Research Paper

The Prevalence of Astigmatism in 7 to 13 Years Old Children: A Cross-sectional Study

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ABSTRACT

Background: Refractive errors are among the most common causes of vision loss in patients attending healthcare facilities in the first and second decades of life. Astigmatism stands out as one of the common and treatable causes of vision loss in pediatrics.

Methods: In this cross-sectional study, the samples were chosen by random cluster sampling among children aged between 7 and 13 years from elementary schools in 2014-2015 academic year. For all students, refractive errors were assessed by Autorefractor Keratometer and retinoscopy. Internal astigmatism was defined as the difference between refractory and corneal astigmatism. SPSS software, version 16 was used for data analysis.

Results: A total of 1009 children participated in the study. Among them, 468(46.4%) were male, and 541(53.6%) were female. Their mean age was 9.2±1.7 years. About 14.5% of them had refractory astigmatism. Corneal astigmatism was the most common type, with 12.5% of students suffering from it. The prevalence of corneal astigmatism was not significantly different between males and females (P=0.19). Also, there was no significant relationship between increasing age and prevalence of astigmatism in this age group (P=0.06).

Conclusions: There was no significant difference in the rate of refractory astigmatism, lenticular and corneal astigmatism, between males and females. Because correcting refractory errors in students has a positive effect on learning ability and physical and mental development, screening and follow-up are recommended in this age group.

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Introduction

Around the world, the principal cause of visual impairment is uncorrected refractive errors (REs) (43%) and cataracts (33%). RE is an eye condition in which light from a distant object is not focused on the retina but instead in front of or behind the retina. There are three types of RE: Myopia, hypermetropia, and astigmatism [1]. Astigmatism is one of the most notable and prevalent REs that can have detrimental visual effects if at high levels (>4.00 diopter cylinder) from a young age [2, 3]. Studies have shown that significant astigmatism during the visual system's development can disrupt emmetropization and cause meridional amblyopia in children [4, 5]. The World Health Organization (WHO) estimates that 153 million people worldwide have visual impairment due to uncorrected REs [6]. According to studies conducted in Iran, the prevalence of astigmatism in Iranian children was less than 20% [7-9]. However, few studies have reported higher percentages (25% and 45.3%) in children under 15 [10, 11].

Astigmatism may also be associated with reduced performance on complex visual and cognitive tasks, such as reading fluency. Previous studies have reported that simulated astigmatic blur can reduce reading speed [12]. In addition, patients with astigmatism may experience decreased quality of vision, increased glare, difficulty driving at night, risk of falls, and dependence on glasses, leading to reduced vision-related quality of life [13]. REs cannot be prevented but can be diagnosed by an eye examination and treated with corrective glasses, contact lenses, or refractive surgery. If corrected in time and by eye-care professionals, they do not impede the full development of good visual function [6].

Two components of astigmatism can be independently measured: Refractive total astigmatism (TA) and corneal astigmatism (CA). Knowledge of the distribution and relationship between the components of astigmatism is important for understanding the development and progression of TA [14-16].

The prevalence of astigmatism varies in different places of the world based on age, sex, ethnicity, and geographical location [7]. Most changes due to astigmatism and its effects are observed in individuals under 15 [17, 18]. This study aimed to describe the characteristics and components of astigmatism in elementary school children in Sari City, Iran.

Methods

The present study, conducted from 2014 to 2015, is cross-sectional. A total of 1009 students from four elementary schools were selected using a random cluster sampling method. The sample size was determined to be 1000 based on the standard deviation reported in Yekta et al.'s study [9], which assessed the prevalence of refractive errors among the students of northeastern Iranian schools, a test power of 80% and a confidence interval of 95%. The city of Sari has two educational districts; each district has four public schools for girls and four public schools for boys. Two schools were selected from girls' and boys' schools in each district, and finally, four girls' schools and four boys' schools were selected. Each of the selected schools had six grades and four classes from each grade; two classes were randomly selected in each grade. Finally, 12 girls' and 12 boys' classes from each of the two districts (48 classes in total) were chosen. All the students of the selected classes were examined. After choosing the classes, the parents of the students were called, explained the study's objectives. Out of 1260 students, 1038 participated in the study. After obtaining written consent from the legal parents and explaining the examination process, all students were examined in the Eye Clinic of Bo Ali Sina Sari Medical Education Center in alphabetical order, one by one. Each participant was interviewed before the examination, and their school grade was recorded.

The study's inclusion criteria were all students aged 7 to 13 years in elementary school. The exclusion criteria included lack of parental consent, a history of eye surgery or traumatic eye injuries, childhood diabetes, significant ocular deviation, and inflammatory and infectious diseases of the cornea. Also, students with congenital cataracts, congenital ptosis, cleft palate, tropia, and other pathological conditions were excluded from the study.

First, an experienced operator assessed the refraction of participants by a Nidek (ARK-510 AK) Autorefractor Keratometer, and the average of three measurements was recorded. Then, subjective refraction was performed, and the students' vision was recorded without refractive correction and with the best refractive correction. E-chart was used to measure visibility at a distance of 6 m.

Definitions

In this study, the cylinder was recorded with a negative sign. Astigmatism was defined as a cylinder error ≥0.50 diopter (D). The average cylinder after three measurements

Table 1. Prevalence of astigmatism in two eyes in two genders

Variables	No. (%)				P
	Eye	Boy	Girl	Total	
Astigmatism	Right	61(6)	86(8.5)	147(14.5)	0.199
	Left	78(7.7)	89(8.8)	167(16.5)	0.497
Corneal astigmatism	Right	56(5.5)	71(7)	127(12.5)	
	Left	76(7.5)	81(8)	157(15.5)	
Lenticular astigmatism	Right	3(0.3)	11(1)	14(1.4)	
	Left	2(0.2)	6(0.6)	8(0.8)	
Corneal and Lenticular astigmatism	Right	2(0.2)	4(0.4)	6(0.6)	
	Left	0	2(0.2)	2(0.2)	

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with an Autorefractor Keratometer was considered refractive astigmatism. The dioptric power difference between the two main axes of the eye resulting from keratometry was considered corneal astigmatism, and the difference between corneal astigmatism and total astigmatism was considered as internal astigmatism.

Data analysis

Data analysis was conducted using SPSS software version 16, with descriptive statistics methods consisting of Mean±SD for quantitative variables. A frequency table was used for qualitative variables. The t-test and chi-square test were used for demographic information comparison. A P of 0.05 was considered significant.

Results

Of 1260 selected students, 1038 participated in the study (82.38% response rate). After considering the inclusion and exclusion criteria, the data of 1009 students were analyzed, of which 541(53.6%) were girls. The participants' mean age was 9.2±1.7 years (range: 7-13 y).

According to the Snellen chart, the visual acuity showed no significant difference between boys and girls regarding the right (P=0.35) and left eyes (P=0.635). In general, 14.5% of the studied subjects had astigmatism; the most prevalent astigmatism in the right and left eyes was corneal astigmatism, with 127 cases (12.5%) and 157(15.5%), respectively. Other information is presented in Table 1. There was no difference in the type of astigmatism (corneal and lenticular) between boys and girls in both eyes P>0.05. The highest number of astigmatism cases were in the left eye at 7 to 8 years (30.5%). There was no significant relationship between age and the degree of astigmatism of the right (P=0.1) and left (P=0.084) eyes.

Discussion

In this study, the prevalence of total corneal and internal astigmatism and its changes were assessed in relation to age and sex. The prevalence of astigmatism in the present study was 14.5%, and the most common astigmatism was corneal type. In the meta-analysis study conducted for children according to WHO regions, Southeast Asia reported the lowest prevalence (9.8%) of astigmatism. In comparison, the highest prevalence was seen in the Americas (27.2%), followed by the Eastern Mediterranean region [19, 20]. Also, in the studies conducted in different areas of Iran, the prevalence of astigmatism has been reported to be 16.7% in Shahrood City in primary school [21], 11.3% in Shiraz City in the age group of 7-15 years [9], 11.5% in Bojnourd City [7], and 14.5% in Khaf rural areas [22]. These results are consistent with our findings, and reported differences could indicate the role of genetics as well as the geographical locations of the race. A study on school children in an Iranian city (Dezful) found a prevalence of 45.3% for astigmatism [23], which is significantly higher than our findings and the results of most previous investigations. Because the definitions in this study and prior studies conducted in Iran were fairly similar, and their methodology was not significantly different, the significant variation may be attributable to environmental variables affecting astigmatism.

In the present study, the prevalence of astigmatism in girls and boys was not different. The results of different studies in this regard are controversial. For example, many studies have shown no gender preponderance [24-26]. Some studies have reported a higher prevalence in girls [21, 27] and boys [28, 29]. There was no significant relationship between age and the degree of astigmatism. Studies that reported a significant relationship between age and the prevalence of astigmatism examined a wider range and reported the role of environmental factors as the reason for the higher prevalence of astigmatism in the elderly [30, 31]. Since most of the changes in the cornea, except pathological cases such as keratoconus [32], occur in the first years of childhood, not much change is expected in this age group [33].

Out of 14.5% of cases with refractive astigmatism, 12.5% was caused by corneal astigmatism, 1.4% was caused by internal astigmatism, and 0.8% was caused by changes in both the corneal and internal surfaces, which confirms the important role of the cornea in causing astigmatism in people.

Conclusion

The prevalence of astigmatism in this study was not high compared with previous studies. Considering the relatively high prevalence of astigmatism, especially the corneal type, in students and its effects on the quality and performance of their vision and, subsequently, their learning and cognitive activities, screening children before entering school can help identify significant cases that can lead to amblyopia and irreparable problems to be effective.

Ethical Considerations

Compliance with ethical guidelines

The present study was approved by the Ethics Committee of the Research and Technology Deputy of Mazandaran University of Medical Sciences (Code: 1770).

First, the patients were informed of the general objectives of the study. The study was conducted according to ethical guidelines. Informed consent was obtained from the patient's legal guardians. Then, each patient was given a code, and the information extracted from the patient file was anonymous and general.

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Authors contributions

All authors equally contributed to preparing this article.

Conflicts of interest

The authors declared no conflict of interest.

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