.5)	0.392	12 (50)	12 (50)	0.836
Abnormal	9 (45)	11 (55)		8 (40)	12 (60)	

Table 6: Relationship of anthropometry to hypermetropia of the right and left eyes in β-thalassemia major children

Anthropometry	Hypermetropia OD		p-value	Hypermetropia OS		p-value
	Yes	No		Yes	No	
	n (%)	n (%)		n (%)	n (%)	
Weight						
Normal	0 (0)	10 (100)	0.452	0 (0)	10 (100)	0.593
Abnormal	3 (8.8)	31 (91.2)		2 (5.9)	32 (94.1)	
Height						
Normal	0 (0)	8 (100)	0.539	0 (0)	8 (100)	0.666
Abnormal	3 (8.3)	33 (91.7)		2(5.6)	34 (94.4)	
Head circumference						
Normal	3 (7.1)	39 (92.9)	0.867	2 (4.8)	40 (95.2)	0.910
Abnormal	0 (0)	2 (100)		0 (0)	2 (100)	
BMI						
Normal	1 (4.2)	23 (95.8)	0.430	2 (8.3)	22 (91.7)	0.292
Abnormal	2 (10)	18(90)		0 (0)	20 (100)	

Table 7: Relationship of anthropometry to the right eye and left eye astigmatism in β-thalassemia major children

Anthropometry	Astigmatism OD		p-value	Astigmatism OS		p-value
	Yes	No		Yes	No	
	n (%)	n (%)		n (%)	n (%)	
Weight						
Normal	0 (0)	10 (100)	0.140	2 (20)	8 (80)	0.594
Abnormal	7 (20.6)	27 (79.4)		8(23.5)	26 (76.5)	
Height						
Normal	1 (12.5)	7 (87.5)	0.624	1 (12.5)	7 (87.5)	0.406
Abnormal	6 (16.7)	30 (83.3)		9 (25)	27 (75)	
Head circumference						
Normal	7 (16.7)	35 (83.3)	0.704	10 (23.8)	32 (76.2)	0.593
Abnormal	0 (0)	2 (100)		0 (0)	2 (100)	
BMI						
Normal	2 (8.3)	22 (91.7)	0.672	5 (20.8)	19 (79.2)	0.511
Abnormal	5 (25)	15 (75)		5 (25)	15 (75)	

bodyweight, height, head circumference, and body mass index with myopia. Many factors influenced the incidence of myopia in children. Axial length, axial length to corneal radius ratio, and environmental factors greatly influenced the incidence of myopia in children [10]. Myopia did not have a significant correlation with head circumferences in β-thalassemia major children. The study conducted by Rahman *et al*. in Medan explained that head circumference did not have a significant difference in β-thalassemia major children when compared to normal children [6]. Table 6 shows that there was no significant correlation between bodyweight, height, head circumference, and body mass index with hypermetropia. Hypermetropia did not have a significant correlation to bodyweight in β-thalassemia major children. This study has similar result with the previous study conducted in Sydney that explaining there was no relationship between bodyweight and hypermetropia in the normal child population [11]. Table 7 shows that there was no significant correlation between bodyweight, height, head circumference, and body mass index to astigmatism in β-thalassemia major children. This study was different from the previous study by Elkitkat *et al*. in Egypt that denoted that there was a relationship between height and the incidence of astigmatism in β-thalassemia major children [5]. This study also different from the study in Taiwan by Lai et al. explained the significant correlation between preschoolers with high body mass index and astigmatism. Lai *et al*. also found that obese children that have folds of fat in the upper eyelid will have pressure on the cornea, besides layer of fat that found in the periorbita. Those two factors and the shallower orbital space caused astigmatism in children with high body mass index [12].

Conclusion

There is a significant correlation between height and axial length, and also between height and anterior chamber depth in children with β-thalassemia major. Moreover, there is no correlation between bodyweight, head circumference, and body mass index with axial length, anterior chamber depth, lens thickness, the incidence of myopia, hypermetropia, and astigmatism in β-thalassemia major children.

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