

The prevalence of refractive errors in 6- to 15-year-old schoolchildren in Dezful, Iran

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Abstract

Purpose: To determine the prevalence of refractive errors, among 6- to 15-year-old schoolchildren in the city of Dezful in western Iran.

Methods: In this cross-sectional study, 1375 Dezful schoolchildren were selected through multistage cluster sampling. After obtaining written consent, participants had uncorrected and corrected visual acuity tests and cycloplegic refraction at the school site. Refractive errors were defined as myopia [spherical equivalent (SE) -0.5 diopter (D)], hyperopia (SE ≥ 2.0 D), and astigmatism (cylinder error > 0.5 D).

Results: 1151 (83.7%) schoolchildren participated in the study. Of these, 1130 completed their examinations. 21 individuals were excluded because of poor cooperation and contraindication for cycloplegic refraction. Prevalence of myopia, hyperopia, and astigmatism were 14.9% (95% confidence interval (CI): 10.1–19.6), 12.9% (95% CI: 7.2–18.6), and 45.3% (95% CI: 40.3–50.3), respectively. Multiple logistic regression analysis showed an age-related increase in myopia prevalence ($p < 0.001$) and a decrease in hyperopia prevalence ($p < 0.001$). There was a higher prevalence of myopia in boys ($p < 0.001$) and hyperopia in girls ($p = 0.007$).

Conclusion: This study showed a considerably high prevalence of refractive errors among the Iranian population of schoolchildren in Dezful in the west of Iran. The prevalence of myopia is considerably high compared to previous studies in Iran and increases with age.

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Keywords: Refractive errors; Children; Epidemiology; Middle-east

Introduction

With over 280 million visually impaired and 39 million blind, visual impairment is a major health issue that imposes a great burden to all nations globally.¹ The leading causes of visual impairment are refractive errors and cataracts, which

have been the focus of many studies since 1990.^{1,2} Nonetheless, recent studies still stress the magnitude of the problem with these two visual disorders because they affect the elderly as well as the young and children.¹ Studies around the world indicate that refractive errors are common in all ages.^{3–5} A look at these studies shows that over 40% of children and schoolchildren in eastern Asian countries are affected with refractive errors.^{6–8} Refractive errors have received much attention globally over the past decade, and studies have been able to answer many questions about these problems.⁹ Iran is the second most populous country in the Middle East. Many

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studies have discussed these problems in Iran in the past decade.^{3,9–12} According to these studies, hyperopia is the most common refractive disorder in Iranian children.

Although many studies have been conducted about the prevalence of refractive errors in Iranian schoolchildren, the results of these studies are inconsistent.^{3,9–12} In order to achieve a common result about the prevalence of hyperopia and myopia in Iranian students, further studies should be done using refractive error study in children (RESC) protocol across the country. Therefore, in the current study the prevalence of refractive errors has been studied using RESC protocol among the population of schoolchildren in Iran.

Materials and methods

This study was performed cross-sectionally between November 2013 and January 2014. The target population of the study was schoolchildren of the city of Dezful who were selected through multistage cluster sampling. There are 271 schools with 50177 students in Dezful. Twenty-four schools were selected as clusters in this study. In each school, using a simple random method, a number of students were selected from each class proportionate to the number of students in that school. After sample selection, the project was explained to their parents to invite them to participate, and consenting invitees were enrolled in the study. A suitable space was selected on the school site one day before the study. In each school, examinations were started with first graders, and students in each class were examined in alphabetical order.

Examinations

After the interview, students were guided into the examination room to have non-cycloplegic auto-refraction with the Topcon RM8800 autorefractor (Topcon Corporation, Japan) by a single skilled technician. Then students had their visual acuity tested with their present spectacles, if any, using a Snellen tumbling E chart distanced at 6.0 m from the examinee. For these students, lensometry was done with the Topcon LM 800 lensometer (Topcon Corporation, Japan), the results of which were recorded along with the date they received the prescription. Next, uncorrected visual acuity (UCVA) was tested for all participants, and auto-refractor results were refined through retinoscopy (HEINE BETA, Heine Optotechnik, Germany) and trial lenses (MSD, Italy). Finally, 2 drops of Cyclopentolate (1%) (Alcon Cusi El Masnou-Barcelona, Spain) were instilled 40 and 35 min before refraction.

Definition

Definitions – To provide grounds for accurate and valid comparisons with other studies using the RESC protocol,^{3,5,10,12–15} we set spherical equivalent based on cycloplegic refraction cut-points of -0.50 diopter (D) for myopia and $+2.0$ D for hyperopia. Astigmatism was defined as a cylinder

error > 0.5 D.^{3,5,10,12–15} We categorized myopia as mild (-0.5 D to -3.0 D), moderate (-3.1 D to -6.0 D), and high (worse than -6.0 D). Hyperopia was categorized as mild ($+2.0$ D to $+3.0$ D), moderate ($+2.1$ D to $+4.0$ D), and high ($> +4.0$ D).¹⁶

Astigmatism axis was classified as with-the-rule (WTR) if the axis was between 150° and 180° or between 0° and 30° , against-the-rule (ATR) if the axis was between 60° and 102° , and others were considered oblique astigmatism.

Cycloplegia was not induced in children with a history of epilepsy, cardiovascular disease, or cerebrovascular disease; these cases were excluded from the study. Another exclusion criterion was parents' non-consent.

Statistical analysis

Here we present the prevalence of refractive errors in percentages and 95% confidence intervals. The effect of cluster sampling was taken into account in calculating standard errors. Logistic regression was used to examine relationships of refractive errors with other studied factors, and odds ratios were calculated. To control for confounding factors, multiple logistic regression was used. A significance level of 95% was considered, and any P value less than 5% was reported significant.

Ethical issues

The Ethics Committee of Dezful University of Medical Sciences approved the study protocol, which was conducted in accord with the tenets of the Helsinki Declaration.

Results

In this study, 1375 schoolchildren were selected through cluster sampling, and 1151 (83.7%) of them participated.

We excluded 21 individuals because of poor cooperation and contraindication for cycloplegic refraction.

Refractive errors examinations were completed for 1130 children, whose data was used in the analyses. The mean age of the participants was 11.05 ± 2.93 (range: 6–15) years, and 520 (46.0%) were female. Mean spherical equivalent based on cycloplegic refraction was 0.47 ± 1.08 (range: -5.56 to 13.39) D. The prevalence of eyeglass wear was 6.02% [95% confidence interval (CI): 4.63–7.41].

Table 1 summarizes the prevalence of different types of refractive errors by age and gender. The overall prevalence of myopia was 14.9% (95% CI: 10.1–19.6); 17.0% and 12.3% in boys and girls, respectively. Logistic regression showed higher odds of myopia in boys ($p < 0.001$). Also, as shown in Table 1, the prevalence of myopia increased with age from 7.1% in the 6- to 7-year-old age group to 22.6% in the 14- to 15-year-age group ($p < 0.001$). Based on results of the multiple logistic regression model (Table 2), myopia prevalence directly correlated with older age ($p < 0.001$) and male gender ($p < 0.001$). Hyperopia was detected in 12.9% (95% CI: 7.2–18.6) of the studied students, and as

Table 1
The prevalence of myopia, hyperopia, and astigmatism in schoolchildren of Dezful by age and gender.

		Myopia% (95%CI)	Hyperopia% (95%CI)	Astigmatism (> 0.5D) % (95%CI)	Astigmatism (> 1D) % (95%CI)	Astigmatism (> 2D) % (95%CI)
Gender	Total	14.9(10.1–19.6)	12.9(7.2–18.6)	45.3(40.3–50.3)	12.6(10.2–14.9)	3.2(1.9–4.4)
	Female	12.3(7.8–16.9)	15.4(8.2–22.6)	41.5(34.8–48.3)	10.0(5.4–14.6)	2.3(1.1–3.5)
	Male	17.0(12.0–22.1)	10.8(6.2–15.4)	48.5(43.1–53.9)	14.8(8.9–20.6)	3.9(1–6.9)
Age (years)	6–7	7.1(6.7–7.6)	25.0(17.5–32.5)	47.3(42.6–52)	12.5(11.7–13.3)	3.6(0.3–6.8)
	8–9	8.0(2.5–18.5)	18.0(9.6–26.4)	38.0(9.9–66.1)	12.0(0.4–24.4)	2.0(0.3–6.3)
	10–11	11.8(9.6–13.9)	12.7(9.8–15.7)	52.0(48.8–55.1)	13.7(9.1–18.4)	2.9(1–4.9)
	12–13	17.7(15.9–19.4)	9.1(6.4–11.9)	43.3(34.3–52.3)	11.6(8–15.1)	2.4(2.3–2.5)
	14–15	22.6(20–25.3)	5.8(5.5–6.2)	43.8(38.6–49)	13.1(7.4–18.9)	4.4(1.6–7.1)

CI: confidence interval.

D: diopter.

Table 2
The association between myopia, hyperopia, and astigmatism with age and gender in multiple logistic regression.

	Variables	OR (95%CI)	p-value
Myopia	Age (year)	1.19 (1.13–1.26)	< 0.001
	Gender (male/female)	1.49 (1.29–1.72)	< 0.001
Hyperopia	Age (year)	0.81 (0.78–0.85)	< 0.001
	Gender (male/female)	0.65 (0.5–0.86)	0.007
Astigmatism	Age (year)	0.99 (0.94–1.05)	0.843
	Gender (male/female)	1.33 (1.03–1.71)	0.032

OR: odds ratio.

CI: confidence interval.

demonstrated in Table 1, the prevalence was significantly higher in girls ($p < 0.001$) and significantly decreased with age ($p < 0.001$). Multiple logistic regression identified female gender ($p = 0.007$) and younger age ($p < 0.001$) as risk factors related to hyperopia. Of the participants with myopia, 74.3% had mild myopia, 16.7% had moderate myopia, and 9% had severe myopia. Mild, moderate, and severe hyperopia was seen in 84.4%, 10.5%, and 5.1% of the hyperopic participants, respectively. As demonstrated in Table 1, the prevalence of astigmatism was significantly higher in boys ($p = 0.033$), but age-related changes in astigmatism were not statistically significant ($p = 0.861$). Results of the multiple model showed that only the male gender ($p = 0.032$) statistically significantly correlated with the prevalence of astigmatism. In the studied sample, 24.2% and 17.5% had with-the-rule and against-the-rule astigmatism, respectively, and the prevalence of oblique astigmatism was 3.5%.

The results of our study showed that the uncorrected Visual Acuity was 0.05 ± 0.16 LogMar in all individuals.

The findings of this study represented the uncorrected Visual Acuity as the lowest in myopic individuals and the highest in emmetropic participants. It was 0.02 ± 0.07 , 0.51 ± 0.25 and 0.20 ± 0.31 LogMar in emmetropic, myopic, and hyperopic individuals, respectively ($P < 0.001$).

The uncorrected Visual Acuity was 0.23 ± 0.25 and 0.03 ± 0.12 LogMar in astigmatic and non-astigmatic individuals, respectively ($p < 0.001$).

Discussion

Visual disorders in children and schoolchildren have been discussed in several studies in recent years in Iran and the rest of the world.^{7,9,11,12,17–20} However, conclusive results require further studies in this area. In this study, we demonstrated the prevalence of refractive errors, in schoolchildren in Dezful in western Iran.

As presented, 14.9% of the studied schoolchildren were myopic, and myopia prevalence increased from 7.1% in the 6- to 7-year-old age group to 22.6% in the 14- to 15-year-old age group. This observation was not unexpected; many studies have demonstrated a correlation between age and myopia in the second decade of life.^{13,14,21} The most important cause of this increase in this age group is the growth-related increase in axial length (AL). Increased AL during the first and second decades of life has been documented in cross-sectional and prospective studies.²² As for the higher myopia prevalence in boys compared to girls, our finding is in line with previous studies; while few studies have shown this relation in school-age children, most studies in older age groups agree that the prevalence of myopia is higher in males.^{4–7,10,11,20,21,23–28} This can again be explained by longer AL in males.²⁹ Of note, however, was the high prevalence of myopia in this study compared to previous studies in Iran.^{3,10,12} According to the summary of previous studies presented in Table 3, the rate of myopia previously reported in this age group was 2.4%–4.4%. Even in Dezful,³ the reported rate in this age group in 2004 was 3.4%.

As demonstrated in this study, the prevalence of myopia in schoolchildren is significantly higher than the previous study performed 10 years ago in this population. Possible explanations include the effect of birth-cohort effect and changes in lifestyle. One of the important lifestyle changes in the past 10 years is increased near work activity as a result of increasing popularity and use of computers and portable computerized

Table 3
Summary of similar previous studies on the prevalence of refractive errors.

Country	Year of publication	Age (year)	Sample size	Myopia	Hyperopia	Astigmatism
China ³⁰	2010	6–15	3070	13.75%	3.26%	3.75%
Morocco ⁵	2009	6–16	545	6.1%	18.3%	23.5%
India ³¹	2002	7–15	4074	4.1%	0.78%	OD = 2.6%
Poland ²³	2007	6–18	5724	13%	38%	4%
Malaysia ²⁵	2008	6–12	705	5.4%	1.0%	0.6%
Chile ¹³	2000	5–15	5303	5.8%	14.5%	27%
China ³²	2008	11.4–17.1	1892	62.3%	0.28%	1.7%
Ethiopia ²⁸	2013	7–18	4238	6.0%	0.33%	–
Laos ³³	2012	6–11	2824	0.8%	2.8%	–
Cambodia ²⁷	2012	12–14	5527	2.2%	0.4%	2.0%
Nepal ¹⁸	2012	5–15	133	34%	15%	47%
Nepal ³⁴	2010	7–15	440	59.8%	31.0%	–
Mexico ³⁵	2003	12–13	1035	44%	6.0%	9.5%
Tunisia ³⁶	2002	11.9 ± 3.21	708	9.1%	31.6%	16.4%
Turkey ¹⁷	2013	6–14	21062	3.2%	5.9%	14.3%
Sweden ³⁷	2006	4–15	143	6%	9%	22%
India ³⁸	2009	6–15	12422	3.16%	1.06%	0.16%
Ethiopia ³⁹	2014	7–15	420	5.47%	1.4%	1.9%
Saudi Arabia ⁴⁰	2013	5–15	2246	65.7%	9.9%	–
Pakistan ⁴¹	2014	5–16	45122	1.89%	0.63%	0.76%
Iran (Dezful) ³	2007	7–15	5544	2.5%	28.9%	18.7%
Iran (Shiraz) ¹²	2010	7–15	1872	1.73%	8.95%	11.27%
Iran (Bojnourd) ¹⁰	2012	6–17	1551	0%	10.8%	11.5%

devices. The addition of non-native immigrants to this city has also significantly increased, and this may be another reason for the observed difference in the prevalence of myopia.

As presented in Table 3, myopia has a high prevalence in countries such as China and Singapore, and affects more than half the children. We know from previous studies that East Asian countries are hotspots for myopia, and as demonstrated, rates are still lower in European countries. One important explanation for such differences can be study differences in age groups, definitions of myopia, and measurement methods. Nonetheless, even with similar age groups, myopia definition, and cycloplegic refraction, the myopia prevalence in this study is considerably high. Recent studies in Iran point to a high prevalence of myopia. While this can be difficult to explain, the most important reason seems to be changes in lifestyle, especially an increase in near work activity. This finding could indicate that we are in the pre-epidemic stage of myopia in children, and thus, serious work is needed to identify and treat refractive errors in this age group. Experimental studies are also needed so that a high incidence of myopia can be prevented.

As for hyperopia, the prevalence was higher in girls and decreased with age. This relationship has been shown by many studies and is explained by AL changes with age and gender.^{13,14} However, as demonstrated, the prevalence of hyperopia was also relatively high in this study and is higher than that previously reported from Iran and other parts of the world. (Table 3) A previous study in Dezful also confirmed the high prevalence of hyperopia in this city; therefore, genetics and ethnicity might have a role in this regard.³

Astigmatism was also highly prevalent in this study. Similar to myopia, astigmatism has been reported to be highly

prevalent in East Asian countries.^{4,6–8,14,19,21,42} Nonetheless, we did not expect to see a rate of 45% in the studied schoolchildren. As demonstrated in Table 3, apart from Singapore and Brazil, the prevalence of astigmatism is less than 20% in most countries. A possible explanation is the development of astigmatism as a result of incyclotorsion during near work activity which causes the contraction of ciliary muscles for accommodation and leads to central corneal steepening and increased power as well.^{43,44} The new generation of children is also using computer devices more frequently which could lead to increased dry eye, eye rubbing, and consequently, astigmatism. In this study, the prevalence of astigmatism showed no significant change with age, but the prevalence was higher in males. Results of other studies regarding age, gender, and astigmatism are inconclusive, although more of them are in agreement with our results and showed higher rates of astigmatism in males.^{3–5,15,31}

This study presented valuable information regarding refractive errors in school-age children. Nonetheless, the smaller sample size compared to previous studies and sampling from an urban population are limitations that should be noted. Lack of data on biometric measurements, family history, and history of near work activity are other limitations, without which we would be able to present better analytical results.

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