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The association between schoolchildren intelligence and refractive error

A. AKRAMI, N. BAKMOHAMMADI, M. SEYEDABADI*, I. NABIPOUR*, Z. MIRZAEI, S. FARROKHI*, M. ASSADI*

Department of Ophthalmology, School of Medicine, *The Persian Gulf Nuclear Medicine Research Center; Bushehr University of Medical Sciences, Bushehr (Iran)

Abstract. – PURPOSE, The relationship between refractory errors and intelligence and the importance of genetic, regional and environmental factors in such associations, were investigated in a group of school children.

SUBJECTS AND METHODS, One hundred and thirty-seven students (34.3% boys and 65.7% girls) from two primary schools were enrolled in the study. Cycloplegic refraction was performed and a spherical equivalent (SE) ≥ 0.5D were determined as hyperopia; <-0.5D myopia and <1 cyl D astigmatism. Demographic factors, parent's education level, teacher based assessment of school performance and average score were also evaluated.

RESULTS, Seventy-eight (56.9%) of subjects showed a form of refractory error; 27%, 3% and 2.9% were myope, hyperope or astigmat, respectively, whereas 12.4% of them had both myopia and astigmatism and 10.2% showed hyperopia and astigmatism; 43.1% were normal.

CONCLUSIONS, Although our data revealed no distinction of average score between normal group and myopia, hyperopia, astigmatism or hyperopia-astigmatism, there is a statistically significant difference between normal group and those who had both myopia and astigmatism in which the later had a lower mediocre. Our results is somehow in contrast with other parallel studies demonstrating that positive connection between school performance and myopia can be explained by the geographical or racial discrepancies as well as subjects involved in the study and divergent set of cut off limits.

Key Words:

Intelligence, Refractive error, Schoolchildren, Myopia, Hyperopia, Astigmatism.

Introduction

Refractory errors are among the most prevalent ocular disorders in paediatric ophthalmology; a considerable amount of studies have stated that refractive errors have a higher incidence in children with developmental delay[1-4]; Higher incidence of refractive errors particularly hyperopia and astigmatism in developmentally retarded children and the relations between low IQ and hyperopia as well as high IQ and myopia[5-7] have elicited the idea that school children must be screened for every potential refractory errors to determine whether or not they need a sort of special care. However, extreme myopia has been described to be associated with inferior IQ and genetic chromosomal syndromes[8] and the existence of such an association between myopia and higher IQ is denied by Young et al[9,10] who stated a possibility of better reading ability in myopic children which culminates in better school performance and higher marks in IQ tests.

School achievement is a cumulative outcome of academic and reading ability as well as IQ and perseverance and has been utilized to evaluate the correlation among refractory errors, near work activity and intelligence[11].

Based on the increasing curiosity toward the relationship between refractory errors and intelligence and the importance of genetic, regional and environmental factors in such associations, in this study we aimed to investigate the possible correlation of refractive errors with school grade in a group of school children.

Subjects and Methods

A total of 137 students (34.3% boys and 65.7% girls) from two primary schools who were doing either their forth (61.3% or fifth (47.4%) year in school were enrolled in the study. Children with severe medical conditions such as congenital heart disease, metabolic and hormonal disorders and chronic eye diseases such as congenital cataract were excluded.

Corresponding Author: Majid Assadi, MD; e-mail: assadipoya@yahoo.com, asadi@bpums.ac.ir

Demographic factors, parent's education level, teacher based assessment of school performance and average score were obtained using a questionnaire.

Cycloplegic refraction was performed as following: three drops of 1% cyclopentolate hydrochloride were administered with the intervals of 5 min to achieve a cycloplegic condition and refractory dimensions were then examined 30 min later using a closed-field autorefractors (model RK5; Canon Inc. Ltd, Tochigiken, Japan). The average of five consecutive measurements was applied to get a spherical equivalent (SE) and SE of at least 0.5 Dioptre was defined as refractory error [hyperopia (≥ 0.5D); myopia (< -0.5D); astigmatism (< 1 cyl D)].

Written consent was obtained from all parents and the study was performed in accordance with the tenets of Helsinki Declaration and was approved by the institutional Ethics Committee of Bushehr University of Medical Science.

Statistical Analysis

Data are presented as Mean ± SD with confidence interval (CI) given when appropriate. One-way analysis of variance (ANOVA) followed by Tukey test was applied to determine the possible differences of average score among the groups. Kruskal-Wallis non-parametric analysis of variance was applied to find the possible differences in teacher based school achievement. Spearman Rank Order Correlation was performed to find any correlation between sex and refractive disorders or a possible association between parents training level and school performance. A p value of less than 0.05 was considered statistically significant. SPSS for Windows software package, version 11.5 (Chicago, IL, USA) was used for statistical analysis.

Results

A total of 137 students (34.3% boys and 65.7% girls) from two primary schools, age between 10 to 14 years (10.4 ± 0.6) were included in the study.78 (56.9%) subjects with the above mentioned criteria were designated to have a form of refractory error in which 38 (27%), 5 (3%) and 4 (2.9%) of students were myope, hyperope or astigmat, respectively. 17 (12.4%) of subjects had both myopia and astigmatism and 14 (10.2%) of them showed hyperopia and astigmatism at the same time.

59 (43.1%) were normal.

Statistical analysis of data revealed no significant relationship between sex distribution and refractory errors. Spearman Rank Order Correlation revealed that there is a noteworthy correlation between father and mother education level and average scores. The average score of children whose paternal didactic level was reading and writing only (17.66 ± 2.45) observed to be obviously lower than whose father was highly educated (19.36 ± 1.05). The same result was observed when maternal training was taken in to account (18.00 ± 2.23 vs. 19.53 ± 1.46) ($p < 0.01$).

The average score of students involved in this study is summarized at Table I. The normal students average score (18.95 ± 1.5) was significantly higher than children with refractive errors (17.59 ± 2.44) ($p < 0.05$). Although our data showed any distinction of mediocre between normal group and myopia, hyperopia, astigmatism and hyperopia-astigmatism, there is a statistically significant disparity between normal group and those who had both myopia and astigmatism ($p < 0.05$) in which the later had a lower mediocre (18.96 ± 1.6 vs. 17.23 ± 3.1). On the other hand,

Table I. The distribution of subjects and their average score in different refractive categories.

	N	Frequency of sex distribution		Average score	SD	95% of confidence interval
		Boy	*Girl*			
Normal	59	43	16	18.9556	1.57643	18.5448-19.3664
Myopia	38	25	13	17.9934	2.09513	17.3048-18.6821
Hyperopia	5	5	0	18.58	1.16445	17.1341-20.0259
Astigmatism	4	2	2	17.1525	2.16629	13.7054-20.5996
Myopia+astigmatism	17	6	11	17.2347*	3.16271	15.6086-18.8608
Hyperopia+astigmatism	14	9	5	18.3693	2.80211	16.7514-19.9872

*$p < 0.05$.

teacher-based evaluation of school performance showed no conspicuous difference among the categorized groups ($p = 0.465$).

Discussion

There is a growing concern regarding a correlation between refractory errors and intelligence.

In 1959 Hirsch[12] proposed a four-item hypothesis which all discuss the probable reasons of upper school grade and intelligence quotient (IQ) in myopes. A comprehensive literature review by Czepita et al[5] concluded that children with myopia show a higher IQ level which is perhaps determined by genetic and environmental factors. They have also based on the previous studies stated that school children with myopia represents a better school performance regardless of their IQ, whereas hyperopic students have a lower IQ and get inferior school achievements. Nielsen et al[13] based on a clinical study of 1126 developmentally delayed children (IQ < 80) with divergent etiology in Denmark have described that visual impairment has a prevalence of 10.5%. In another cross sectional study[14] on 923 children they have found a correlation between lower IQ and refractive errors specially hyperopia, strabismus and reduced contrast sensitivity. However, the existence of such a relationship between myopia and higher IQ is denied by Young et al[9,10] that have proposed a possibility of better reading ability in myopic children which culminates in better school performance and higher outcomes in IQ tests.

Investigators all over the world utilize a variety of parameters to assess the connection between refraction and intelligence. While some of them apply IQ tests, near work activity, book reading per hour or week, others use school performance for such a purpose. School achievement is a cumulative outcome of academic and reading ability as well as IQ and perseverance and has been utilized to evaluate the correlation among refractory errors, near work activity and intelligence[11].

We did not observe any correlation between neither myopia and better school performance nor hyperopia and inferior school achievement. However, students who had both astigmatism and myopia showed a lower average score in comparison to those with typical visual condition. Our findings are in contrast with other reports in which they had found a positive and negative association between myopia and hyperopia with intelligence, respectively. Such an inconsistency might to some extent be explained by geographical and racial distinctions[14] as well as different sets of cut off for myopia and hyperopia[14]. We have determined a spherical error of less than -0.5 D as myopia, more than 0.5 as hyperopia and ≤ 1.0 cyl D for astigmatism, and concluded that there is no such a relation between myopia and higher intelligence or hyperopia and retardation, whereas Nielsen et al[13, 14] have taken a SE < -0.5 as myopia as well as SE > 3D as hyperopia and ≤ 1.0 cyl D for astigmatism, and reported a positive association of myopia and higher intelligence as well as hyperopia and lower IQ. With afore mentioned cut off limits we showed that 78 (56.9%) subjects were designated to have a form of refractory error while 59 (43.1%) were normal. The distribution of visual impairment in subcategories were 38 (27%), 5 (3%) and 4 (2.9%) myope, hyperope or astigmat, respectively. 17 (12.4%) of subjects had both myopia and astigmatism and 14 (10.2%) of them showed hyperopia and astigmatism at the same time. On the other hand Nielsen et al[13,14] have reported a significant hyperopia in 15.3%, myopia in 10.8%, and astigmatism in 20.6% of the subjects. However, the sample size and the subjects of study are also different: while we have evaluated the refractive errors on a normal society, Nielsen et al have examined a group of developmentally retarded students in special schools. Other sets of cut off have also been applied with a variety of investigators which have resulted in dissimilar outcomes[1,3,4,14,15]. It is also noteworthy to mention that only 5.1% of patients with refractive errors had been corrected while in other parallel studies almost all of the errors in subjects were modified which can to some extent explain our controversial results.

Age at time of assessment is another factor of importance which impinges the refraction. Subjects enrolled in our study had an age of 10 to 14 years (10.4 ± 0.6). It is described that the mean spherical equivalent declines in children aged 4-5 years to those aged 14-15 years[16]. The discrepancies in the age range may also be a reason behind our controversial results in comparison to the others.

Students who were suffering from both myopia and astigmatism showed a lower average score in comparison to normal group which can be as a consequence of difficulty in accommodation for reading.

Finally it concluded that we did not observe any contrast in normal group average score and myopia, hyperopia, astigmatism and hyperopia-astigmatism. However, there is a statistically considerable difference between normal group and children who had both myopia and astigmatism in which the later had a lower mediocre. Our results is somehow in contrast with other parallel works demonstrating that positive correlation of school performance with myopia can be explained by the geographical or racial discrepancies as well as subjects involved in the study and different sets of cut off limits.

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