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A Comparison of Intelligence Quotient in Children with and without β-Thalassemia Major

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Abstract

Background: Thalassemia is the most common hemoglobinopathy worldwide. Children with β-thalassemia major have several risk factors for cognitive problems. The aim of this study is to evaluate intelligence quotient in children with β-thalassemia major and healthy counterparts using Wechsler Intelligence Scale. **Materials and Methods:** Within a case-control design and using convenience sampling method, the present study was carried out in Zahedan and Shiraz in 2012. Participants were matched based on their age, gender and city of residence (40 children with β-thalassemia major and 40 healthy children aging 6 to 12 years. Wechsler Intelligence Scale Revised (WISC-R) was used to find the participants' Verbal Performance and Full intelligence scores. The scores of the two groups were then compared using descriptive analysis and independent t-test. **Results:** As compared with their healthy counterparts, children with β-thalassemia major had lower scores on both Verbal Scale and Full Scale ($P<0.01$); however, the difference between the two groups' scores on Performance Scale fell short of significance. **Conclusions:** Intelligence decline does not necessarily occur in children with β-thalassemia. They are just slightly lower than their healthy counterparts and they need to receive more attention in education in order to improve. **[GMJ.2015;4(4):130-31]**

Keywords: Thalassemia; β-Thalassemia; Intelligence Quotient; Cognitive Function; Children

Introduction

Thalassemia is the most common hereditary hemoglobinopathy worldwide and a major problem in our society and many other countries [1-4]. β -thalassemia is the most common type of thalassemia occurring in three forms: thalassemia minor, thalassemia intermedia and thalassemia major.

Children with β-thalassemia major suffer from severe anemia, and if not treated with blood, the disease will lead to heart failure and death in early childhood. During the first few months of life, β-thalassemia major which is often diagnosed in childhood shows itself with decrease in fetal hemoglobin levels on the one hand, and an increase in iron deposition in the blood on the other [4-7]. In children

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with β-thalassemia major, iron overload is the main cause of disorders in various organs [8]. Iron accumulation damages tissues at the end of the first decade of life and that is the time when a set of symptoms appears. These symptoms include impaired growth, hypothyroidism, adrenal insufficiency, cardiac and hepatic complications, hypoxemia, cognitive disorders in the central nervous system (CNS) and long-term brain injuries. Several studies examined the brain of thalassemic patients and reported higher iron deposition in their putamen, caudate nucleus, and motor and temporal cortices [9-13]. In addition to pain and discomfort related to treatment complications, the fact that these children are aware of their difference with other children may adversely affect the mood of school-age thalassemic children. Besides, the need for ongoing medical care may result in frequent absences from school and would weaken their academic performance [14, 15]. Due to iron overload in their brain, children with β-thalassemia are more likely to have disorders in their CNS; therefore, timely diagnosis along with adequate treatment for problems in their CNS comes critical to improving their intelligence and cognitive functions [12, 13]. According to Piaget's theory of cognitive development and assuming that biological principles governing the individuals' physical activities and growth can also be applied to their mental activity and growth, intellectual development follows a certain pattern and qualitative differences exist in the classification of cognition in thinking of children of all ages. In this theory, intelligence is thought as an adaptive process which requires a balance between organism and environment. Also, novel cognitive constructs and abilities, which require general factors emanating from social life, grow in accordance with growth and aging [16]. Confirming Piaget's findings about the influence of biological growth on one's performance, Ghasemzadeh's study revealed a relation between children's IQ, weight and head circumference [17]. In the literature, there are few studies on the Verbal, Performance and Full intelligences of children with β-thalassemia and healthy counterparts as a part of their cognitive perception. Such findings are generally contradictory and ambiguous. A number of studies suggest that Thalassemia causes cognitive disorders but other studies found that this disease has no impact on cognition or if there is any, it is very limited [13, 14, 18-21]. Based on the effect of thalassemia on the body and CNS and its crucial role in forming the person's thought and attention to the environment, the present study seeks to compare children with β-thalassemia major and normal counterparts in Verbal, Performance and Full intelligence quotients (IQs). While the areas of strengths and weaknesses of these children are identified, appropriate educational and rehabilitation strategies can be suggested.

Materials and Methods

Subject

Within a case-control design and through convenience sampling method, the present study was carried out in 2012. According to Duman *et al* [19] and Nevruz et.al [22], the sample size was estimated 40 participants in each group. 20 children with β-thalassemia major were selected from Ali Asghar Hospital in Zahedan and 20 children with β-thalassemia major were selected from Dastgheyb Hospital in Shiraz. The control group included 40 healthy children without any blood disease, selected out of four elementary schools in each city through convenience sampling method. They were then matched with the experimental group based on age, gender and city of residence. In each group, participants were categorized into four subgroups according to their gender and city of residence. In β-thalassemia major group, 20 children were selected from Zahedan (10 girls and 10 boys) and 20 children were selected from Shiraz (10 girls and 10 boys). Similarly, in healthy children group, 20 children were selected from Zahedan (10 girls and 10 boys) and 20 children from Shiraz (10 girls and 10 boys). All participants aged between 6 and 12 years. Children in β-thalassemia major group were receiving blood once a month regularly, and they were taking Deferoxamine as medication.

Data Collection

The present study was approved by the re-

search ethic committee of Zahedan University of Medical Sciences (code: 5819). After receiving participants' consent and following medical ethics, all participants were assessed physically, psychologically and intellectually in two separate sessions in order to bring research conditions under control. In the first session, Mini Mental Status Interview (MMSI) was performed by the researchers and nothing that might cause poor performance on the test (i.e. psychiatric disorder such as mood and anxiety disorders, physical disorders like neurological ones, alcohol or drug abuse, head trauma or medication) was observed among participants. The interview was done in the hospital with the experimental group and at school with the control group. In the second session, Wechsler Intelligence Scale Revised (WISC-R), which is made for children aging from 6 to 13, was administered in order to find Intelligence Quotient (IQ) of the two groups.

Wechsler Intelligence Scale Revised (WISC-R)
This test assesses the intelligence of children in three scales of Full IQ, Verbal IQ and Performance IQ using 6 Verbal Subscales (including Information, Digit Span, Vocabulary, Arithmetic, Comprehension and Similarities) and 6 Performance Subscales (including Picture Completion, Picture Arrangement, Block Design, Object Assembly, Symbol Search and Mazes), totally 12 subscales. Classification of intelligence into two main Verbal and Performance types is due to its diagnostic value and not due to existence of two different intelligence types. Verbal Scale of WISC-R IQ test includes 6 subtests or subscales as follows: (1) Information Subtest with 30 questions which measures the child's information and depends highly on the child's culture as well as his formal and informal education, (2) Digit Span Subtest with two parts: to repeat sequences of numbers either as heard or in reverse order, (3) Vocabulary Subtest with 32 items identifying the child's cognitive abilities, memory, information span and verbal reasoning, (4) Arithmetic Subtest with 18 questions on simple calculations, (5) Comprehension Subtest with 17 questions measuring child's understanding of social issues and (6) Similarities Subtest with 17 items measuring child's understanding of how two words are alike or similar. Similarly, Performance Scale includes 6 subtests or subscales as follows: (1) Picture Completion in which the child is shown artwork of common objects with an important missing part, and asked to identify the missing part, (2) Picture arrangement with 12 items. Each item consists of 3 to 5 cards containing pictures that are placed in front of the child in an incorrect order; the child must rearrange the pictures to tell the intended story within a limited time, both accuracy and speed are scored, (3) Block Design Subtest in which children put together red-and-white blocks in a pattern according to a printed red-and-white model. This subtest is also timed, (4) Object Assembly Subtest including four items, each item being a cut-up object like a puzzle. The child must correctly assemble the parts of a puzzle in a limited time, (5) Symbol Search Subtest with two forms: form A for children under 8 in which they mark rows of shapes with different lines according to a code, and form B for children over 8 in which they transcribe a digit-symbol code. This task is also time-limited, (6) Mazes Subtest with 11 square mazes presented to the child. The child must find the way out of the maze and draw lines at the time given. During 1982-1985, the test was translated into Farsi in Shiraz University and its psychometric properties were reported. Eleven tests out of twelve (except Vocabulary test) were translated into Farsi and those questions improper for Persian culture were identified and substituted with suitable equivalents after preliminary survey. However, the test instruction, the time for each subtest and scoring of responses did not change. Instead of mental age, deviated IQ was used to calculate IQ of Wechsler scale. Raw scores of WISC-R subtests (the scores given to the items according to participant's response) were converted to subtest scaled scores by referring to a table of score equivalents appropriate for examinee's age. Then, with a 4-month difference from each other, Verbal, Performance and Full IQs of each age group were found with a mean of 100 and standard deviation of 15. The reliability of tests and IQs was calculated using the methods of test-retest and split-half; the

median reliability coefficient of this test was 0.73. For the standard measure of validity, the correlation coefficient of subtests with each other and also with Verbal Performance, and Full IQs was used [23, 24].

Statistical Analysis

Statistical calculations were done on the scores of two groups and data were analyzed using SPSS-18 software. The results and goals were analyzed using descriptive tables and independent t-tests.

Results

In the present study, all participants were elementary school students, and aged between 6 and 12 years old. The mean and standard deviation of the age of children with β-thalassemia major was 9.57±1.33 and that of the healthy children was 9.5 ±1.31. Table 1 presents characteristics of the two groups according to gender and city of residence. Based on the results of WISC-R, the mean Verbal IQ in children with β-thalassemia and their normal counterparts were 96.27 ± 6.71 and 104.42 ± 6.38, respectively. The mean Performance IQ in children with β-thalassemia and their normal counterparts were 105.10 ± 4.80 and 105.40 ± 4.80, respectively; and the mean Full IQ in children with β-thalassemia and their normal counterparts were 101.27 ± 6.08 and 105.70 ± 5.65, respectively. Table 2 presents the mean, standard deviation, t-test results and the significance level of performance difference between children with and without β-thalassemia major in Wechsler subscales. As can be seen, there was no significant difference between the two groups in terms of Similarities (P= 0.63), Vocabulary (P= 0.53) and Block Design (P= 0.43), Subscales (P>0.05), while the performance of β-thalassemic children was significantly lower than that of healthy group in terms of Information (P= 0.001), Arithmetic (P= 0.001), Comprehension (P= 0.001), Digit Span (P= 0.001), Picture Completion (P= 0.001), Symbol Search (P= 0.008) and Mazes (P= 0.004) Subscales (P<0.01). However, children with β-thalassemia performed better than healthy children on Picture Arrangement (P= 0.001, P<0.01) and Object Assembly (P= 0.02, P<0.05). Furthermore, comparison of Verbal (P=0.001), Performance (P=0.82) and Full Iqs (P=0.001) between the two groups revealed that Verbal and Full IQs in β-thalassemic children were significantly lower than those of healthy children (P<0.01), but no significant difference was seen in their Performance IQ.

Table 1. Frequency Distribution of Participants according to Gender and City

Gender	City	ß-Thalassemic	Healthy counterparts
Girl (n=40)	Zahedan	10	10
	Shiraz	10	10
Boy (n=40)	Zahedan	10	10
	Shiraz	10	10
Total (Mean ± SD)		1.33±9.57	1.31±9.5

Discussion

The present study assessed the intelligence quotient of children with β-thalassemia major and healthy counterparts in terms of Full, Verbal and Performance Scales of IQ using 12 subscales of Wechsler IQ test for children. Results indicated that children with β-thalassemia major had lower performances in Full and Verbal IQs. But, according to mean scores of the two groups and Wechsler's views on IQ classifications, this downfall is not necessarily considered as serious. However, the two groups did not perform significantly different on Performance subscales. In his research on 7 to 15-year-olds, Duman reported that children with β-thalassemia major had lower scores than the control group in Full, Verbal and Performance scales of WISC-R test [19]. These findings are not consistent with the results of the present study about lower performance of children with β-thalassemia on the Performance Scale. Economou investigated the IQs of children with β-thalassemia major using WISC III and reported that those children had higher scores on Verbal Scale than Full and Performance Scales, and suggested that β-thalassemia potentially increased deficits in cognitive performance [14]. These findings about higher Verbal scale scores are

Table2. Comparison of IQs between β-thalassemic Major Children and their Healthy Counterparts in Wechsler Intelligence Scale

Subscale	ß - Thalassemic (n=40) Mean ± SD	Healthy counterparts (n=40) Mean ± SD	t test (independent t test)	P value
Information	8.37± (1.82)	10.65± (1)	-6.92	0.001*
Similarities	10.9 ± (1.66)	10.75± (1.12)	.47	0.63
Arithmetic	7.07± (1.62)	9.75± (1.17)	-8.45	0.001*
Vocabulary	10.55± (1.64)	10.77± (1.56)	-0.62	0.53
Comprehension	8.72± (1.54)	10.90± (1.14)	-6.48	0.001*
Digit span	7.85± (1.64)	9.45± (1.15)	-5.04	0.001*
Picture completion	8.95± (2.11)	10.9± (0.98)	-5.21	0.001*
Picture arrangement	12.1± (2.03)	10.50± (0.90)	4.54	0.001*
Block design	10.37± (1.37)	10.57± (0.84)	-0.78	0.43
Object assembly	11.35± (1.64)	10.70± (0.91)	2.22	0.02*
Symbol Search	8.92± (2.31)	10.05± (1.23)	-2.71	0.008*
Maze	9.25± (2.07)	10.40± (1.27)	-2.98	0.004*
Verbal intelligence	96.27± (6.71)	104.42± (6.38)	-5.56	0.001*
Performance intelligence	105.40± (7.17)	105.10± (4.80)	0.22	0.82
Full intelligence	101.27± (6.08)	105.70± (5.65)	-3.37	0.001*

* Significant

also inconsistent with the results of the present study. In another study, the IQs of neurologically intact adults with sickle cell anemia were assessed by Vichinsky using WAIS III, and it was reported that they had lower scores on Full, Verbal and Performance Scales of the test than the control group. These findings are consistent with the present study in terms of Verbal and Full intelligences but inconsistent in terms of Performance Scale [20]. Using WISC-III, Zafeiriou *et al*. concluded that sickle cell thalassemia did not necessarily endanger cognitive function of patients [21]. Karimi assessed IQs of β-thalassemia major patients and their healthy peers through Raven test and concluded that β-thalassemia major patients did not differ from their peers in IQ. These findings are in contrast with the results of the present study and other similar studies. The type of test used as the tool for cognitive evaluation by Karimi *et al*. can be one reason of different findings [18]. Canatan *et al*. conducted a research in Antalya on psychosocial burden of β-thalassemia major, and reported that academic problems were found in 60% of sample population of thalassemic children [25]. These problems indicate that there is an insufficient attention to the quality of education of these children. Regarding this study and previous ones and bearing in mind that in children with β-thalassemia major Verbal IQ score, which depends highly on education, linguistic and communication skills as well as general physical health is dropped, it can be concluded that children with β-thalassemia major need to receive more academic attention in order to improve their IQs. However, as children with β-thalassemia did not perform significantly different from healthy counterparts on the Performance Scale, it is put that these children do not need specific formal training for Performance IQ, and can have a normal and successful lives through interaction and adjustment with environment and common factors of social life; therefore, those children with valuable experience in social interactions are less likely to be damaged in this area [14-16]. However, due to their illness, children with β-thalassemia major are more likely to have disorders in their CNS

and timely diagnosis along with adequate treatment for problems in their CNS are critical to improving their intelligence and cognitive functions. Most of the studies suggest that Anemia can lead to hypoxia, iron deposition and long term brain injuries in people with thalassemia; however, there are few studies on brain impairments in the literature and the reported findings are generally contradictory [13, 14, 18-21]. Contradictions can be due to assessment tools, the extent to which the illness has affected body, social environment, the extent to which the patient is supported and primary individual differences. Metaferati confirmed the statements on the effect of thalassemia on CNS by reporting higher iron deposition in putamen, caudate nucleus, and motor and temporal cortices of thalassemic patients [13]. β-thalassemia major is often diagnosed in childhood and the treatment starts at the same time; however, unpleasant and long regimens used along with their increased life expectancy and prognosis in the middle age put patients and their families at risk for physical, emotional and behavioral problems [7]. That is why Pakbaz suggested that it was necessary to pay careful attention to the needs and life problems of patients with thalassemia and their families [26]. Therefore, considering several limitations of this study and relying just on primary biographic information and IQ assessment, the results should be interpreted and generalized with caution. Limitations may include: not having considered the age of treatment initiation and the amount of iron deposition in different brain parts and not having other cognitive parts such as Learning Disorders and academic improvements measured.

Conclusion

These findings suggest that in addition to the impact of disease on the patients' perception mechanisms, other factors such as primary learning situations, the impact of life experiences and individual differences on the way they respond to their environment are also possible determinants of how these patients perform differently from healthy control groups. Furthermore, their IQs would improve if children with β-thalassemia major received adequate training for increasing their apprehension and awareness. Much more research in this area needs to be carried out considering the mentioned limitations.

Conflicts of Interest

Authors declare that they do not have any conflicts of interest.

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