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DAMIAN CZEPITA, EWA ŁODYGOWSKA[1], MACIEJ CZEPITA

ARE CHILDREN WITH MYOPIA MORE INTELLIGENT? A LITERATURE REVIEW

CZY DZIECI Z KRÓTKOWZROCZNOŚCIĄ SĄ BARDZIEJ INTELIGENTNE? PRZEGLĄD PIŚMIENNICTWA

Katedra i Klinika Okulistyki Pomorskiej Akademii Medycznej w Szczecinie
al. Powstańców Wlkp. 72, 70-111 Szczecin
Kierownik: prof. dr hab. n. med. *Danuta Karczewicz*

[1] Ośrodek Psychoterapii i Treningów Psychologicznych „Margo"
ul. Kaliny 7/27, 71-118 Szczecin
Kierownik: mgr *Ewa Łodygowska*

Streszczenie

Wstęp: Wady refrakcji są poważnym problemem całego świata. Do tej pory jedynie w kilku pracach opisano zależność pomiędzy wadami refrakcji a inteligencją. Jednak ze względu na rosnące zainteresowanie zależnością pomiędzy wadami refrakcji a ilorazem inteligencji (IQ) zdecydowano się na zaprezentowanie oraz omówienie wyników najnowszych badań klinicznych na ten temat.

Materiał i metody: Dokonano przeglądu piśmiennictwa na temat zależności pomiędzy wadami refrakcji i IQ.

Wyniki: W 1958 r. *Nadell* i *Hirsch* stwierdzili, że amerykańskie dzieci z krótkowzrocznością mają wyższy IQ. Podobną zależność opisali inni badacze z USA, Czech, Danii, Izraela, Nowej Zelandii i Singapuru. Zaobserwowano, że krótkowzroczne dzieci, niezależnie od IQ, uzyskują lepsze wyniki w szkole – tabela 1. Stwierdzono również, że dzieci z nadwzrocznością mają niższy IQ oraz uzyskują gorsze wyniki w szkole – tabela 2.

Opublikowano szereg hipotez tłumaczących zależność pomiędzy wadami refrakcji a inteligencją. Ostatnio *Saw i wsp.* stwierdzili, że wyższy IQ może występować u uczniów z krótkowzrocznością, niezależnie od ilości przeczytanych w tygodniu książek. Według nich „zależność pomiędzy genetycznie uwarunkowanym IQ oraz dziedzicznymi predyspozycjami do krótkowzroczności może być spowodowana plejotropiczną zależnością pomiędzy IQ i krótkowzrocznością, w której jeden czynnik wpływa na dwie cechy genetyczne. Być może podobne geny wpływają na wielkość lub wzrost oka (towarzyszące krótkowzroczności) oraz na wielkość *neocortex* (prawdopodobnie towarzyszące IQ)".

Wnioski: Przeprowadzone obserwacje kliniczne sugerują, że dzieci z krótkowzrocznością mogą mieć wyższy IQ. Prawdopodobnie jest to uwarunkowane genetycznie oraz środowiskowo.

H a s ł a: krótkowzroczność − nadwzroczność − iloraz inteligencji.

Summary

Purpose: Refractive errors are a serious worldwide problem. So far a few papers have described the relationship between refractive errors and intelligence. However, based on the growing interest into the relationship between refractive errors and intelligence quotient (IQ) we decided to present and discuss the latest results of the clinical studies on that subject.

Material and methods: A review of the literature concerning the relationship between refractive errors and IQ was done.

Results: In 1958 *Nadell* and *Hirsch* found that children in America with myopia have a higher IQ. A similar relationship has been described by other researchers from the USA, the Czech Republic, Denmark, Israel, New Zealand,

and Singapore. In other related studies, it was reported that myopic children regardless of their IQ gain better school achievements – table 1. It was also observed that schoolchildren with hyperopia have a lower IQ and gain worse school achievements – table 2.

Several hypotheses explaining the relationship between refractive errors and intelligence have been published. Recently, *Saw et al*. concluded that higher IQ may be associated with myopia, independent of books read per week, in schoolchildren. According to them „the association between genetically driven IQ and myopia of hereditary predisposition could be forged because of a pleiotropic relationship between IQ and myopia in which the same causal factor is reflected in both genetic traits. There may be similar genes affecting eye size or growth (associated with myopia) and neocortical size (possibly associated with IQ)".

Conclusions: The conducted clinical observations suggest that children with myopia may have a higher IQ. This relationship is most probably determined by genetic and environmental factors.

K e y w o r d s: myopia − hyperopia − intelligence quotient.

Introduction

Refractive errors are a serious worldwide problem [1, 2, 3, 4, 5]. *Czepita et al*. [6] found that 13% of Polish students in the age group from 6 to 18 years have myopia, 38% of students have hyperopia and 4% have astigmatism. So far a few papers have described the relationship between refractive errors and intelligence [7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22].

In 1958 *Nadell* and *Hirsch* [15] reported that children in America with myopia aged from 14 to 18 have a higher intelligence quotient (IQ). A similar relationship has been observed by other researchers from the USA [7, 11, 12], the Czech Republic [9], Denmark [20], Israel [16], New Zealand [10], and Singapore [17, 18].

Worth noting is the work of *Rosner* and *Belkin* [16], who stated a strong association of myopia with both intelligence and years of school attendance in a group of 157 748 males aged from 17 to 19 years. The prevalence of myopia was found to be significantly higher in the more intelligent and more educated groups. By fitting models of logistic regressions, they worked out a formula expressing the relationship among the rate of myopia, years of schooling, and intelligence level. *Rosner* and *Belkin* [16] concluded that years of schooling and intelligence weigh equally in the relationship with myopia.

However, *Young* [21, 22] in studies carried out on American schoolchildren did not describe this type of correlation. In other related studies, it was observed that myopic children regardless of their IQ gain better school achievements [7, 9, 10, 12, 16, 20, 21] – table 1.

A different relationship was found in children with hyperopia. *Nadell* and *Hirsch* [15] stated that American schoolchildren with hyperopia have a lower IQ. These findings were confirmed by other researchers from the USA [11], the Czech Republic [9], and New Zealand [10]. However, *Young* [21] did not report such a relationship. In addition, hyperopic children regardless of their IQ gain worse school achievements [10, 21] – table 2.

Based on the growing interest into the relationship between refractive errors and IQ we decided to present and discuss the latest results of the clinical studies on that subject.

Pathogenesis of myopia and hyperopia

Myopia is classified as axial myopia (when the axial length of the eyeball is increased) and refractive myopia (when the optic centers of the eye refract light too strongly). Based on clinical aspects myopia can be classified as high myopia (< -6 D) as well as low myopia (≥ -6 D). High myopia is genetically determined. Low myopia is mostly determined by environmental factors, especially by intensive visual near-work-reading, writing, working on a computer [1, 2, 3, 4, 5, 23].

Hyperopia is also classified as axial hyperopia (when the eyeball has a decreased axial length) and refractive hyperopia (when the optic centers of the eye refract light too weak). Hyperopia is mainly genetically determined. However, a higher prevalence among people who spend more time on visual far-work has been reported [1, 5, 23].

That is the reason why, it is currently believed that visual near-work may lead to the creation of myopia, while visual far-work may lead to the creation of hyperopia [1, 2, 3, 4, 5, 23]

Hypotheses

In 1959 *Hirsch* [11] examined four hypotheses concerning the relationship between intelligence test scores and refractive errors:

1. According to the first hypothesis myopia is an overdevelopment of the eye just as hyperopia is an underdevelopment, and ocular and cerebral development are related.
2. A second hypothesis assumes that intelligence test scores may be influenced by the amount of reading which a child does. The myopic child, better adapted for reading than for playing games, might do more reading and, hence, obtain a better intelligence test score: the hyperopic child, on the other hand, handicapped to some degree in reading, might read less, and, hence, make a lower score.
3. According to the third hypothesis the intelligence rather than refraction might determine the amount of reading done. The more intelligent child may read more, and thus become more myopic. The less intelligent child, on the other hand, might read less and, hence, avoid becoming myopic.

T a b l e 1. **Intelligence quotient (IQ) and school achievements in children with myopia**

T a b e l a 1. **Iloraz inteligencji (IQ) i osiągnięcia szkolne u dzieci z krótkowzrocznością**

Authors / Autorzy	Country / Kraj	N	Age (years) Wiek (lata)	IQ	School achievements Osiągnięcia szkolne
Young 1955	USA	633	6–17	average / przeciętny	
Nadell, *Hirsch* 1958	USA	414	14–18	higher / wyższy	
Hirsch 1959	USA	554	6–17	higher / wyższy	
Young 1963	USA	251	5–17	average / przeciętny	better / lepsze
Grosvenor 1970	New Zealand Nowa Zelandia	707	11–13	higher / wyższy	better / lepsze
Karlsson 1976	USA	2 527	17–18	higher / wyższy	better / lepsze
Benbow 1986	USA	416	13	higher / wyższy	better / lepsze
Rosner, *Belkin* 1987	Israel / Izrael	157 748	17–19	higher / wyższy	better / lepsze
Teasdale et al. 1988	Denmark / Dania	15 834	18	higher / wyższy	better / lepsze
Doležalová, *Mottlová* 1995	Czech Republic Czechy	30	14	higher / wyższy	
		195	15–18	higher / wyższy	better / lepsze
Saw et al. 2004	Singapore / Singapur	1 204	10–12	higher / wyższy	
Saw et al. 2006	Singapore / Singapur	994	7–9	higher / wyższy	

T a b l e 2. **Intelligence quotient (IQ) and school achievements in children with hyperopia**

T a b e l a 2. **Iloraz inteligencji (IQ) i osiągnięcia szkolne u dzieci z nadwzrocznością**

Authors / Autorzy	Country / Kraj	N	Age (years) Wiek (lata)	IQ	School achievements Osiągnięcia szkolne
Nadell, Hirsch 1958	USA	414	14–18	lower / obniżony	
Hirsch 1959	USA	554	6–17	lower / obniżony	
Young 1963	USA	251	5–17	average / przeciętny	worse / gorsze
Grosvenor 1970	New Zealand Nowa Zelandia	707	11–13	lower / obniżony	worse / gorsze
Doležalová, Mottlová 1995	Czech Republic Czechy	30	14	lower / obniżony	
		195	15–18	lower / obniżony	

4. A fourth hypothesis implies that the hyperopic child, maintaining accommodation with difficulty, is certainly at a disadvantage, just as the myopic child, requiring little or no accommodation, will be ideally situated to perform well in this test situation. In taking the test, a premium is placed upon the ability to perceive fine detail efficiently, thus giving the myope an advantage.

Hirsch [11] concluded that the fourth hypothesis, which was supported by his own data, seemed the most probable.

In a later period *Young* [21] rejected the idea that there was a relationship between refractive state and intelligence, but favored the idea of a relationship between reading ability and intelligence. However, *Grosvenor* [10] stated that all four of Hirsch's hypotheses could be working together to swing the balance slightly in favor of the myope.

According to *Karlsson* [13] and *Miller* [14] a pleiotropic relationship between intelligence and myopia has been shown to exist. Large eyes (as measured by axial length) have been shown to lead to myopia, and large brains have been shown to be more intelligent. Therefore, *Karlsson* [13] and *Miller* [14] have hypothesized that the myopia-intelligence relationship could arise because a single genetically controlled mechanism affects both brain size and eye size, possibly through a growth factor affecting both organs.

Cohn et al. [8] adopted two alternative hypotheses: (1) genetically determined myopia leads to a preference for close work and studiousness, which in turn leads to higher performance on IQ tests, and (2) genetically and environmentally conditioned higher IQ leads to a preference for reading and studiousness, which in turn strains the eyes, causing myopia.

Recently, *Saw et al*. [17, 18] concluded that higher IQ may be associated with myopia, independent of books read per week, in schoolchildren. According to them „the association between genetically driven IQ and myopia of hereditary predisposition could be forged because of a pleiotropic relationship between IQ and myopia in which the same causal factor is reflected in both genetic traits. There may be similar genes affecting eye size or growth (associated with myopia) and *neocortical* size (possibly associated with IQ)".

Conclusions

The conducted clinical observations suggest that children with myopia may have a higher IQ. This relationship is most probably determined by genetic and environmental factors.

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Komentarz

Praca pt. „Czy dzieci z krótkowzrocznością są bardziej inteligentne? Przegląd piśmiennictwa" wywołuje sprzeciw; od lat 60. ubiegłego wieku wszystkie prace związane z badaniem inteligencji wymagają szczególnie ostrożnej i właściwej metodologii. Źle prowadzone bowiem badania były źródłem wielu nieporozumień społecznych.

Powyższa praca metodologicznie jest niedoskonała z uwagi na brak definicji inteligencji, opisu rodzaju i metody badania poziomu inteligencji; opiera się na nieaktualnych pracach. W związku z tym może stać się źródłem szkodliwego utrwalenia stereotypów społecznych.

dr n. hum. *Maria J. Siemińska*