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Risk Factors in Adult Myopia in Macedonia

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Abstract

AIM: In our case–control study of the Caucasian Macedonian myopia population of adults aged over 40 years, to analyze the environmental risk factors such as education level and outdoor activity levels in hours.

MATERIALS AND METHODS: We included 53 patients with myopia and 64 control subjects. The following demographic characteristics were evaluated using questionnaires: Age, gender, level of education, outdoor activities (hours), and parental myopia. Ophthalmic examination was performed with slit-lamp biomicroscopy and parameters: best corrected visual acuity, cycloplegic autorefraction, and corneal curvature radius were recorded.

RESULTS: About 54.7% of the myopia study population were male, and most of the subjects had high education (58.5%). About 43.4% of the myopia subjects did have parental myopia in the family history. The mean age of onset of myopia was 22.5 years, and the mean age when myopia stopped was 37.1 years. The mean value of near tasks (screen time, reading, etc.) time in hours, in the myopia group was 5.6, whereas in the emmetropia group 4.9. The mean value of outdoor activity in hours per day (prior 26 years of age, recent years, and today) was: 5.1 h, 4.2 h, 3.9 h in the myopia group versus 4.8 h, 3.8 h, 3.3 h in the emmetropia group, respectively.

CONCLUSION: The prevalence of male gender in myopia group was higher. Near task time in hours was higher in myopia group versus emmetropia group. Parental history of myopia was significantly more present in patients with myopia. Environmental risk factors such as outdoor activities in hours and level of education did not differ significantly among the groups.

Introduction

The prevalence of myopia in the population over 40 years of age in Europe and the USA increased since 2010 [1]. Results from the Multi-Ethnic Study of Atherosclerosis in the USA showed that the prevalence of adult myopia in Caucasians increased from 25.4% in 2004 to 31.0% in 2013 [1], [2].

Similar results were found in Europe where the prevalence of adult myopia increased from 25.4–26.6% in 2000 to 35.1% in 2014 [2], [3]. The Gutenberg Health Study (2014) found myopia prevalence of 35.1% in European adults [4], whereas it was 25.4–26.6% in the 2000s [2], [3].

The prevalence of myopia of equal or more than 0.50D in East Asians at age over 40 years was 26.2–41.8% [5], [6], [7], [8], which is higher compared with Caucasians.

The prevalence of myopia in Japanese adults between the ages of 40 and 79 years was 45.7% in men and 38.3% in women [9].

The prevalence of myopia and high myopia were higher among populations in well-developed countries (35.9–41.4%) [10] than in developing countries. The socioeconomic disparity in the prevalence of myopia suggests that the population in more developed countries may experience more intensive education and limited outdoor time, which could promote the development of myopia.

Recent knowledge in the etiology of myopia suggests that environmental risk factors (such as education level and outdoor activity) play the predominant role in the development of myopia [11].

Previous studies of early learning [12], near work [13], and lack of outdoor activities [14], [15] showed that environmental factors were more related to myopia than genetic factors.

Only a few studies have been conducted regarding the risk factors of myopia in the adult population [1], [2]. In our case–control prospective study of the Caucasian Macedonian myopia cohort of adults aged over 40 years, we analyzed the family history of myopia and the environmental risk factors such as the level of education and outdoor activity levels in hours.

Materials and Methods

Study population

This is an observational case–control study of Caucasian citizens of Macedonian origin over the age of 40 years. The study was conducted according to the tents of the Declaration of Helsinki. Data collection was conducted with reference to Caucasian patients over 40 years of age in the private polyclinics "Medika Plus" and "Dr. Lazar Trenchev," Skopje, Macedonia, in the period from April 2021 to December 2022. All lived in urban environments.

We included two study groups: (a) a Myopia group involving patients older than 40 years of age having myopia higher than −0.50 D Sph and (b) a control group of subjects older than 40 years of age having refractory anomaly less than ±0.50 D Sph. Exclusion criteria were: Any major ocular pathology (including glaucoma, pterygium, and retinal disease), hypermetropia ≥0.50 D Sph, history of ocular surgery, or ocular trauma.

Measurements

Questionnaires were given to subjects that were willing to participate in the study. In the demographic section, following data were analyzed: Age, gender, family history of myopia, present professional occupation, type of occupation – indoor versus outdoor work, level of education (primary school; middle/high school; and university), as well the type of university (state or private). In the myopia questionaries, the age of onset of myopia and the age of progression of myopia cessation were also included.

In the risk factors section, the following data were analyzed: (1) Outdoor activity before the age of 26 years (in hours), (2) outdoor activity in recent years (in hours), (3) outdoor activity in the moment (in hours), and (4) number of hours spent on near tasks (screen, reading, etc.).

The ocular examination included: Visual acuity assessment, slit-lamp biomicroscopy, intraocular pressure measurement (with Goldmann tonometry), and autokeratorefractometry.

Assessment of refractive errors

We perform cycloplegic autorefraction and corneal curvature radius measurements using photorefraction (Auto Ref-Keratometer PRK-5000, Potec, Daejeon, Korea).

Uncorrected visual acuity and best-corrected visual acuity were measured by a logarithmic E chart (Geohide 955-95-43, Germany).

An examination of the anterior segment of the eye was performed by slit-lamp biomicroscopy (Topcon Slit lamp SL-1E, Tokyo, Japan).

For each subject, we used spherical equivalent (SE) to evaluate the refractive error data, which was defined as a sphere plus half cylinder. In our study, emmetropia was defined as SE −0.50 D–+0.50 D, and myopia as SE ‹ −0.50 D. Low myopia was defined as SE −0.75–−3.00 D, moderate myopia −3.25 D–−6.00 D and high myopia ‹ −6.00 D.

The power and axis of the cylinder in the myopia group were recorded. Clinically significant astigmatism was defined as a refractive error of more than 1.00 D of the cylinder. In the evaluation, a minus form of cylinder was used. The axis of astigmatism was classified as: With the rule ("WTR"), against the rule ("ATR"), and oblique astigmatism (axis between 100–170° and 10–80°).

Statistical analysis

Data were categorized as ordinal and categorical. Descriptive statistics are presented with frequency tables, and mean percentage and corresponding standard deviation (SD) and standard error are reported. The 2-tailed χ^2 test of independence was applied to corresponding contingency tables and when low subject numbers precluded its use, Fisher's exact test was applied. Data were processed in Microsoft Office Excel 2007 and using the statistical software package R (version 2.15.2; R Foundation for Statistical Computing Vienna, Austria).

Results

The mean age of the subjects in the myopia group was 49.2 (SD = 7.2) years, whereas in the control emmetropia group 53.3 (7.7) years. In myopia, the study population 54.7% (6.8%) were male, whereas in the emmetropia group 32.8% (5.9%) were male.

Most of the myopia patients had high education (58.5% [6.8%]), whereas in the emmetropia group 73.4% (5.5%) did have high education (Table 1).

Table 1: Characteristics and risk factors in myopia and emmetropia group

Myopia Characteristics	Myopia group Mean (SD) or % (SE) *n* = 53	Control group Mean (SD) or % (SE) *n* = 64
Age	49.2 (7.2)	53.3 (7.7)
Sex (m)	54.7% (6.8%)	32.8% (5.9%)
Type of education		
Primary education	1.9% (1.9%)	3.1% (2.2%)
Secondary education	39.6% (6.7%)	23.4% (5.3%)
Higher education	58.5.% (6.8%)	73.4% (5.5%)
Parental myopia	43.4% (6.8%)	0% (0%)
Outdoor activity (in hours, per day)		
Before 26 years of age	5.1 (1.8)	4.8 (1.7)
In recent years	4.2 (1.8)	3.8 (1.4)
Today	3.9 (1.8)	3.3 (1.4)
Near tasks (screen, reading, etc.), in hours, per day	5.6 (3.6)	4.9 (2.3)
Sphere equivalent		
Right eye	−3.4 (2.7)	0.2 (0.4)
Left eye	−3.4 (2.8)	0.2 (0.3)
BCVA		
Right eye	0.8 (0.2)	1 (0)
Left eye	0.8 (0.2)	1 (0)

SD: Standard deviation, SE: Standard error, BCVA: Best corrected visual acuity.

About 43.4% (6.8%) of the myopia subjects did have parental myopia in the family history. The mean age of onset of myopia was 22.5 (12) years, and the mean age when myopia stopped was 37.1 (12.8) years.

Outdoor activity (in hours) before 26 years of age, in the myopia group was 5.1 (1.8), whereas in the emmetropia group 4.8 (1.7).

Outdoor activity (in hours) in the past years, in the myopia group was 4.2 (1.8), whereas in the emmetropia group 3.8 (1.4).

Outdoor activity (in hours) now, in the myopia group was 3.9 (1.8), whereas in the emmetropia group was 3.3 (1.4).

The mean value of near tasks (screen time, reading book, etc.) time in hours, in the myopia group was 5.6 (3.6), whereas in the emmetropia group 4.9 (2.3) (Table 1).

In Table 2, different refractive characteristics of myopia group were presented. The mean value of SE in the myopia group, for the right eye was −3.4 (2.7) Dsph, whereas in the left eye −3.4 (2.8) Dsph. About 71.5% (6.2%) of the myopia subjects did have astigmatism in the right eye, whereas 58.5% (6.8%) in the left eye. The mean numerical value of astigmatism in the right eye was −2.1 (1.3) Dcyl, whereas in the left eye −2.3 (1.6) Dcyl. The most common astigmatism in the right eye was oblique (47.4% [8.1%] of the patients), whereas in the left myopic eye WTR astigmatism (43.3% [9.1%]).

Table 2: Refractive characteristics of myopia group.

Myopia Characteristics	Mean (SD) or %(SE)
Onset of myopia	22.5 (12)
Age at which the myopia stopped increasing	37.1 (12.8)
Presence of astigmatism	
Right eye	71.7% (6.2%)
Left eye	58.5% (6.8%)
Numerical value of astigmatism	
Right eye	−2.1 (1.3)
Left eye	−2.3 (1.6)
Type of astigmatism right eye	
WTR	34.2% (7.7%)
ATR	18.4% (6.3%)
OBL	47.4% (8.1%)
Type of astigmatism left eye	
WTR	43.3% (9.1%)
ATR	20% (7.3%)
OBL	36.7% (8.8%)

SD: Standard deviation, SE: Standard error, WTR: With the rule, ATR: Against the rule, OBL: Oblique.

Considering the distribution of professional occupational tasks (indoor and outdoor), the prevalence of indoor occupations was higher in both myopia and emmetropia groups.

About 69.8% (37/53) of the subjects in the myopia group do have indoor professional occupation whereas in emmetropia 84.4% (54/64). The prevalence of outdoor occupations was 30.2% (16/53) in the myopia group versus 15.6% (10/64) in the emmetropia group.

Regarding the distribution of low, moderate, and high myopia in the examined group, 58.5% (31/53) of the subjects were with low myopia (mean SE −2.01 D), 32.1% (17/53) were with moderate myopia (mean SE −4.41 D), and only 9.4% (5/53) were with high myopia (mean SE −9.4 D).

Discussion

In our Macedonian urban study population, the prevalence of males was higher in the myopia group than in the emmetropia group. Regarding gender as a myopia risk factor, there is a weak evidence/causal relationship [16].

In older studies, the prevalence of male subjects tends to be higher, whereas more recent studies more commonly report higher prevalence in female subjects [16]. Our results are according to the Blue Mountains Eye Study [17], which reported that the prevalence of myopia was higher in older male adults than in female.

About 43.4% of the myopic subjects in our study population had parental myopia in the family history. Regarding parental myopia as a myopia risk factor, there is a strong evidence/causal relationship [16].

Studies covering a range of different ethnic groups, have shown that having one or two parents with myopia, increases the risk of myopia in children [18], [19], [20], [21].

Three major risk factors for myopia with strong evidence/causal relationship are: Education, time outdoors and parental myopia, and equivocal evidence/causal relationship for near tasks (screen time, reading books, etc.) [16].

Regarding education level, 58.5% of the myopia subjects in our study population had high education (university degree), and a higher amount of hours on near tasks work compared to the emmetropia group.

The classical epidemiological evidence strongly suggests that education has a strong evidence/causal relationship for myopia, as it is connected with small time outdoors [16].

It has generally been assumed that reading and writing (near work) that are an integral part of education, provide the link. Many but not all studies have found associations between near work and myopia, and in general, the associations have been weak and inconsistent, although meta-analyses suggest that the effects, while small, are real [22].

A large body of epidemiological evidence on the protective effects of time outdoors has been accumulated [23] and a recent systematic review and meta-analysis has confirmed the association [24].

Rose *et al*. [25] postulated that brighter light outdoors during daylight hours led to more dopamine release in the retina which in turn inhibited axial elongation.

In our study, adult myopia group outdoor activity (in hours) before 26 years of age, in recent years, and the moment was: 5.1 h, 4.2 h, and 3.9 h per

day, retrospectively. In our Macedonian urban cohort, there was no significant difference in the outdoor activity hours per day between the adult myopia and emmetropia groups. Late onset of myopia at 22 years of age can explain the non-significant difference.

Conclusion

In the Macedonian urban adult myopia population, the prevalence of the male gender was higher. Near half of the subjects did have parental myopia in the history. Near task time in hours was higher compared to emmetropia subjects. There was no significant difference in the outdoor activity hours per day between adult myopia and emmetropia groups.

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