

# Prevalence of Uncorrected Refractive Errors in Schoolchildren; A Crucial Vision Screening to Consider!

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## Abstract

**Purpose:** To determine the prevalence of the uncorrected refractive errors in Bojnourd students

**Methods:** In a cross-sectional study, the samples were selected proportionate to the population of the schools using stratified randomized cluster sampling. The target population was the primary and junior high school students of the city of Bojnourd. Visual acuity (VA) (Snellen chart) and cycloplegic, non-cycloplegic and subjective refraction were measured in all students. Uncorrected visual acuity (UCVA) was defined as improvement in corrected vision for at least 2 lines as compared to the presenting vision.

**Results:** Of 2,020 selected students, 1,551 were included in the study (response rate 76.7%). The prevalence of uncorrected refractive errors was 6.2% (95% CI: 5-7.4) in at least one eye and 2.8% of the students had uncorrected refractive errors in both eyes. The prevalence of the uncorrected refractive errors was marginally higher in girls ( $p=0.068$ ). Age, education level of the father and employment of the mother did not correlate with uncorrected refractive error. Myopic individuals followed by astigmatic students had the highest uncorrected refractive error. The presenting vision did not differ with the corrected vision in 83.3% of the participants. In 2.5% and 0.8% of the study population, vision improved by at least 3 and 4 lines after correcting vision, respectively. In individuals with glasses, the vision improved by at least 2, 3 and 4 lines in 21.1%, 9.5% and 3.2% respectively as compared to their present glasses.

**Conclusion:** The prevalence of the uncorrected refractive errors in students was not low in this study. Girls, myopes, and cases of astigmatism showed high rates of uncorrected refractive errors, and it is important that they receive attention. Correcting these errors can help prevent visual impairment at young ages. Identifying uncorrected refractive errors should be among priorities of the health system, specially for students.

**Keywords:** Uncorrected Refraction Errors, Cross Sectional Study, Iran

*Iranian Journal of Ophthalmology 2013;25(1):59-65 © 2013 by the Iranian Society of Ophthalmology*

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Received: July 24, 2011

Accepted: April 14, 2012

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Competing interests: None

## Introduction

The most common visual problem in children and students are refractive errors.<sup>1-7</sup> Different studies have reported the prevalence of the refractive errors in different parts of the world using the Refractive Error Study in Children (RESC) protocol.<sup>4,7-12</sup> Non-correction of the refractive errors may result in visual impairment; according to some studies, refractive errors cause visual impairment in children in about 80% of the cases.<sup>13</sup> Also, Dandona reported that 12.3% of the cases of blindness and 42.8% of the cases of severe visual impairment are caused by uncorrected refractive errors and about 95 million people have uncorrected refractive error worldwide.<sup>14</sup> Uncorrected refractive errors refer to cases who have refractive errors but they either have no spectacles, or their spectacles do not support full correction.

Uncorrected refractive errors may correlate with a decreased quality of life, diminished learning performance and economic conditions in different societies.<sup>15,16</sup> In the past two decades, many studies were performed to investigate the prevalence of the refractive errors worldwide and we now know that these problems are the most common reasons for ophthalmology and optometry visits. However, few studies have addressed uncorrected refractive errors in different societies.<sup>2,17-19</sup> According the Dandona's report, we already know that the prevalence of uncorrected refractive errors is high in South East Asia; however, our information in this regard from the Middle East is limited.<sup>20</sup> Several studies have reported the prevalence of refractive errors in different age groups in Iran but uncorrected refractive errors has been only discussed in a report from Tehran Study exclusively.<sup>4,13,21-26</sup> Although one study evaluated the presenting vision of the students in Dezful, no report exists regarding the uncorrected refractive errors of the Iranian students to date.<sup>4</sup>

Considering the importance of the refractive errors in students, identifying the prevalence of the uncorrected refractive errors is of great importance in public health. For this reason, we decided to investigate the prevalence of the uncorrected refractive errors and its determinants in Bojnourd students.

## Methods

This cross-sectional study was conducted in Bojnourd, north east of Iran, in 2010.

The target population of this study was the primary and junior high school students of this city. In this study, multistage random cluster sampling was performed. Bojnourd has two educational districts and we considered each district as one stratum, and we calculated the sample number proportionate to the number of students in each stratum. The sample sizes were divided into the number of schools in each district, and an equal number of students were randomly chosen from each grade in elementary schools and high schools which we considered as clusters.

Lack of parental consent, contraindication to cycloplegic refraction, and existence of any ocular disease such as media opacities, congenital anomalies or retinal lesions comprised the exclusion criteria of the study.

Upon visiting each school, an appropriate room was chosen for the examinations in the first place. This room was controlled for required distance between the patient and the Snellen's chart (4 m), appropriate light conditions and no light reflection from the chart. Students entered the examination room in alphabetical order one by one and were interviewed before examinations started. In the interview, grade, education levels of the parents and some economic factors were evaluated. Also, the history of ocular examinations, use of glasses of near vision activity was inquired.

## Examinations

Initially, ophthalmoscopy was carried out by an experienced optometrist. If no ocular disease was diagnosed, the refraction error was determined with Topcon RM8800 auto refraction. The mean values obtained by auto refraction were checked with retinoscopy. In this stage, if the student used glasses, the power of the lenses was determined with LM 800 lensometer and the prescription time was recorded. Then, the student's visual acuity was measured with and without his (her) current glasses using the Snellen's chart at 4 m. If the visual acuity (VA) of one eye was lower than  $\frac{10}{10}$ , after refinement, sphere, cylinder and astigmatism axis were measured using subjective and refraction retinoscopy, and the corrected vision of each student was

recorded. In the next step, binocular vision tests including cover test at 4 m and 40 cm, evaluation of the near point of convergence and accommodation, measurement of AC/A, pupillary distance and stereopsis assessment were performed for all students. Finally, the students underwent cycloplegic refraction after receiving Cyclopentolate 1% drops; auto refraction was performed 5 times 40 minutes after instilling 3 drops of cyclopentolate in each eye at 5-minute intervals and mean values of the results were checked with retinoscopy.

### Definitions

We used spherical equivalent (cycloplegic refraction) cut-points of -0.50 diopter (D) for myopia and +2.0 D for hyperopia. Astigmatism was defined as a cylinder error  $\geq 0.75$  D. The uncorrected refractive error was defined as an improvement in BCVA of at least 2 lines compared to the presenting VA.<sup>18</sup>

### Statistical analysis

The prevalence was calculated in percentages and 95% confidence intervals (CI). The design effect of cluster sampling was considered in calculating the 95% CIs, and results were adjusted. The association between uncorrected refractive errors and age, gender, father's education, mother's employment status, and type of refractive errors was assessed using the multiple regression logistic analysis.

### Ethical Issues

A written informed consent was obtained from each student and their parents or guardians for all steps of the study, including use of eye drops before examinations. The Research and Ethics Committee of Vice Chancellor for Research of Mashhad University of Medical Sciences approved the study.

### Results

Out of 2,020 invited students, 1,551 participated in this study (response rate: 76.7%). Male students comprised 41.5% (n=643) of the study population. The mean age of the students was  $11.2 \pm 2.4$  years (range: 6-17).

The prevalence of the uncorrected refractive errors was found to be 6.2% (95% CI: 5-7.4) in at least one eye. Also, 2.8% of

the students had bilateral uncorrected refractive errors.

The prevalence of uncorrected refractive errors was 7.1% (95% CI: 5.4-8.8) in girls and 4.8% (95% CI: 3.2-6.5) in boys which differed marginally ( $p=0.068$ ). The prevalence of the uncorrected refractive errors did not have a significant relationship with age ( $p=0.612$ ). Table 1 presents the prevalence of the uncorrected refractive errors by age and gender. The education level of the father and employment of the mother did not correlate with uncorrected refractive errors of the students significantly ( $p=0.612$  and  $p=0.961$ , respectively).

Figure 1 shows the percentage of the uncorrected refractive errors by the type of the refractive error. As this figure shows, the highest proportion of uncorrected refractive errors was observed in myopic individuals, as 39.4% of the myopic individuals did not have their refractive errors corrected while uncorrected refractive errors were seen in 17.7% and 25.7% of the hyperopic and astigmatic individuals, respectively.

Results of logistic regression showed that the odds of the uncorrected refractive errors were 13.2 fold higher in myopic individuals as compared to non-myopic people (95% CI: 7.6-22.8). This value was 3.6 (95% CI: 2.0-6.8) and 9.1 (95% CI: 5.8-14.1) in individuals with hyperopia and astigmatism, respectively ( $p<0.001$ ). After entering the variables age, gender, father's education level, mother's employment status, myopia, astigmatism, and hyperopia in the multivariate logistic regression model, we found that myopia (OR=11.3), hyperopia (OR=3.6) and astigmatism (OR=6.7) significantly correlated with uncorrected refractive errors ( $p<0.001$ ).

Table 2 presents the distribution of VA improvement after correction. As this table shows, the presenting vision did not differ with the corrected vision in 83.3% of the individuals. Also, table shows that 2.5% and 0.8% of the participants experienced an improvement of at least 3 and 4 lines after correction, respectively. These values have been also presented according to the current glasses. According to Table 2, the corrected vision and the vision with current glasses did not differ in 58.8% of the students; however, 21.1%, 9.5% and 3.2% of the students

experienced an improvement of at least 2, 3, and 4 lines after correction, respectively.

**Table 1.** The prevalence of uncorrected refractive errors by age and gender

Age (year)	%(95%CI)
7	7.9 (3.6 -12.2)
8	6.9 (2.8 -11.0)
9	7.6 (3.5 -11.7)
10	5.4 (1.9 -8.9)
11	5.0 (1.7 -8.3)
12	4.2 (1.7 -6.7)
13	6.9 (3.6 -10.2)
14	5.5 (2.4 -8.6)
15	7.8 (2.5 -13.1)
Male	4.8 (3.2 -6.4)
Female	7.1 (5.3 -8.9)
Total	6.2 (5.0-7.4)

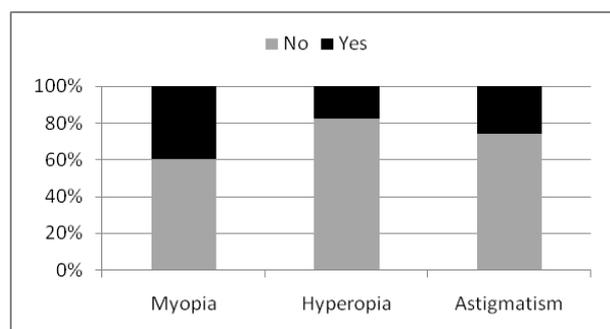
**Table 2.** Visual improvement after correcting refractive errors

Gained lines	Uncorrected VA	Current VA with glass
0 line	83.3%	56.8%
1 lines	16.7%*	43.2%*
2 lines	6.1%	21.1%
3 lines	2.5%	9.5%
4 lines	0.8%	3.2%

VA: Visual acuity

\*: For example, 16.7% gained one line of visual acuity after correcting their refractive errors.

\*\* : For example, 43.2% of students with glasses gained 1 line after correcting their presenting vision.



**Figure 1.** The prevalence of uncorrected refractive errors by type of refractive error

As the number of the lines increases indicating VA improvement, the percentage of the individuals with glasses increases, too. However, about 63% and 50% of the students who experienced an improvement of at least 3

and 4 lines in their vision after correction did not use glasses, respectively. After correcting their presenting vision, 2 students gained 6 lines and 1 student gained 7 lines of corrected visual acuity.

In general, 3.9% of the students (95% CI: 2.9-4.9) had uncorrected refractive errors and did not use glasses.

## Discussion

Considering the importance of the refractive errors and use of glasses to correct them, knowledge of the percentage of the students whose refractive errors are not corrected or do not use appropriate glasses is necessary from the viewpoint of public health. The present report is the first report on uncorrected refractive errors in Iranian students. The prevalence of the uncorrected refractive errors in the general population of Tehran has been previously reported while the present report exclusively focuses on the students.<sup>22</sup> Uncorrected refractive errors were noted in 6.2% of our study population.

Table 3 summarizes the findings of some studies. As this table shows, the prevalence of uncorrected refractive errors varies from 1.4% in South Africa to 22.3% in Chinese students (Table 3). Although the rates of uncorrected refractive errors in our study were lower than some countries such as China and Chile, the rates of uncorrected refractive errors in studies in South Africa, Pakistan, Tehran, Andhra Pradesh and Nepal point to the high prevalence of uncorrected refractive errors in our study (Table 3). Since uncorrected refractive errors are one of the most important causes of visual impairment among children and students, the 6.2% prevalence rate in this study can be a public health issue for these students.

**Table 3.** Prevalence of uncorrected refractive errors in other studies

Place	Age	%
South Africa <sup>8</sup>	5-15	1.4
Pakistan <sup>34</sup>	5-15	2
Tehran <sup>23</sup>	5-15	2.1
Andhra Pradesh <sup>9</sup>	5-15	2.7
Nepal <sup>11</sup>	5-15	2.9
This study (Bojnourd)	6-17	6.2
New Delhi, India <sup>35</sup>	5-15	6.4
Shunyi District, China <sup>10</sup>	5-15	12.8
Chile <sup>12</sup>	5-15	15.8
Guangzhou, China <sup>33</sup>	5-15	22.3

However, this point should be taken into consideration that in some Iranian families, wearing glasses are culturally disapproved, specially for girls, or cannot be afforded by them. This fact seems to necessitate the related education, the provision of useful information, specially in schools, and supporting finances for purchasing glasses for such persons.

Generally, there are two definitions for uncorrected refractive errors and therefore the difference between the definitions should be noted in comparisons. Also, different age groups of the different studies may affect the results. Although the prevalence of the refractive errors was lower in Nepalese, Pakistani and South African students as compared to our students, there are reports of high prevalence rates in Chinese and Malaysian students (Table 3).

Although the prevalence of the uncorrected refractive errors is reported to be considerable in adults as well, it is prudent to pay special attention to school aged children since visual impairment may ensue following non-correction of the refractive errors in this age range. However, employment of screening programs with high validity can reduce the consequences. We noted that uncorrected refractive errors were more prevalent in girls but the reports in this regard are controversial in spite the fact that many studies support our finding. Although it cannot be stated with certainty, unwillingness of the girls to wear glasses can be considered as one of the reasons.

As mentioned earlier, uncorrected refractive errors did not correlate with age significantly although age is regarded as one of the most important risk factors of uncorrected refractive errors in most studies. For example, Varma (USA),<sup>18</sup> Munouz (Mexican American),<sup>27</sup> Thiagalingam (Australia),<sup>28</sup> Rosman (Singapore)<sup>29</sup> and Liou (Victoria, Australia)<sup>30</sup> reported that the prevalence of the uncorrected refractive errors increased with age. Of course, it should be noted that most of these studies were performed on adults and the existing results in children and students regarding the relationship between uncorrected refractive errors and age are controversial. However, it seems that the increase in age, due to the increase in some ocular diseases, reduces the

individual's motivation to correct his (her) refractive errors.

One of the important findings of this study was the high prevalence of the uncorrected refractive errors in myopic individuals which is also supported by many other studies.<sup>2,23,31</sup> Moreover, regarding astigmatism, these individuals are more prone to non-correction of their refractive errors.

As mentioned earlier, we defined uncorrected refractive errors as improvement of at least 2 lines in vision after correction. Since hyperopic individuals mostly have problems with near vision, we identified uncorrected refractive errors mostly in myopic students and the hyperopic individuals who were identified with uncorrected refractive errors were most probably those who had high levels of hyperopia and their far vision was also impaired. Other reports<sup>32</sup> have also shown that the prevalence of the refractive errors is high in myopic individuals. Overall, this finding suggests the more effective role of myopia in visual impairment.

Lamoureux et al evaluated the role of refractive errors correction in visual functioning and showed that correction of myopia was more effective in visual functioning as compared to hyperopia correction.<sup>31</sup> Some other studies have also put emphasis on the role of myopia in visual impairment, specially in students.<sup>4,13,33</sup> This finding also suggests that one reason for the high prevalence of uncorrected refractive errors in East Asian countries is high myopia in these countries. In our study, 4% of the students who had uncorrected refractive errors did not have glasses as well. They are either unaware of their refractive errors or their current glasses are not appropriate and therefore require special attention.

## Conclusion

The prevalence of uncorrected refractive errors in students was not low in this study. Girls, myopes, and cases of astigmatism showed high rates of uncorrected refractive errors, and it is important that they receive attention. Correcting these errors can help prevent visual impairment at young ages. Identifying uncorrected refractive errors should be among priorities of the health system, specially for students.

**Acknowledgments**

This article was presented as a poster at the Annual Meeting of the European Association for Vision and Eye Research in Crete, Greece on October 2010. We thank the research vice

chancellor of Mashhad University of Medical Sciences for supporting this study (grant code: 88387). The results described in this paper were part of an MSc optometry thesis.

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