Original Article

Prevalence of Refractive Errors among Elementary School Students in Iranshahr, Iran

Mojgan Jamalzehi *[1], MS

1- Iranshahr University of Medical Sciences, Iranshahr, Iran.

***Corresponding Author:** Mojgan Jamalzehi
E-mail: dr.kiasha93@gmail.com

Abstract

Purpose: To determine the prevalence of refractive errors among elementary school students in Iranshahr, Iran.
Materials and Methods: For this cross-sectional study, 1,745 students from elementary schools in Iranshahr city, Sistan and Baluchestan province, Iran, were chosen using a multi-staged cluster sampling method. The examinations included measuring uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), cycloplegic refraction, cover test, and ophthalmoscopy. In this study, the refractive error study in children (RESC) protocol was used. Cycloplegic refraction spherical equivalent of less than or equal to -0.50 D was considered myopia, ≥ 2.00 D was considered hypermetropia, and a cylinder ≥ 0.50 D was considered astigmatism.
Results: Information was completed for 1,576 students (response rate: 90.31 %). Participants were on average 9.76 ± 1.86 years old. UCVA and BCVA of 20/20 or lower were found in 15.7 % and 2.5 % percent of the study population, respectively. The prevalence of hyperopia and myopia were 5.7 % and 7.3 % respectively.
Conclusion: Elementary school children in Iranshahr city, Iran, show a relatively high prevalence of refractive errors, particularly astigmatism. It is necessary for the health system to focus on identifying and correcting refractive errors among this age group.

Keywords: Prevalence; Hyperopia; Myopia; Astigmatism; Elementary School; Children.

Article Notes: Received: Oct. 12, 2022; Received in revised form: Nov. 06, 2022; Accepted: Jan. 02, 2023; Available Online: Apr. 02, 2023.

How to cite this article: Jamalzehi M. Prevalence of Refractive Errors among Elementary School Students in Iranshahr, Iran. Journal of Ophthalmic and Optometric Sciences . 2023;7(2): 1-8.

Introduction

Refractive errors are the most common cause for visiting an ophthalmologist (21.1 %), followed by glaucoma (19.3 %), lens pathology/cataract (14.9 %), and diseases affecting the posterior segment of the eye (14.9 %) [1]. If left untreated, refractive errors are the most common cause of visual impairment in students, negatively impacting their educational process as well as their physical and mental development [2-8]. Uncorrected refractive errors affect an estimated 108 million people globally and are the leading cause of visual impairment in developing countries [9, 10].

Refractive errors are caused by an imbalance of the eye's axial length and optical power, which prevents light from focusing directly on the retina, resulting in blurred retinal images [11]. The three primary types of refractive errors are hyperopia, myopia and astigmatism. Astigmatism can be present in both hyperopic and myopic eyes, despite being considered a separate category of refractive error [12]. Symptoms of refractive errors include blurry vision, headaches, and asthenopia [13, 14].

Uncorrected refractive errors can be addressed with an eye examination and the prescription of suitable correction options such as spectacles, contact lenses, or refractive surgery [7, 10, 15, 16]. Although refractive errors can be easily corrected, they remain untreated in some populations due to various reasons, including limitations in high-quality refractive error services, social issues, and economic problems [15, 17-22]. Uncorrected refractive error has significant long-term impacts, particularly in children, and has become an important socioeconomic and public health issue [15, 23]. Additionally, amblyopia, a condition where one or both eyes lose normal vision, can develop in children if refractive error is not corrected early [15].

In recent decades, numerous studies have focused on the frequency of refractive error in student populations worldwide, reporting varying percentages based on genetic and environmental conditions [20, 21, 24]. Recent studies have highlighted a higher prevalence of myopia in East Asian societies, with Japan, Taiwan, Hong Kong, Mainland China, Singapore, and South Korea being particularly affected [23, 25-30].

Studies in different cities in Iran, including Aligudarz, Bojnurd, Dezful, Mashhad, Shahrood, and Shiraz, have reported the prevalence of myopia between 3.4 % and 29.3 %, hyperopia between 5.4 % and 27.4 %, and astigmatism between 9.8 % and 20.7 % [3, 13, 21, 31]. Given the vast and diverse population of Iran and the varying prevalence levels of refractive errors reported in different studies, further research is required to improve our understanding of the prevalence levels in different geographical regions of the country.

The present study, performed based on the refractive error study in children (RESC) protocol, aimed to assess the prevalence of refractive errors among elementary school students in Iranshahr, Iran. Iranshahr city is located in the Sistan and Baluchestan province in southeastern Iran, where few extensive studies regarding the prevalence of refractive errors have been conducted. The findings of this study can add valuable input to previous studies carried out in Iran, enhancing our understanding of the refractive status in the country.

Materials and Methods

This study was conducted on a cross-sectional basis among elementary school students in Iranshahr city, Sistan and Baluchestan province, Iran. Samples were chosen using

a multi-stage cluster sampling method, and 1,745 students were selected to participate in the study. Written informed consent was obtained from the students and their parents for the examinations. The Research and Ethics Committee of the Iranshahr branch of the Ministry of Education approved the study protocol, and the study adhered to the Declaration of Helsinki.

Inclusion criteria were being an elementary school student residing in the Iranshahr region during the time of the study. Exclusion criteria included lack of parental consent, the presence of pathological eye disorders except for refractive errors (such as glaucoma, retinal disorders, opacity in the visual pathway), any history of ocular surgery, contraindications for the use of cycloplegic drops, and lack of cooperation from the student.

All participants were examined individually by one optometrist. The examinations included measuring the uncorrected visual acuity (UCVA), best corrected visual acuity (BCVA), cycloplegic spherical equivalent refractive error, cover test to detect deviations, and ophthalmoscopy to examine the anterior segment, lens opacity, and retina.

First, direct ophthalmoscopy was used to rule out diseases in the posterior and anterior segments of the eye. In the absence of disease, the UCVA was measured using a projector chart (Topcon Company) at a distance of 6 meters. Then, the refractive error was determined by an auto refractometer (Topcon Company, model 8900) and confirmed by a Heine retinoscope. The refractive error of the student was then corrected, and BCVA was measured using a projector chart (Topcon Company) at a distance of 6 meters. Possible deviations were examined by the cover test. Finally, cycloplegic refraction was performed. The cycloplegic refraction was determined 40 minutes after administering cyclopentolate 1 % drops three times within 5 minutes using an auto refractometer (Topcon Company, model 8900) and a Heine retinoscope. All data were recorded in a special form designed for this study.

In this study, RESC protocol was used. Cycloplegic refraction spherical equivalent of less than or equal to -0.50 D was considered myopia, ≥ 2.00 D was considered hypermetropia, and a cylinder ≥ 0.50 D was considered astigmatism. The axis of astigmatism was categorized as with-the-rule (WTR) with an axis of 180 ± 30 degrees, against-the-rule (ATR) with an axis of 30 ± 90 degrees, and oblique with axes of 30-60 degrees and 120-150 degrees.

SPSS version 21 (Armonk, NY: IBM Corp.) was used to analyze the data. The prevalence rates and 95 percent confidence intervals (CI) were provided, adjusted for cluster sampling. Chi-square analysis was used to examine the relationships between hyperopia, myopia, astigmatism, and age. The level of significance was set at 5 %.

Results

Out of 1,745 students, 1,576 were examined and their data were recorded (response rate: 90.31 %). Of those examined, two were diagnosed with anterior segment problems, and three suffered from retinal and posterior segment disorders and were excluded from the study. The other exclusions were due to lack of parental consent, or lack of cooperation from the student. The mean age of participants was 9.76 ± 1.86 years (range: 6-11 years). UCVA was 20/20 in 84.3 % of cases and BCVA was 20/20 among 97.5 % of participants. UCVA and BCVA of 20/20 or lower were found in 15.7 % and 2.5 % percent of the study

population, respectively. The prevalence of hyperopia and myopia were 5.7 % and 7.3 % respectively.

Information regarding UCVA and BCVA among participants is presented in table 1.

Table 1: Distribution of UCVA and BCVA among participants in the study

Visual acuity	UCVA	BCVA
20/20	84.3 %	97.5 %
Between 20/40 and 20/20	13 %	2.5 %
Between 20/200 and 20/40	2.7 %	0.0

The mean cycloplegic spherical equivalent refractive error was 0.40 ± 0.89 diopters (range: - 4.75 D to 4.87 D). The mean cycloplegic spherical refractive error was 0.59 ± 0.85 diopters, and the mean astigmatism refractive error was - 0.38 ± 0.44 diopters. Myopia was found to be present in 6.5 % of the study population (95 % CI: 5.43 % - 7.57 %), and the prevalence of hypermetropia was 5.6 % (95 % CI: 4.61 % - 6.59 %).

Our findings indicated an increase in myopia prevalence (Pearson Chi- Square = 508.284, df = 350, P < 0.001) and a decrease in hyperopia prevalence (Pearson Chi-Square = 37.311, df = 10, P < 0.001) with increasing age.

The prevalence of astigmatism in this study was 18.9 % (95 % CI: 17.21 % - 20.59 %). As figure 1 shows, the prevalence of astigmatism increased with age (Pearson Chi-Square = 20.57, df = 5, P < 0.001).

Of the students with astigmatism 53.6 % had WTR, 29.9 % had ADR and 16.4 % had oblique astigmatism (Table 2). There was no significant correlation between the type of astigmatism and age (Pearson Chi-Square= 15.69, df= 10, P = 0.109).

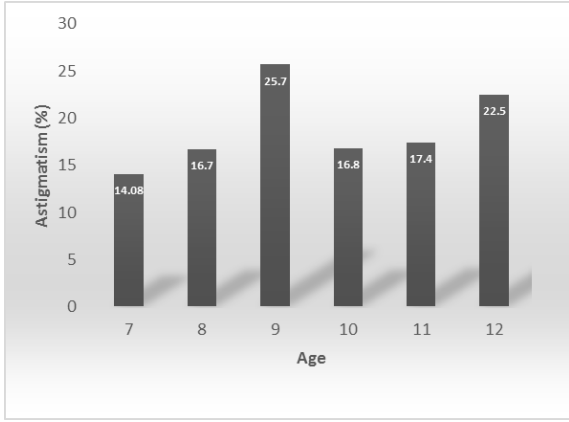

Figure 1: The prevalence of astigmatism by age

Table 2: The age distribution of different types of astigmatism

Age (years)	WTR (%)	ADR (%)	Oblique (%)
7	60.5	21.6	18.0
8	57.3	24.4	18.3
9	51.6	32.1	16.3
10	50.0	32.1	17.9
11	52.4	32.5	15.2
12	52.4	34.9	12.7
Total	53.6	29.9	16.4

WTR: With-the-rule; ATR: Against-the-rule

Discussion

In this investigation, we assessed the prevalence of refractive errors among male elementary students in Iranshahr city, Iran. This has been done for the first time in this region. The participation rate in this study was notable (96.5 %), which is a strength of our research.

The prevalence of UCVA below 20/20 was 15.7 %, which is similar to studies in Denmark, Oman, and Egypt, but much higher

compared to studies in Iranian cities such as Dezful, Shiraz, and Bojnoord [21, 25, 31-34]. The prevalence of BCVA below 20/20 was 2.5 %, which is close to studies in Denmark, Egypt, and Nepal, but lower than studies in Dezful and Shiraz [3, 25, 31-35].

The prevalence of hyperopia in this study was 5.7 %. In our study the prevalence of hyperopia was lower than myopia, which in similar to results from high school students in Western Iran [21], but in contrast with results from school children in Northeastern Iran [3]. In the present study similar to other studies hyperopia decreased with increasing age [3]. Since hyperopia has been found to be one of the most important risk factors for amblyopia, this form of refractive error and its correction require special attention [36-39].

Myopia is becoming more prevalent worldwide, and in some areas, it has reached epidemic levels [40]. The prevalence of myopia in this study was 7.3 %. Myopia is on the rise throughout Asia, despite its prevalence differing between countries [41]. Studies in Southeast Asia, such as Hong Kong, Japan, and China, have reported higher levels of myopia [41, 42]. In this study, the prevalence of myopia increased from 4.5 % at age 7 to 9.8 % at age 12; several studies have also observed such an increase [43, 44]. The increased prevalence of myopia with age may be due to the elongation of the axial length of the eye and increased near work [45].

The most prevalent type of astigmatism in this study was WTR astigmatism, with a prevalence of 54.7 %, which is consistent with many other studies [46, 47]. In this study, WTR astigmatism decreased from 60.5 % to 52.4 %, and ATR astigmatism increased from 21.6 % to 29.9 % over five years (From age 7 to age 12). According to the literature, there is a strong correlation between age and the orientation of refractive astigmatism, suggesting that as people age, astigmatism shifts from WTR to ATR [48, 49].

In conclusion impaired visual acuity in the current study was higher than some studies conducted in Iran. In this region, specific population screening plans along with training services for ophthalmologists and optometrists should be implemented to ensure timely treatment of these disorders.

Conclusion

Elementary school children in Iranshahr city, Iran, show a relatively high prevalence of refractive errors, particularly astigmatism. It is necessary for the health system to focus on identifying and correcting these refractive errors among this age group.

Authors ORCIDs

Mojgan Jamalzehi:
https://orcid.org/0000000349201578

References

1. Schiefer U, Kraus C, Baumbach P, Ungewiß J, Michels R. Refractive errors. Dtsch Arztebl Int. 2016;113(41):693-702.

2. Kannan U, Rajendiran A, Yeraballi D, Shanmugavel K, John NA, Rene S. Refractive error and associated risk factors in 6-12 years school children. National Journal of Physiology, Pharmacy and Pharmacology. 2016; 6(6): 554-8.

3. Rezvan F, Khabazkhoob M, Fotouhi A, Hashemi H, Ostadimoghaddam H, Heravian J, et al. Prevalence of refractive errors among school children in Northeastern Iran. Ophthalmic Physiol Opt. 2012;32(1):25-30.

4. Verhoeven VJ, Wong KT, Buitendijk GH, Hofman A, Vingerling JR, Klaver CC. Visual

consequences of refractive errors in the general population. Ophthalmology. 2015;122(1):101-9.
5. O'Donoghue L, McClelland JF, Logan NS, Rudnicka AR, Owen CG, Saunders KJ. Refractive error and visual impairment in school children in Northern Ireland. Br J Ophthalmol. 2010;94(9):1155-9.
6. Muma S, Obonyo S. The prevalence and causes of visual impairment among children in Kenya - the Kenya eye study. BMC Ophthalmol. 2020;20(1):399.
7. Casas Luque L, Naidoo K, Chan VF, Silva JC, Naduvilath TJ, Peña F, et al. Prevalence of Refractive Error, Presbyopia, and Spectacle Coverage in Bogotá, Colombia: A Rapid Assessment of Refractive Error. Optom Vis Sci. 2019;96(8):579-86.
8. Keel S, McGuinness MB, Foreman J, Scheetz J, Taylor HR, Dirani M. Prevalence, associations and characteristics of severe uncorrected refractive error in the Australian National Eye Health Survey. Clin Exp Ophthalmol. 2020;48(1):14-23.
9. Almudhaiyan T, Alhamzah A, AlShareef M, Alrasheed A, Jaffar R, Alluhidan A, et al. The prevalence of refractive errors among Saudi adults in Riyadh, Saudi Arabia. Saudi J Ophthalmol. 2020 Nov 22;34(1):30-4.
10. Sheeladevi S, Seelam B, Nukella PB, Borah RR, Ali R, Keay L. Prevalence of refractive errors, uncorrected refractive error, and presbyopia in adults in India: A systematic review. Indian J Ophthalmol. 2019;67(5):583-92.
11. Yang L, Vass C, Smith L, Juan A, Waldhör T. Thirty-five-year trend in the prevalence of refractive error in Austrian conscripts based on 1.5 million participants. Br J Ophthalmol. 2020;104(10):1338-44.
12. Harb EN, Wildsoet CF. Origins of Refractive Errors: Environmental and Genetic Factors. Annu Rev Vis Sci. 2019;5:47-72.
13. Hashemi H, Asharlous A, Khabazkhoob M, Yekta A, Emamian MH, Fotouhi A. The profile of astigmatism in 6-12-year-old children in Iran. J Optom. 2021;14(1):58-68.
14. Hashemi H, Saatchi M, Yekta A, Ali B, Ostadimoghaddam H, Nabovati P, et al. High Prevalence of Asthenopia among a Population of University Students. J Ophthalmic Vis Res. 2019;14(4):474-82.
15. Tagoh S, Kyei S, Kwarteng MA, Aboagye E. Prevalence of Refractive Error and Visual Impairment among Rural Dwellers in Mashonaland Central Province, Zimbabwe. J Curr Ophthalmol. 2020;32(4):402-7.
16. Hashemi M, Amiri MA, Tabatabaee M, Ayatollahi A. The results of photorefractive keratectomy with Mitomycin-C in myopia correction after 5 years. Pak J Med Sci. 2016;32(1):225-8.
17. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. Br J Ophthalmol. 2012;96(5):614-8.
18. Hashemi H, Pakzad R, Ali B, Yekta A, Ostadimoghaddam H, Heravian J, et al. Prevalence of Refractive Errors in Iranian University Students in Kazerun. J Curr Ophthalmol. 2020;32(1):75-81.
19. Naidoo KS, Leasher J, Bourne RR, Flaxman SR, Jonas JB, Keeffe J, et al. Global Vision Impairment and Blindness Due to Uncorrected Refractive Error, 1990-2010. Optom Vis Sci. 2016;93(3):227-34.
20. Rudnicka AR, Kapetanakis VV, Wathern AK, Logan NS, Gilmartin B, Whincup PH, et al. Global variations and time trends in the prevalence of childhood myopia, a systematic review and quantitative meta-analysis: implications for aetiology and early prevention. Br J Ophthalmol. 2016;100(7):882-90.
21. Hashemi H, Rezvan F, Beiranvand A, Papi OA, Hoseini Yazdi H, Ostadimoghaddam H,

et al. Prevalence of Refractive Errors among High School Students in Western Iran. J Ophthalmic Vis Res. 2014;9(2):232-9.
22. Giloyan A, Khachadourian V, Petrosyan V, Harutyunyan T. Prevalence and determinants of uncorrected refractive error among a socially vulnerable older adult population living in Armenia. Public Health. 2021;190:30-6.
23. Cheng F, Shan L, Song W, Fan P, Zhang L, Wang X, et al. Prevalence and risk factor for refractive error in rural Chinese adults in Kailu, Inner Mongolia. Ophthalmic Physiol Opt. 2021;41(1):13-20.
24. Williams KM, Verhoeven VJ, Cumberland P, Bertelsen G, Wolfram C, Buitendijk GH, et al. Prevalence of refractive error in Europe: the European Eye Epidemiology (E(3)) Consortium. Eur J Epidemiol. 2015;30(4):305-15.
25. Chin MP, Siong KH, Chan KH, Do CW, Chan HH, Cheong AM. Prevalence of visual impairment and refractive errors among different ethnic groups in schoolchildren in Turpan, China. Ophthalmic Physiol Opt. 2015;35(3):263-70.
26. Pan CW, Dirani M, Cheng CY, Wong TY, Saw SM. The age-specific prevalence of myopia in Asia: a meta-analysis. Optom Vis Sci. 2015;92(3):258-66.
27. Wu LJ, Wang YX, You QS, Duan JL, Luo YX, Liu LJ, et al. Risk Factors of Myopic Shift among Primary School Children in Beijing, China: A Prospective Study. Int J Med Sci. 2015;12(8):633-8.
28. Grzybowski A, Kanclerz P, Tsubota K, Lanca C, Saw SM. A review on the epidemiology of myopia in school children worldwide. BMC Ophthalmol. 2020;20(1):27.
29. Zhang J, Li Z, Ren J, Wang W, Dai J, Li C, Huang X, Sun X, Liu L, Wang C. Prevalence of myopia: A large-scale population-based study among children and adolescents in weifang, china. Front Public Health. 2022;10:924566.
30. Ding BY, Shih YF, Lin LLK, Hsiao CK, Wang IJ. Myopia among schoolchildren in East Asia and Singapore. Surv Ophthalmol. 2017;62(5):677-97.
31. Norouzirad R, Hashemi H, Yekta A, Nirouzad F, Ostadimoghaddam H, Yazdani N, et al. The prevalence of refractive errors in 6- to 15-year-old schoolchildren in Dezful, Iran. J Curr Ophthalmol. 2015;27(1-2):51-5.
32. Buch H, Vinding T, La Cour M, Appleyard M, Jensen GB, Nielsen NV. Prevalence and causes of visual impairment and blindness among 9980 Scandinavian adults: the Copenhagen City Eye Study. Ophthalmology. 2004;111(1):53-61.
33. Mousa A, Courtright P, Kazanjian A, Bassett K. Prevalence of visual impairment and blindness in Upper Egypt: a gender-based perspective. Ophthalmic Epidemiol. 2014;21(3):190-6.
34. Al Harby S, Al-Asbali T, Khandekar R. Visual acuity and refractive status of Omani students with refractive error in grades 1, 4 and 7: A retrospective cohort study. Oman J Ophthalmol. 2016;9(1):27-31.
35. Talebnejad MR, Nowroozzadeh MH, Mahdaviazad H, Khalili MR, Masoumpour MB, Keshtkar M, et al. The Shiraz Pediatric Eye Study; a Population Based Survey of School Age Children: Rationale, Design and Baseline Characteristics. J Ophthalmic Vis Res. 2018;13(3):293-300.
36. Pascual M, Huang J, Maguire MG, Kulp MT, Quinn GE, Ciner E, et al. Risk factors for amblyopia in the vision in preschoolers study. Ophthalmology. 2014;121(3):622-9.e1.
37. Al-Haddad C, El Moussawi Z, Hoyeck S, Mehanna CJ, El Salloukh NA, Ismail K, et al. Amblyopia risk factors among pediatric patients in a hospital-based setting using photoscreening. PLoS One.

2021;16(7):e0254831.
38. Kulp MT, Ying GS, Huang J, Maguire M, Quinn G, Ciner EB, et al. Associations between hyperopia and other vision and refractive error characteristics. Optom Vis Sci. 2014;91(4):383-9.
39. Rajavi Z, Sabbaghi H, Baghini AS, Yaseri M, Moein H, Akbarian S, et al. Prevalence of Amblyopia and Refractive Errors Among Primary School Children. J Ophthalmic Vis Res. 2015;10(4):408-16.
40. Morgan IG, French AN, Ashby RS, Guo X, Ding X, He M, et al. The epidemics of myopia: Aetiology and prevention. Prog Retin Eye Res. 2018;62:134-49.
41. Spillmann L. Stopping the rise of myopia in Asia. Graefes Arch Clin Exp Ophthalmol. 2020;258(5):943-59.
42. Xiang ZY, Zou HD. Recent Epidemiology Study Data of Myopia. J Ophthalmol. 2020;2020:4395278.
43. Schuster AK, Krause L, Kuchenbäcker C, Prütz F, Elflein HM, Pfeiffer N, et al. Prevalence and Time Trends in Myopia Among Children and Adolescents. Dtsch Arztebl Int. 2020;117(50):855-60.
44. Edwards MH. The development of myopia in Hong Kong children between the ages of 7 and 12 years: a five-year longitudinal study. Ophthalmic Physiol Opt. 1999;19(4):286-94.
45. Bullimore MA, Ritchey ER, Shah S, Leveziel N, Bourne RRA, Flitcroft DI. The Risks and Benefits of Myopia Control. Ophthalmology. 2021;128(11):1561-79.
46. Chebil A, Jedidi L, Chaker N, Kort F, Limaiem R, Mghaieth F, et al. Characteristics of Astigmatism in a Population of Tunisian School-Children. Middle East Afr J Ophthalmol. 2015;22(3):331-4.
47. Yang Z, Lu Z, Shen Y, Chu T, Pan X, Wang C, et al. Prevalence of and factors associated with astigmatism in preschool children in Wuxi City, China. BMC Ophthalmol. 2022;22(1):146.
48. Wu Z, Liu C, Chen Z. Prevalence and Age-Related Changes of Corneal Astigmatism in Patients Undergoing Cataract Surgery in Northern China. J Ophthalmol. 2020;2020:6385098.
49. Namba H, Sugano A, Murakami T, Utsunomiya H, Nishitsuka K, Ishizawa K, et al. Age-Related Changes in Astigmatism and Potential Causes. Cornea. 2020;39 Suppl 1:S34-Fhyper8.

Footnotes and Financial Disclosures

Conflict of interest:

The authors have no conflict of interest with the subject matter of the present manuscript.