The Prevalence of Refractive Errors, Strabismus and Amblyopia in Schoolboys of Varamin, Iran, in 2010

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Abstract

Purpose: To determine the prevalence of refractive errors, strabismus and amblyopia in the schoolboys of Varamin city, Iran

Methods: In a cross-sectional population-based study in 2010, we used random cluster sampling to select the participants from Varamin high school students. Examinations were conducted at the school site under standard conditions. All students had non-cycloplegic refraction, visual acuity (VA) test and cover test.

Results: Of the 1,430 selected, 79.2% participated in the study: their mean age was 16.3±1.3 years (range, 14 to 18). The prevalence of myopia [spherical equivalent (SE)≤-0.5 diopter (D)], hyperopia (SE≥+0.5 D) and hyperopia (SE≥+1.0 D) were 33.2% (95% confidence interval (CI) : 25.0 to 41.4), 17.5% (95% CI: 8.6 to 26.4) and 6.1% (95% CI: 2.6 to 9.6), respectively. Astigmatism (cyclinder power ≥0.75 D) and anisometropia (difference in SE ≥1.0 D) were detected in 10.5% (95% CI: 8.4 to 12.6) and 3.8% (95% CI: 1.8 to 5.8) of the students. The prevalence of strabismus was 1.5% (95% CI: 0.9 to 2.1) and exotropia was the most prevalent type of strabismus (0.9%). The prevalence of amblyopia was 2.1% and anisometropia was the most common cause (54.2%). There was an unmet need for refractive correction in 15.4% (95% CI: 13.3 to 17.4) of the students.

Conclusion: The most common refractive error in the students in this study was myopia, however, the prevalence rate of hyperopia was relatively higher than that in other studies. The unmet need for refractive correction was higher as well. In comparison to other populations, the prevalence of strabismus was low while the prevalence of amblyopia was similar.

Keywords: Refractive Errors, Strabismus, Amblyopia, Cross-Sectional Study

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Introduction

In 2000, Negrel et al[1] published a report concerning the methodology of epidemiologic studies of refractive errors in 5-15-year-old children, and presented the Refractive Error Study in Children (RESC) protocol. This protocol was used in China, Nepal, and Chile to assess refractive errors in schoolchildren.[2-4] Later, the RESC protocol was used in different parts of the world to study the 5-15-year-old age group which provided ophthalmic researchers with valuable information.[5-11]

Reports concerning refractive errors in Iran, based on the RESC protocol, have been published, and give an understanding of the situation in the Middle Eastern region.[6,7,12]

The prevalence of amblyopia was reported 1.9% and 2.31% in Mashhad and Shiraz,[7,12] respectively. Among schoolchildren of Dezful and Shiraz, the prevalence rates of myopia were 3.4% and 4.4%, and the prevalence rates of hyperopia were 16.6% and 5.0%, respectively.[6,7]

In all these studies, however, high school students have received less attention because of the 5-15-year-age range. Some studies have evaluated schoolchildren,[6,12] but there are few studies concerning this age group (over 15 years).[13,14] With the emmetropization process in mind, less refractive errors are expected in these students, however, most RECS studies have shown an increase in myopia in the under 15-year-age group, and thus, high school students could be affected with myopia more than hyperopia.[5,6,9,11] Studying Singapore high school students, Quek et al demonstrated a 74% rate for myopia and only 1.5% for hyperopia, and a similar observation in the rural areas of south China was reported by He et al.[13,14] The higher prevalence of myopia in Singapore and China can be attributed to their race. However, this age group needs to be assessed as well. High school students are about to enter university, and visual disorders can affect their learning and education. In light of these facts, we decided to conduct an exclusive study on high school students in a region in Iran, so that we can expand our knowledge concerning students. The present report is prepared to describe refractive errors, amblyopia and strabismus in the high school students of Varamin City in Iran. Varamin is one of the cities of Tehran Province, located south east of Tehran city and between the north and center of the country.

Methods

The present cross-sectional study was based on the population of Varamin male high school students in 2010. We selected samples through random cluster sampling from this population, using boys' high schools as clusters.

We randomly selected 10 of the 24 boys' high schools in Varamin. Using student record numbers, 35 students were randomly selected from each high school. One week before the examinations, which were done at the school site, parents were informed by letter about the details of the project and its benefits, and they signed informed consents for their children to participate in the study. On the day of the examination, the inclusion criterion was handing in a signed form. Each participating student first had an interview to complete a questionnaire concerning demographics, and the education and economic status of the parents.

Examinations

After the interview, students had non-cycloplegic autorefraction using a TOPCON RM8800 (Topcon Corporation, Tokyo, Japan) autorefractometer by a trained operator. Each examination was done 3 times and results were recorded. Then, for patients who used glasses, we did presenting visual acuity (VA) tests using the E-optotype chart at a distance of 6 m, tested their spectacle lenses with the Topcon LM 800 (Topcon Corporation, Tokyo, Japan) lensometer, and recorded the prescription date. In the next step, uncorrected visual acuity (UCVA) tests were done, and autorefraction results were refined using the HEINE BETA 200 (HEINE Optotechnic Germany) retinoscope and the Refinement MSD (MSD Meniscuc Trial Lenses, Italy) lenses. In all cases, first the right and then the left eye was examined. Students with UCVA worse than $^{20}/_{25}$ had subjective refraction and best corrected visual acuity (BCVA) tests. All VA tests, lensometry, and subjective refraction tests were completed by a skilled optometrist. We used the cover test to detect strabismus; distance cover test

at 6 m, and the near cover test at 50 cm with a fixation target. In students with UCVA worse than $^{20}/_{20}$, cover tests were done was done with best spectacle correction.

Definitions: In this study, myopia was defined as a spherical equivalent (SE) refractive error ≤0.5 diopter (D). Considering the different definitions for hyperopia in other studies, we describe the prevalence of hyperopia based on 3 SE cutoffs of ≥0.5 D, ≥1.0 D, and ≥2.0 D. Astigmatism was defined as a cylinder error of 0.75 D or more, and recorded with a minus sign.

Astigmatism axis was classified as with-the-rule (WTR), an axis of 150+30 and 0+30, against-the-rule (ATR), an axis of 60 to 90, with the remainder classified as oblique astigmatism. Anisometropia was defined as interocular SE difference greater than 1.0 D. Similar to other studies,[15] the unmet need for refractive correction was defined as an improvement in BCVA of at least 2 lines compared to the presenting VA. Amblyopia was defined as BCVA of $^{20}/_{30}$ or less or 2-line interocular optotype acuity differences with no pathology.

Statistical analysis

The prevalence of eye problems was calculated as the number observed by the total sample of the study. Results are presented along with the 95% confidence intervals (CI). Adjustments were made for the effect of cluster sampling on calculating CI. Associations with factors such as age were assessed using logistic regression. The χ^2 and linear regression tests were also used in some cases.

Ethical Issues

Written informed consent was obtained from the students for all steps of the study. This study was approved by the Research Committee of the School of Allied Health Sciences of Mashhad University of Medical Sciences and the original study was as a master's thesis project.

Results

Of the 1,430 selected students, 1,133 participated in the study (response rate=79.2%). The mean age of the participants was 16.3±1.3 (range, 14 to 18)

years. Mean SE was -0.35±1.18 D, and its distribution is demonstrated in Figure 1.

Myopia was detected in 33.2% (95% CI: 25.0 to 41.4) of the students. The prevalence rates of hyperopia based on SE≥0.5 D and ≥1.0D were 17.5% (95% CI: 8.6 to 26.4) and 6.1% (95% CI: 2.6 to 9.6), respectively, and the prevalence of hyperopia ≥2.0D was 0.9% (95% CI: 0.3 to 2.5). Table 1 describes the prevalence of hyperopia and myopia by age; logistic regression analysis found no significant association between age and myopia (Table 2). The prevalence of spherical myopia and spherical hyperopia (SE≥1.0 D) were 25.9% (95% CI: 17.5 to 34.4) and 10.1% (95% CI: 4.7 to 15.4), respectively.

Astigmatism and anisometropia were seen in 10.5% (95% CI: 8.4 to 12.6) and 3.8% (95% CI: 1.8 to 5.8), respectively. The most common type of astigmatism among these students was WTR astigmatism; 6.4% had WTR astigmatism while 3.7% and 0.4% had ATR and oblique astigmatism, respectively. The prevalence of ametropia was 2.1% (95% CI 38.0-47.3) in our study sample.

The prevalence of strabismus in the studied sample was 1.5% (95% CI: 0.9 to 2.1), and exotropia was the most common type of strabismus with a prevalence of 0.9%, followed by esotropia and vertical strabismus with prevalence rates of 0.4% and 0.3%, respectively.

Hyperopia was significantly more prevalent among esotrope students (P=0.003) while myopic students showed more amounts of exotropia (P<0.001).

Amblyopia was detected in 2.1% of the students; in 54.2% of them the cause was anisometropia, in 8.3% it was caused by strabismus, in 12.5% the cause was anisometropia and strabismus, and the cause was isoametropia in 25%.

In the studied students, 15.4% (95% CI: 9.7 to 21.1%) had an unmet need for refractive correction; this was not significantly associated with age, but the odds of myopia was 31.2 times greater for myopes than non-myopes (P<0.001), and 3.3 times greater for astigmatic cases than the rest of the sample; there was no significant correlation between hyperopia and an unmet need for refractive correction.
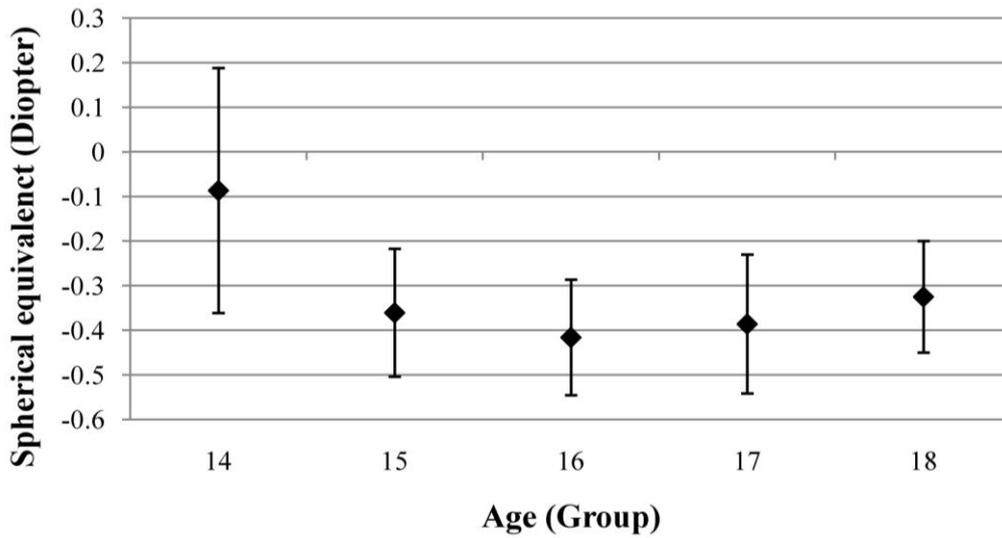
Figure 1. Distribution of spherical equivalent by age

Table 1. The prevalence of myopia and hyperopia

Age	Myopia (SE≤-0.5)	Hyperopia (SE≥1 D)	Astigmatism	Anisometropia
	% (95%CI)	% (95%CI)	% (95%CI)	% (95%CI)
14	30.7 (17.8-43.6)	9.9 (0.1-19.7)	8.9 (7.2-10.6)	6.9 (1.9-25.2)
15	29.9 (21.4-38.3)	4.8 (0.02-9.9)	10.8 (8.1-13.6)	3.5 (0.6-21)
16	34.5 (20.3-48.8)	6.5 (0.4-14.7)	11.9 (7.2-16.5)	4 (1.6-6.3)
17	36.5 (24-48.9)	5.6 (1.5-9.7)	8.8 (3.9-13.7)	3.9 (2.3-5.4)
18	31.9 (18.2-45.7)	5.9 (4.6-7.2)	11.3 (5.2-17.5)	2.5 (0.7-9.5)
Total	33.2 (25-41.4)	6.1 (2.6-9.6)	10.5 (8.4-12.6)	3.8 (1.8-5.8)

SE: Spherical equivalent
CI: Confidence interval

Table 2. Association between age and refractive errors with simple logestic regression

Age	Myopia		Hyperopia		Astigmatism		Anisometropia	
	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P	OR (95%CI)	P
14	1		1		1		1	
15	0.96 (0.43-2.13)	0.898	0.46 (0.16-1.31)	0.108	1.24 (0.77-1.99)	0.275	0.48 (0.28-0.83)	0.02
16	1.19 (0.82-1.74)	0.269	0.63 (0.17-2.32)	0.381	1.38 (0.89-2.13)	0.112	0.55 (0.18-1.74)	0.225
17	1.3 (0.86-1.96)	0.156	0.54 (0.12-2.45)	0.322	0.98 (0.47-2.08)	0.952	0.54 (0.16-1.84)	0.234
18	1.06 (0.53-2.11)	0.828	0.57 (0.18-1.75)	0.237	1.31 (0.7-2.45)	0.302	0.35 (0.04-3.04)	0.247

OR: Odds ratio
CI: Confidence interval

Discussion

Most assessments of visual disorders in students concern refractive errors and strabismus which are presented separately. As demonstrated, here we studied the unmet need for refractive correction as well as refractive errors and strabismus. To our knowledge, there are few studies reporting these entities together. Nonetheless, one of the most important limitations of our studies was sampling boys' schools only, as well as the small age range of our samples.

For comparison, we refer only to studies which, like us, used non-cycloplegic refraction results to determine refractive errors, and included an almost similar age range. In our study, 33.2% of the students were myopic; in Dezful and Mashhad,[6,12] this rate was 33% and 24%, respectively. The 13-17-year-old students in China were also 36.8% myopic, while the rate among 15-19-year-old students in Singapore was about 74%.[13,14] Overall, this study and previous ones in Iran indicate an intermediate prevalence rate for myopia, while the rates are high in Eastern Asian countries. Reports concerning different age ranges confirm this finding.[6,7,14,16-18] It seems that the most important factors that can explain such global differences in the prevalence of refractive errors are race, genetics, and even life style.

Hyperopia is more difficult to compare, because definitions have been based on SE cutoffs of 0.5 D, 1.0 D, or 2.0 D or more. We described hyperopia using these 3 definitions to make valid comparisons.

The prevalence of hyperopia was not significant compared to other studies in Iran, nevertheless, other studies in Iran in different age groups have reported contrasting results.

In Dezful[6] students, the rate of ≥2.0 D or more hyperopia was 2.1%, and in Mashhad,[12] the rate of ≥0.5 D or more hyperopia was 8.4%. Reports from the East Asia indicate low rates of hyperopia in that region.[13,14] There have been other studies in different age groups in Iran as well, and we believe hyperopia is the most important refractive error in different age groups in Iran, and this is clearly evident in the Tehran Eye Study, the Mashhad study on the elderly, and the Dezful study on schoolchildren.[6,7,12,18,19] People with hyperopia tend to have more eye problems such as asthenopia, and thus require certain attention, specially students who should be screened and receive proper correction.

The prevalence of astigmatism in our study was 10.5%. Reported rates vary greatly from a minimum of 3.5% in Nepal[2] to a maximum of 42.7% in China.[20] According to previous studies in Iran, the rates are 18.7%, 9.8%, and 11.3% for schoolchildren in Dezful, Mashhad, and Shiraz, respectively.[6,7,12] These rates indicate a relatively lower rate of astigmatism for students in Iran, compared to high reported rates in Eastern Asian countries,[20] and Read et al suggest race and genetic factors to be responsible in this region.[21]

In terms of anisometropia, the schoolchildren in Singapore[14] and Greece[22] showed a prevalence of 11.2% and 10.3%, respectively, and the prevalence was 9.3% and 9.2% in Taiwan[23] and Hong Kong,[24] respectively. Results of our study and previous studies in Iran give rates in the range of 2.2% to 5.5%, indicating that anisometropia is not a common problem in Iran.[6,12,25]

Strabismus was detected in 1.5% of our sample, which is a low rate compared to other studies (Table 3) which reported rates in a range between 0.5% and 4.3%. The relatively lower rate of strabismus in our study could be attributed to the higher age of our sample, as strabismus is expected to be diagnosed and treated at young age. Similar to the study in Shiraz, strabismus was mostly in the form of exotropia.[25] This is also true about Eastern Asian countries, while the most common type of strabismus in Western countries is mostly esotropia.[26-35] These differences could probably be explained by differences in race, genetics, and even type of refractive error.

Table 3. Prevalence rates of strabismus in different studies

Author	n	Age (years)	Prevalence
Chew[30]	39,227	7	4.2
Lu[31]	1,084	6-14	2.49
Williams[41]	7,825	7	2.3
Yekta[25]	2,683	7-17	2.02
This study	1,430	11-13	1.5
Matsuo[33]	86,531	6-12	1.28
Jamali[36]	815	6	1.2
Matsuo[42]	84,619	6-11	0.99
Fotouhi[6]	5,544	7-18	0.8
Al Faran[29]	3,521	schoolboys	0.5

The prevalence of amblyopia in our study was close to that reported previously in Iran, and we can conclude that the average prevalence rate in our schoolchildren is about 2%.[6,25,36] Meanwhile the rates between 0.14%[33] and 3.9%[37] have been reported from other countries. It must be noted that an important factor that contributes to differences would be various definitions and diagnostic methods in different studies. In agreement with other studies, however, we found that anisometropia and refractive errors were the most common cause of amblyopia.[25,35,38,39] Thus, screening for refractive errors and their correction at young age can prevent a large percentage of amblyopia.

One of the highlights of our study was our findings regarding the unmet need for refractive correction; 15.4% of the sample had such need. Minimum and maximum reported rates are 0.7% and 22.3% in the schoolchildren in Indonesia and China, respectively.[40] Our findings have implications for public health due to the observed high rate of refractive errors. One important factor could be household economic status. Continuing screening programs effectively could help identify these cases in schools.

Conclusion

The most common refractive error in the students in this study was myopia, however, the prevalence rate of hyperopia was relatively higher than that in other studies. The unmet need for refractive correction was higher as well, and this aspect of public health requires more attention. In comparison to other populations, the prevalence of strabismus was low while the prevalence of amblyopia was similar.

Since high school students are about to enter college and go into society, it is important that the health system give priority to visual problems in this age group; failure to identify and treat visual impairment in this age group can have reduce their educational and career efficiencies.

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