

(04)

The effect of genetic factors on the occurrence of myopia

Wpływ czynników genetycznych na występowanie krótkowzroczności

Czepita Damian, Mojsa Artur, Ustianowska Maria, Czepita Maciej, Lachowicz Ewelina

Department of Ophthalmology, Pomeranian Medical Academy in Szczecin, Poland
Head: Professor Danuta Karczewicz, MD, PhD

Summary: Purpose: The aim of this study was to investigate on a large population if and how genetic factors have an influence on the occurrence of myopia.
Material and methods: A total of 5533 students were examined (2659 boys and 2874 girls, in age 6-18 years, mean age 11.9, S.D. 3.2). The examination included retinoscopy under cycloplegia induced with 1% tropicamide. Myopia was defined as a spherical equivalent of at least -0.5 dioptres. The students and their parents completed a questionnaire on the child's family history of myopia. Data analysis was performed using chi-squared test; p-values of <0.05 were considered statistically significant.
Results: It was found that myopia occurs more often in students whose father ($p < 0.001$), mother ($p < 0.001$) or siblings ($p < 0.0001$) have myopia. A relation between the occurrence of myopia in grandparents and grandchildren was not observed ($p > 0.05$).
Conclusions: The obtained results indicate that genetic factors have a significant effect on the occurrence of myopia.

Słowa kluczowe: czynniki genetyczne, krótkowzroczność.
Key words: genetic factors, myopia.

Introduction

The prevalence of myopia is high in many parts of the world, particularly among the Orientals such as Chinese and Japanese. Myopia is likely to be caused by both environmental and genetic factors, and possibly their interactions (1-3).

Of all the environmental factors the most influential on the creation of myopia is writing and reading. Working on a computer tends to have a lesser role. Watching television by contrast does not have any influence on the occurrence of myopia (4-6).

Myopia is genetically transmitted as a monogenic autosomal dominant, autosomal recessive and in genes that are X-linked recessive. It is believed that myopia is polygenetically inherited. Numerous studies conducted on monozygotic twins confirm this theory. Recently a few genes responsible for the creation of myopia have been identified in chromosomes 1, 2, 3, 4, 7, 8, 10, 11, 12, 17, 18, 22 and X. An additional number of genes responsible for the creation of high myopia have been discovered in chromosomes 2, 7, 12, 17, 18, 22 and X (1,7,8).

At the time being, studies into the heredity of myopia have never been conducted in Poland. A few Doctorate thesis have been published in Poland, revealing a higher prevalence of myopia among people genetically transmitted (4-6). Therefore, the aim of this study was to investigate on a large population if and how genetic factors have an influence on the occurrence of myopia.

Material and methods

A total of 5533 students were examined (2659 boys and 2874 girls, in age 6-18 years, mean age 11.9, S.D. 3.2). The examined

children, students of elementary and secondary schools, were examined in the schools' consulting rooms. The examined students were Caucasian and resided in and around Szczecin, Poland.

Participation was voluntary. Before beginning the examinations, the doctors met with the children, their parents or legal guardians and teachers. It was explained what the examinations were about. The children, parents or legal guardians and teachers had an opportunity to discuss the study with the experimenters prior to giving consent. Informed consent was obtained in each case from children, parents or legal guardians and school principals. The studies were approved by the Bioethics Committee of the Pomeranian Medical Academy. The research protocol adhered to the provisions of the Declaration of Helsinki for research involving human subjects.

The examination included retinoscopy under cycloplegia. Cycloplegia was induced with two drops of 1% tropicamide administered 5 minutes apart. Thirty minutes after the last drop, pupil dilation and the presence of light reflex was evaluated as later retinoscopy was performed. Retinoscopy was performed in a dark room and all schoolchildren were examined by the some doctors (AM and MU).

The refractive error readings were expressed as the spherical equivalent (SE) – sphere power plus half negative cylinder power. Myopia was defined as SE of at least -0.50 D. Both eyes were examined, but only data gathered from the right eye were analysed.

The students and their parents completed a questionnaire on the child's family history of myopia. Data analysis was performed using chi-squared test; p-values of <0.05 were considered statistically significant.

Results

It was found that myopia occurs more often in students whose father ($p < 0.001$) (Tab. I), mother ($p < 0.001$) (Tab. II), or siblings ($p < 0.0001$) (Tab. III), have myopia. A relation between

	Father without myopia	Father with myopia	Total
Child without myopia	4720	114	4834
Child with myopia	662	37	699
Total	5382	151	5533

Tab. I. The effect of father's myopia on its occurrence in children.

Tab. I. Wpływ krótkowzroczności ojca na jej występowanie u dzieci.

	Mother without myopia	Mother with myopia	Total
Child without myopia	4586	248	4834
Child with myopia	621	78	699
Total	5207	326	5533

Tab. II. The effect of mother's myopia on its occurrence in children.

Tab. II. Wpływ krótkowzroczności matki na jej występowanie u dzieci.

	Siblings without myopia	Siblings with myopia	Total
Child without myopia	4726	108	4834
Child with myopia	659	40	699
Total	5385	148	5533

Tab. III. The effect of siblings' myopia on its occurrence in children.

Tab. III. Wpływ krótkowzroczności rodzeństwa na jej występowanie u dzieci.

	Grandfather without myopia	Grandfather with myopia	Total
Grandchild without myopia	4824	10	4834
Grandchild with myopia	698	1	699
Total	5522	11	5533

Tab. IV. The effect of grandfather's myopia on its occurrence in grandchildren.

Tab. IV. Wpływ krótkowzroczności dziadka na jej występowanie u wnuków.

	Grandmother without myopia	Grandmother with myopia	Total
Grandchild without myopia	4813	21	4834
Grandchild with myopia	694	5	699
Total	5507	26	5533

Tab. V. The effect of grandmother's myopia on its occurrence in grandchildren.

Tab. V. Wpływ krótkowzroczności babci na jej występowanie u wnuków.

the occurrence of myopia in grandparents and grandchildren was not observed ($p > 0.05$) (Tab. IV, V).

Discussion

Between 1989 and 2001 Karla Zadnik et al. conducted the Californian Orinda Longitudinal Study. Children in age 7 to 14 years were chosen to participate in this study. It was concluded that children with myopia were more likely to have parents with myopia; to spend significantly more time studying, more time reading, and less time playing sports; and to score higher on the ITBS Reading and Total Language subtests than emmetropic children. According to the authors, this suggests that heredity was the most important factor associated with juvenile myopia, with smaller independent contributions from near work, higher school achievements and less time spent doing sports activities. However, the chance of becoming myopic for children with no myopic parents, compared with those with one or two myopic parents, appears lowest in children with the highest amount of time spent on sports and outdoor activities (9,10).

These results are consistent with those obtained in studies conducted by Saw et al. (11) Singapore. The authors of this study have proven after examining 153 children of ages between 6-12 years that the average rate of progression of myopia for children with a parental history of myopia was -0.63 D per year compared to -0.42 D per year for children, whose parents were not myopic. Lam et al. (12) after conducting a study on 7560 Chinese children and Liang et al. (13) after conducting studies on 887 Taiwanese found strong parental effects on the level and onset of myopia in their offspring.

However, Fan et al. (14) and Iribarren et al. (15) obtained different results. Fan et al. (14) found that parental history of myopia was not to be associated with a myopic refractive error or increased eyeball length in a study on 514 Chinese children in aged between 2.3-6.4 years. This was probably due to the young age of the children in the examined group. Iribarren et al. (15) on the other hand found no relation between family history of myopia and the predictive value for either age of the first prescription or the final refractive error developed in adulthood in a study on 271 Argentines in age 36.5 ± 9.3 years. The authors believe that their negative findings could be explained because family history likely represents multiple genetic as well as environmental factors. According to them the family history should be used with care in the clinic when trying to predict the final amount of refractive error that a subject may develop.

In current studies it has been observed, that the family history of myopia leads to a reduction of refractive errors and to an increase in eyeball axial length. Other dimensions of the eye such as corneal curvature, anterior chamber depth, lens thickness and vitreous chamber depth, change in a smaller scale (9,12-14).

Polish authors – Chmielewska (4), Mojsa (5), Ustianowska (6) – have shown, that family history of myopia plays a role on the occurrence of myopia. The above mentioned authors however did not examine first or second degree relatives to find myopia. That is why in the performed studies we selected a group of parents and siblings (first degree relatives group) as well as grandparents (as a second degree group). A strong correlation was found to be present in first degree relatives. No correlation

was found in second degree relatives. This can be explained by inheriting a greater amount of genes in the group of first degree than in second degree relatives.

Conclusions

The obtained results indicate that genetic factors have a significant effect on the occurrence of myopia.

The paper was presented as electronic poster during 17th Congress of the European Society of Ophthalmology in Amsterdam, 13-16.06.2009.

Praca została zaprezentowana w formie plakatu elektronicznego na 17. Kongresie Europejskiego Towarzystwa Okulistycznego w Amsterdamie w dniach 13-16.06.2009.

References:

1. Czepita D: *Myopia – epidemiology, pathogenesis, present and coming possibilities of treatment*. Case Rep. Clin Pract Rev 2002, 3, 294-300.
2. Czepita D, Żejmo M, Mojsa A: *Prevalence of myopia and hyperopia in a population of Polish schoolchildren*. Ophthalmic Physiol Opt 2007, 27, 60-65.
3. Morgan IG: *The biological basis of myopic refractive error*. Clin Exp Optom 2003, 86, 276-288.
4. Chmielewska I: *Static perimetry in myopia*. PhD Thesis. Pomeranian Medical Academy, Szczecin 2004.
5. Mojsa A: *Prevalence of myopia among urban and rural schoolchildren*. PhD Thesis. Pomeranian Medical Academy, Szczecin 2003.
6. Ustianowska M: *Evaluation of the factors predisposing to the creation of myopia*. PhD Thesis. Pomeranian Medical Academy, Szczecin 2008.
7. Morgan I, Rose K: *How genetic is school myopia?* Progress Ret Eye Res 2005, 24, 1-38.
8. Tang WC, Yap MKH, Yip SP: *A review of current approaches to identifying human genes involved myopia*. Clin Exp Optom 2008, 91, 4-22.
9. Jones LA, Sinnott LT, Mutti DO, Mitchell GL, Moeschberger ML, Zadnik K: *Parental history of myopia, sports and outdoor activities, and future myopia*. Invest Ophthalmol Vis Sci 2007, 48, 3524-3532.
10. Mutti DO, Mitchell GL, Moeschberger ML, Jones LA, Zadnik K: *Parental myopia, near work, school achievement, and children's refractive error*. Invest Ophthalmol Vis Sci 2002, 43, 3633-3640.
11. Saw SM, Nieto FJ, Katz J, Schein OD, Levy B, Chew SJ: *Familial clustering and myopia progression in Singapore school children*. Ophthalmol Epidemiol 2001, 8, 227-236.
12. Lam DSC, Fan DSP, Lam RF, Rao SK, Chong KS, Lau JTF, Lai RYK, Cheung EYY: *The effect of parental history of myopia on children's eye size and growth: results of a longitudinal study*. Invest Ophthalmol Vis Sci 2008, 49, 873-876.
13. Liang C-L, Yen E, Su J-Y, Liu C, Chang T-Y, Par N, Wu M-J, Lee S, Flynn JT, Juo S-HH: *Impact of family history of high myopia on level and onset of myopia*. Invest Ophthalmol Vis Sci 2004, 45, 3446-3452.
14. Fan DSP, Lam DSC, Wong TY, Islam M, Saw SM, Cheung AYK, Chew S: *The effect of parental history of myopia on eye size of pre-school children: a pilot study*. Acta Ophthalmol Scand 2005, 83, 492-496.
15. Iribarren R, Balsa A, Armesto A, Chiaradia P, Despontin L, Fornaciari A, Pfortner T: *Family history of myopia is not related to the final amount of refractive error in low and moderate myopia*. Clin Exp Ophthalmol 2005, 33, 274-278.

The study was originally received 19.10.2009 (1172)/
Praca wpłynęła do Redakcji 19.10.2009 (1172)/
Accepted for publication 22.12.2010/
Zakwalifikowano do druku 22.12.2010 r.

Reprint requests to/ Adres do korespondencji:

Professor Damian Czepita
Department of Ophthalmology,
Pomeranian Medical Academy
Al. Powstańców Wlkp. 72
70-111 Szczecin, Poland
e-mail: czepita@pro.onet.pl

Polskie Towarzystwo Okulistyczne
www.pto.com.pl