



Research Article

Myopia and Environmental Risk Factors: A Comprehensive Study

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Abstract

Background: The global rise in the prevalence of myopia calls for evidence-based strategies to be devised to reduce the incidence and delay the progression of Myopia. The aim is to determine the relationship between myopia incidence and some environmental factors.

Methods: A cross-section observational study was conducted at Alzahraa Teaching Hospital from May 2023 to December 2023. Primary school students of both genders. All students were enrolled in the study after an agreement with their parents/guards. Data was collected using a pre-constructed data collection sheet (questionnaire) including three sections, the first section was sent to the families to fill and sign the consent for participation and provide the required data including the demographic variables, family history and medical history of the students, time outdoors, prolonged near work/increased study hours, high BMI, use of LED lamps for homework, less sleeping hours, low Vitamin D levels, less participation in sports and low socioeconomic status. The second part included the general examination of the students, school grades and education performance (assessed according to the student school Cards). The third section involved the ophthalmological examination, visual acuity and ophthalmoscopic examination.

Results: A total of 100 students were enrolled in this study, they were equally distributed according to gender, 50 boys and 50 girls. The age of students ranged between 6 and 12 years. Only 12 students had positive past medical and surgical history. A family history of myopia was reported in 20% of the studied group, 20 children were wearing spectacles and a history of past

eye complaints was reported in 9 (9%) of children. The refractive errors were 45% hypermetropia, 39% myopia and 16% astigmatism. Abnormal visual acuity was detected in 35%. Myopia was significantly higher in children with family history ($p=0.007$). A statistically significant relationship was found between large time outdoors and myopia ($OR=4.52$, $p=0.02$). A statistically significant relationship was found between prolonged near-work/increased study hours and myopia ($OR=4.52$, $p=0.02$). A statistically significant relationship was found between using LED lamps for homework and myopia ($OR=10.33$, $p<0.0001$). A statistically significant relationship was found between fewer sleeping hours and myopia ($OR=7.5$, $p<0.0001$).

Conclusion: Prevention of the onset of myopia and delay in the progression of myopia can be altered by modifying the contributing environmental risk factors. Raise outdoor time with adequate sunlight exposure, rural environment, less duration of near work, use of incandescent lamp and normal sleeping rhythms with adequate regular sleeping hours can prevent the onset and progression of myopia. Myopia is associated with high BMI, watching television and playing digital devices. High socioeconomic status associated with more indoor activity, increased academic pressure, sedentary lifestyle contribute to the prevalence of myopia.

Keywords: Myopia; Hypermetropia; BMI; Time Outdoors; Sunlight Exposure; LED Lamps

Introduction

Myopia is a complex disease with both genetic and environmental risk factors, the 1st group cannot be modified but the environmental risk factors can be modified to a certain extent and thereby help in reducing the prevalence. The prevalence of

myopia is increasing globally at an alarming rate, with a significant increase in the risks for vision impairment from pathologic conditions associated with high myopia, including retinal damage, cataracts and glaucoma [1].

The definition of myopia is a condition in which the spherical equivalent objective refractive error is ≤ -0.50 diopter (-0.50 D) in either eye. The clinical definition of Myopic Macular Degeneration (MMD) is a vision-threatening condition in people with myopia, usually high myopia, which comprise diffuse, patchy macular atrophy with or without lacquer cracks, choroidal neovascularization and Fuchs spot [1].

Myopia is classified into Early-Onset Myopia (EOM) which manifests before 13 years of age, resulting in a high degree of refractive error and Late-Onset Myopia (LOM) manifests after 15 years of age, resulting in a low degree of refractive error. One of the leading causes of blindness and MSVI (moderate and severe visual impairment) worldwide was uncorrected refractive error [2]. The prevalence of myopia is highest in Asian regions and lower in Australia, Europe and America [2].

Epidemiologically speaking, published studies indicated that more than 1569 million individuals were affected with myopia in 2000. It is predicted by 2050 there will be 5786 million people with myopia [3]. The prevalence of myopia in children teenagers and young adults is substantially higher [4].

A systematic review and meta-analysis and a dose-response analysis of published clinical trials consider raised time outdoors to be effective in preventing the onset of myopia as well as in slowing the myopic shift in refractive error. But paradoxically, outdoor time was not effective in slowing the progression of eyes that were already myopic [5]. Sunlight can promote the skin's production of Vitamin D to influence refractive development, stimulate retinal neurons to secrete dopamine to regulate the sclera and prevent eye elongation [6,7].

Near work-Induced Transient Myopia (NITM), refers to the small, transient, pseudomyopic shift in the far point of the eye after a period of sustained near work. It reflects an inability of the crystalline lens to reduce its power appropriately and rapidly, thus reflecting an accommodative aftereffect/hysteresis phenomenon of presumed pharmacologic origin [8]. It is reported that myopes demonstrated larger NITM than emmetropes, early onset myopes exhibited prolonged decay of NITM. NITM is sensitive to prolonged task duration [8].

Elevated BMI is significantly associated with high myopia (spherical equivalent ≤ -6.00 D) and not significantly associated with myopia [9]. Obese children who engage in fewer outdoor activities or have increased near-work activity are more at risk for myopic refractive error [10]. Myopic children spent more time indoors and less outdoors than non-myopic children, had lower vitamin D, had a higher body mass index and participated less in sports [11].

School children using LED lamps for homework had a more myopic RE compared with those using incandescent or fluorescent lamps [12].

Watching television or digital devices for more than 2 hours per day: Prolonged (>60 minutes/day) computer usage and smartphone usage were significantly associated with greater refractive error, while television viewing and after-school study were not reported in Chinese school-going children [8]. Children who spent more than 3-5 hours daily on homework, watched television for more than 2-3 hours daily or played with electronics for more than 1 hour daily all had a higher risk of myopia [13,14].

The number of sleeping hours per day and circadian rhythms are very crucial in regulating the melatonin release and development of refractive error [15].

Lower amounts of sports and outdoor activity increased the odds of becoming myopic in those children with two myopic parents more than in those children with either zero or one myopic parent. The chance of becoming myopic for children with no myopic parents appears lowest in the children with the highest amount of sports and outdoor activity, compared with those with two myopic parents [16].

Economic development is associated with behavioral and lifestyle changes that are detrimental to eyesight. Modern industrialization requires more close, indoor vision compared with agricultural or even some older industrial occupations [17].

Methodology

A cross-section observational study was conducted at Alzahraa Teaching Hospital from May 2023 to December 2023. Primary school students of both genders. All students were enrolled in the study after an agreement with their parents/guards. Exclusion criteria are students whose parents/guardians refused the participation study, those who refused the examination, low visual acuity and history of traumatic eyes. The sample size was calculated by:

$$N = \frac{Z^2 * PQ}{d^2}$$

Where N= sample size, Z = standard normal variant at ($P \leq 0.05$), P= expected prevalence in the population, d= absolute allowed error (0.05) at 95% CI.

Data was collected using a pre-constructed data collection sheet (questionnaire) including three sections, the first section was sent to the families to fill and sign the consent for participation and provide the required data including the demographic variables, family history and medical history of the students, time outdoors, prolonged near work/increased study hours, high BMI, use of LED lamps for homework, less sleeping hours, low Vitamin D levels, less participation in sports and low socioeconomic status. The second part included the general examination of the students, school grades and education performance (assessed according to the student school Cards). The third section involved the ophthalmological examination, visual acuity and ophthalmoscopic examination.

Statistical Analysis

It was performed using the Statistical Package for Social Sciences (SPSS) version 26. For numerical variables calculated with the mean and SD. The bivariate analysis was carried out through cross-tabulation. The Chi-square test with a significance level of p-value <0.05 was used to evaluate the relationship between the categorical variables.

Results

A total of 100 students were enrolled in this study, they were equally distributed according to gender, 50 boys and 50 girls. The age of students ranged between 6 and 12 years. The median age was 8 yrs. Only 12 students had positive past medical and surgical history. Family history of myopia was reported in 20% of the studied group, 20 children wearing spectacles and a history of past eye complaint was reported in 9 (9%) of children, (Table 1).

Refractive errors and visual acuity are shown in (Table 2). The refractive errors were 45% hypermetropia, 39% myopia and 16% astigmatism. Abnormal visual acuity was detected in 35%.

As shown in Table 3, cross-tabulation between myopia and non-myopic groups revealed that age ($p=0.276$), gender ($p=0.837$), past medical and surgical history ($p=0.404$), wearing spectacles ($p=0.259$) and history of past eye trauma ($p=0.074$) had no significant association with groups distribution. Myopia was significantly higher in children with family history ($p=0.007$).

A statistically significant relationship was found between large time outdoors and myopia ($OR=4.52$, $p=0.02$). A statistically significant relationship was found between prolonged near-work/increased study hours and myopia ($OR=4.52$, $p=0.02$). Non-statistically significant relationship was found between high BMI and myopia ($OR=2.5$, $p=0.055$). A statistically significant relationship was found between using LED lamps for homework and myopia ($OR=10.33$, $p<0.0001$). A statistically significant relationship was found between fewer sleeping hours and myopia ($OR=7.5$, $p<0.0001$). Non-statistically significant relationship was found between low vitamin D levels and myopia ($OR=2.11$, $p=0.054$). A non-statistically significant relationship was found between less participation in sports and myopia ($OR=1.05$, $p=0.06$). A non-statistically significant relationship was found between less participation in sports and myopia ($OR=1.12$, $p=0.085$). (Table 4).

Variable		No.	%
Age (year)	≤ 8	40	40
	9 - 12	60	60
Gender	Male	50	50
	Female	50	50
Past medical and surgical history	Yes	12	12
	No	88	88
Family history of myopia	Yes	20	20
	No	80	80
Wear spectacles	Yes	20	20
	No	80	80
History of past eye trauma	Yes	9	9
	No	91	91

Table 1: Students characters.

Variable		No.	%
Refractive errors	Hypermetropia	45	45
	Myopia	39	39
	Astigmatism	16	16
Visual acuity	Abnormal	35	35
	6/6; 6/6	65	65

Table 2: Distribution of Refractive abnormalities and visual acuity.

Variable		Myopia (n = 39)	No myopia (n = 61)	P-value
		%		
Age	≤ 8	13	27	0.276
	9 - 12	26	34	
Gender	Male	19	31	0.837
	Female	20	30	
Past medical and surgical history	Yes	6	6	0.404
	No	33	55	
Family history	Yes	13	7	0.007
	No	26	54	
Wearing spectacles	Yes	10	10	0.259
	No	29	51	
History of past eye trauma	Yes	6	3	0.074
	No	33	58	

Table 3: The socio-demographic characteristics of the studied group.

Environmental Factors	Odd's Ratio	P-value
Time outdoors	4.52	0.02
Prolonged near work/increased study hours	6.6	0.001
High BMI	2.5	0.05

Use of LED lamps for homework	10.33	0.0001
Less sleeping hours	7.5	0.0001
Low vitamin D levels	2.11	0.054
Less participation in sports	1.05	0.06
Low socioeconomic status	1.12	0.085

Table 4: Environmental factors risk and myopia.

Discussion

Data concluded that raised outdoor time prevents the onset of myopia as well as delaying poor outcomes. The hypothesis suggests that light intensity is more outdoors which makes the pupil constrict thereby reducing image blur and resulting in a larger depth of field [18].

Near work Induced Transient Myopia (NITM) is greater in myopes than emmetropes, early onset myopes exhibited prolonged decay of NITM and progressive myopes are more susceptible than stable myopes. NITM is additive to repeated and prolonged work. It reflects impaired sympathetic function and anomalous autonomic input to the ciliary muscle results in anomalous accommodation responses resulting in myopia development and progression [19]. Prolonged near work and stress trigger spasms of accommodation due to prolonged contraction of the ciliary muscle, causing pseudomyopia [20]. Head tilt or close reading distance may cause higher dioptric stimuli, abnormal contractions of extraocular muscles and markedly out of focus in the peripheral retina inducing the development of myopia [21]. Ciliary muscle got thinner after prolonged work [22]. Looking at high-contrast text for prolonged periods has a potential myogenic effect [23].

High BMI is not significantly associated with myopia. An epidemiological study conducted on young adult men in Korea reported that decreased BMI is associated with myopia [24].

Schoolchildren using LED lamps for doing homework were associated with myopic refractive error. In Anyang Childhood Eye Study Group reported myopia association while using fluorescent lamps for doing homework and recommended the usage of incandescent lamps for close reading and writing work, as they provide higher light levels and a wider light spectrum like outdoors [25].

Children who spent more than 3-5 hours daily on homework, watched television for more than 2-3 hours daily or played with electronics for more than 1 hour daily all had a higher risk of myopia. The rationale behind the myopia and >2 hours of watching television is not established.

Randomized controlled trials suggested a significant association between participation in sports and decreased odds of development of myopia, especially in children born to two myopic parents [26].

Economic development, modern industrialization and their associated factors like behavioral and lifestyle changes, more close and indoor vision, increased academic pressure a near-work-focused sedentary lifestyle and less time spent playing outdoors, contribute to the development of myopia [27].

Conclusion

Prevention of the onset of myopia and delay in the progression of myopia can be altered by modifying the contributing environmental risk factors. Raise outdoor time with adequate sunlight exposure, rural environment, less duration of near work, use of incandescent lamp and normal sleeping rhythms with adequate regular sleeping hours can prevent the onset and progression of myopia. Myopia is associated with high BMI, watching television and playing digital devices. High socioeconomic status associated with more indoor activity, increased academic pressure, sedentary lifestyle contribute to the prevalence of myopia.

Conflict of Interests

Authors declare that they have no conflict of interest.

Informed Consent

It was obtained from all parents.

Disclosure

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Disclosure

None

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