Original Article

ANATOLIAN CURRENT MEDICAL

DOI: 10.38053/acmj.1341731

Anatolian Curr Med J. 2023;5(4):360-363

Turkish children myopia progression in the urban area, a retrospective evaluation

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Cite this article as: Kaya P. Turkish children myopia progression in the urban area, a retrospective evaluation. *Anatolian Curr Med J.* 2023;5(4):360-363.

Received: 11.08.2023 ◆ **Accepted**: 23.08.2023 ◆ **Published**: 27.10.2023

ABSTRACT

Aims: To investigate myopia trends and progression in urban school-aged myopic children in Turkey.

Methods: This retrospective study included myopic children aged 6-18 years attending the ophthalmology clinic for regular eye and refractive examinations between 2003 and 2021. Myopia progression was calculated as the difference between the baseline and the last visit spherical equivalent refractive (SER) values. Individuals were further categorized to determine the age-specific myopia progression as 6-11, 12-16, and 17-18 age groups based on the school periods of the country. According to the SER values, individuals were classified into mild, moderate, and high myopic groups.

Results: A total of 602 eyes of 301 children (191 female, 110 male) with a mean age of 11.64±2.81 (6-18) years were included in the study. The mean follow-up time of patients was 37.51±19.18 (6-98) months. The baseline mean SER value was -1.5±1.07 D (range: -0.50 and -5.62) and -2.55±1.50 at the final visit. The overall mean myopia progression was -0.35±0.37 D (range: +0.35 D and -3.75 D/year. There were 46 children between 6-11 years, 173 children between 12-16 years, 82 children between 17-18 years, and the annual SER changes were -0.46±0.40 D; -0.37±0.39 D and -0.26±0.29 D in the groups, respectively ($p < 0.001$). Baseline, final, and annual myopia progression were greater in females. Although there was no statistical significance, myopia progression was faster in moderate myopes (-0.39±0.33 D/a year), followed by mild (-0.35±0.37 D/a year) and high myopes (-0.21±0.20 D/a year) (p=0.37).

Conclusion: The progression of myopia in school-aged Turkish children from the Western Black Sea Region is comparable to the world. Our study revealed the greater myopia progression in the youngest children, moderate myopia group, and females. Myopia prevention recommendations should be carefully advised to the youngest female ones to reduce myopia progression.

Keywords: Myopia, progression of myopia, urban area, myopia in children

INTRODUCTION

Myopia is a common refractive error causing vision loss and is becoming a public health problem due to its increasing prevalence all over the world. The worldwide prevalence of myopia and high myopia is expected to be 52% (almost 5 billion) and 10% (almost 1 billion) by 2050. Myopia may develop in early childhood, late teens, or adulthood.[1,2] Early onset of myopia has been reported to lead to more myopic refractive error or high myopia later in life.[3] Donovan et al.[4] indicated that the mean annual myopia progression in children was about half-a-diopter in Europeans (-0.55 D) and a higher progression rate in Asians (-0.82 D). In our previous study aiming to investigate the relationship between increased digital screen time and the development and progression of myopia during the COVID-19 pandemic, we found the mean annual change in spherical equivalent refractive error (SER) as -0.97±0.66 D in urban area school-aged children in Turkey.[5] The Northern Indian Myopia study that involved 10000 school children aged 5 to 15 years from Delhi reported an annual myopia progression of -0.27±0.42 D.[6]

Both genetic and environmental factors influence myopia.[7] Given the potential role of geographic location on myopia progression, information on the pattern of progression of myopic refractive error across different age groups in Turkish children could help clinicians choose appropriate myopia prevention strategies. In this study, the data on refractive error and the variability between ages were obtained from urban school-aged children living in the Western Black Sea Region of Turkey.

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METHODS

This retrospective study was conducted in accordance with the Declaration of Helsinki with written permission from Zonguldak Bülent Ecevit University Faculty of Medicine Clinical Researches Ethics Committee (Date: 06.04.2022, Decision No:2022/07). The study was carried out in Devrek State Hospital, Zonguldak, Turkey. 301 individuals aged 6 to 18 years and only with the diagnosis of 'myopic refractive error' at their first visit (taken as a baseline) were included in the study. Patients examined at least twice with six months intervals between 2003-2021 years were evaluated. Children were categorized into three groups according to their refractive error. Mild myopia was defined between -0.50 to -2.99 D SER value, moderate myopia as SER between -3.00 to -4.99 D, and high myopia as SER of at least -5.00 D. Based on the World Health Organization (WHO) definition; we defined high myopia as ≤-5.00 D.[1] To determine the age-specific myopia progression, individuals were further categorized as 6-11, 12-16, 17-18 age groups for the school periods in the country. Myopia progression was calculated as the difference between SER at baseline and at the last visit. The best corrected visual acuity was 1.0 for all patients under the correction of refractive status. Patients with other ocular diseases like uveitis, trauma, strabismus, and retinal diseases were excluded from this study.

Statistical Analysis

Descriptive and statistical analyzes were performed using IBM SPSS Statistics 21. Demographic characteristics and clinical data were expressed as mean, standard deviation, frequency, or percentage. The Kolmogorov-Smirnov test evaluated the normal distribution test of continuous data. Since the data were suitable for normal distribution, the independent T-test was used for independent groups. One-way ANOVA test was used for multiple categorical data. P value of 0.05 or less was considered statistically significant.

RESULTS

A total of 602 eyes 301 children with a mean age of 11.64±2.81 (6-18) years were included in the study. 191 (63.5%) patients were female with a mean age of 12.15±2.5 (6-18), and 110 (36.5%) patients were male with a mean age of 10.77±2.98 (6-18) years. The data are summarized in **Table 1**.

The mean follow-up time of patients was 37.51±19.18 (6-98) months. The baseline mean SER value was -1.5±1.07 D (range: -0.50 and -5.62) and -2.55±1.50 D (range: -0.50 and -8.50) at the final visit (p<0.001). The overall mean myopia progression was -0.35±0.37 D/year (range: +0.35 D and -3.75 D). When the patients were evaluated according to age groups, there were 46

Table 1. Follow-up period, baseline and final mean spherical refractive equivalent (SER) values and myopia progression based on age, gender and severity of myopia

	N	Follow-up period (months)	Baseline SER values	Final SER values	P value	Annual SER progression
Total	301	37.51±19.18 (6 - 98)	-1.5±1.07 (Range: -0.50 and -5.62)	-2.55±1.50 (Range: -0.50 and -8.50)	<0.001	-0.35±0.37 (Range +0.37 and -3.75)
Age groups						
6-11	46 (15.3%)	39.17±17.91 (6.23 - 76.53)	-1.61±1.12 (Range: -0.50 and -5.25)	-2.95±1.63 (Range: -0.50 and -7.75)	<0.001	-0.46±0.40 (Range +0.30 and -1.93)
12-16	173 (57.5%)	42.57±19.73 (6 - 98)	-1.43±1.02 (Range: -0.50 and -5.5)	-2.64±1.57 (Range: -0.50 and -8.50)	<0.001	-0.37±0.39 (Range +0.47 and -3.75)
17-18	82 (27.2%)	25.92± 12.77 (6 - 61.87)	-1.57±1.13 (Range: -0.50 and -5.62)	-2.15±1.30 (Range: -0.50 and -6.00)	<0.001	-0.26±0.29 (Range: +0.16 and -1.49)
p value		0.001	0.212	<0.001		<0.001
Gender						
Females	191 (63.5%)	37.36±18.94 (6 - 98)	-1.54±1.11 (Range: -0.5 and -5.62)	-2.67±1.59 (Range: -0.50 and -8.50)	<0.001	-0.37±0.39 (Range: +0.47 and -3.75)
Males	110 (36.5%)	37.77±19.63 (6.23 - 91)	-1.42±1.0 (Range: -0.5 and -5.25)	-2.35±1.43 (Range: -0.50 and -7.50)	<0.001	-0.31±0.33 (Range: +0.3 and -2.06)
p value		0.94	0.149	0.015		0.024
Severity of myopia						
Mild	269	37.17±18.87 (6 - 98)	-1.2±0.64 (Range: -0.5 and -2.87)	-2.24±1.24 (Range: -0.50 and -7.25)	<0.001	-0.35±0.37 (Range: +0.47 and -3.75)
Moderate	27	40.02±22.34 (6 - 79.8)	-3.76±0.59 (Range: -3,0 and -4.875)	-5.03±1.26 (Range: -3.00 and -8.125)	<0.001	-0.39±0.33 (Range: +0.16 and -1.27)
High	5	42.44±18.44 (19.4 - 61.17)	-5.17±0.22 (Range: -5.0 and -5.62)	-6.13±1.04 (Range: -5.00 and -8.50)	=0.018	-0.21±0.20 (Range: 0 and -0.67)
p value		0.42				0.37

Results indicate as mean±standard deviation.

children between 6-11 years with a mean age of 9±0.96, 173 children between 12-16 years with a mean age of 14.29±1.35, 82 children between 17-18 years with a mean age 17,44±0.26. The follow-up period was 39.17±17.19, 42.57±19.73, and 25.92±12.77 months for the groups, respectively. The follow-up period of the last group was significantly lower ($p<0.001$, one-way ANOVA, $F(2,598)=48.99$). There was no significant difference between the baseline refractive values of the groups ($p=0.212$, one-way ANOVA, $F(2,598)=1.556$). However, there was a statistical significance between the final SER values ($p<0.001$, one-way ANOVA, $F(2,598)=9.496$). The annual SER changes were -0.46±0.40 D, -0.37±0.39 D, and -0.26±0.29 D in the groups, respectively. The progression of myopia between the groups was statistically significant ($p < 0.001$, one-way ANOVA, $F(2,598)=8,677$), and the greatest myopia progression was detected in the youngest group.

According to the severity of myopia, while there were 269 patients in the mild myopic group (-0,5 D to -2,99 D), there were 27 patients in the moderate myopic group (-3 D to -4,99 D) and 5 patients in the high myopic group (-5D and above). Although there was no statistical significance, myopia progression was faster in moderate myopes (-0.39±0.33 D/a year), followed by mild (-0.35±0.37 D/a year) and high myopes (-0.21±0.20 D/a year) ($p=0.37$, one-way ANOVA, $F(2.598)=0.995$). The post hoc analysis of the groups revealed no significant difference between the moderate myopic group showing the fastest progression, and the high myopic group showing the slowest progression ($p=0.118$, Mann Whitney U).

Baseline, final SER values, and annual myopia progression were greater in females. They were -1.54±1.1 D, -2.67±1.59 D, -0.26±0.29 D/year in females and -1.42±1.0 D, -2.35±1.43 D, -0.31±0.33 D/year in males, respectively. A statistical significance was observed between the gender when the final SER values and annual change of SER value were examined ($p=0.015$ and $p=0.024$, respectively).

DISCUSSION

The results from this study indicate that the annual myopia progression in school-aged children in urban areas varied with age, the age of onset, the severity of myopia, and gender. The mean myopia progression was about -0.35±0.37 D/a year overall, but this value was -0.46±0.40 D/a year in the 6-11 years old children.

Myopia tends to increase as children grow up. The annual progression values are similar to those in Caucasian children (aged 6 to 15 years) living in Australia (-0.31 to -0.41D), Europe (-0.55D), the UK, and the USA (-0.34 D to -0.50D) and in East Asian countries like China and Singapore (-0.31 to -1.2 D).[4,8-10] In a meta-analysis including 2194 participants in total, children wearing single-vision spectacles with an average age of 9.3 had a progression of -0.52 D (%95 CI -0.39 to -0.72 D) myopia per a year in Europe and -0.82 D (%95 CI -0.71 to -0.93 D) per a year in Asia.[4] The median progression rate of myopia was found to be -0.16 D/year, and 62% of children with myopia progressed in London, UK.[11] Further, 400 children aged 6-12 years with spherical equivalents of -1.00 and -6.00 D were followed for two years. -1.20±0.69 D/2 years myopic change was detected in the non-treated atropine placebo group (n=200) in the ATOM1 study.[12] In the present study, annual change in SER was found to be similar to East Asian countries and higher than in London. The variations in the myopia progression among different countries could be explained by the location, lifestyle, and ethnicity variations among different population groups.

In our study, individuals with a moderate degree of myopia had greater progression than those with a mild and high degree of myopia. Verkicharla PK et al. found different outcomes from our study. They indicated a faster myopia progression in the patients with higher degrees at baseline. A similar result was also reported in Taiwanese, Chinese, and Singaporean school children.[14-17] The conflicting results of our study may be explained by the small number of our high-myopic patient group. In the study conducted in London, the progression was found to be higher in the moderate myopia group than in the mild myopia group ($p<0.001$, -0.54, and -0.37 D/year, respectively), which matches our results.[11] The exact mechanism of why moderate myopes progress at a faster rate compared to that mild myopes needs to be clarified. The moderate myopia population might have a different causal relationship with myopiogenesis, unlike physiological myopia, and influence genes in myopiogenesis and progression.[18]

There is a conflict of gender dominance in myopia. Studies show that myopia is more common but progresses more slowly in school-age girls, and the frequency is higher in boys at advanced ages.[19,20] In our study, myopia was more common in girls, consistent with the literature. However, there was a significant difference between the genders regarding myopia progression. Girls were more prone to have progression of myopia.

The strength of the present study is the inclusion of extensive data for determining the annual myopia progression in 301 patients. Also, being the first study conducted in an urban area in the Western Black Sea Region of Turkey is another feature of this study.

There are several limitations of our study. Being a citywide population study, it may only reflect some of the country, especially due to the known difference in myopia between urban and rural regions. In addition, the retrospective nature and non-cycloplegic refractive measurements may lead to bias. Beyond that, this study did not evaluate the other potential factors, such as time spent outdoors, parenteral myopia, and time spent near work. Further studies involving separate data from rural and urban areas, with data related to various factors such as exposure to light levels/time outdoors, are required in our country.

CONCLUSION

The progression of myopia in school-aged Turkish children from the Western Black Sea Region is comparable to the world. This finding of the greater progression in 'moderate myopes' compared to that of the mild myopes and the tendency of the younger age group emphasizes the need for regular follow-ups with short intervals and the application of anti-myopia strategies to control myopia progression.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Zonguldak Bülent Ecevit University Faculty of Medicine Clinical Researches Ethics Committee (Date: 06.04.2022, Decision No: 2022/07).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version.

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