

# The Prevalence of Amblyopia and Strabismus among Schoolchildren in Northeastern Iran, 2011

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## Abstract

**Purpose:** To determine the prevalence of amblyopia and strabismus in the schoolchildren of the city of Bojnourd, Iran

**Methods:** In 2010, randomized stratified cluster sampling was employed in a cross-sectional study on primary and junior high schoolchildren. All the examinations were performed in schools. All students received refraction, vision and subjective refraction tests. The cover test was used to determine tropia. Amblyopia was defined as best corrected visual acuity (BCVA) <sup>20</sup>/<sub>30</sub> or less or a 2-line interocular optotype acuity difference with no pathology.

**Results:** Of 2,020 selected students, 1,551 participated in the study (response rate: 76.7%). The prevalence of amblyopia was 2.3% (95% CI: 1.6-3.1); 2% of the male students and 2.5% of the female students had amblyopia (P=0.508). Amblyopia decreased significantly with age (P=0.032). The most common type of amblyopia was anisometropic followed by isometropic amblyopia. Hyperopia and astigmatism were the most common refractive errors in individuals with amblyopia. The prevalence of strabismus in the students was 2% (95% CI: 1.3-2.7). Of female and male students, 2.4% and 1.4% had strabismus, respectively (P=0.160). Of the students with strabismus, 67.7%, 25.8% and 6% had exotropia, esotropia and vertical deviations, respectively.

**Conclusion:** The prevalence of amblyopia and strabismus in the current study was intermediate. However, correction of refractive errors at young ages can largely prevent amblyopia and strabismus in children.

**Keywords:** Amblyopia, Strabismus, Schoolchildren, Iran

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## Introduction

The most common reasons for amblyopia in schoolchildren are refractive errors and strabismus.<sup>1-4</sup> Refractive errors are relatively more prevalent as compared to amblyopia and strabismus; however, since they are easier to correct, amblyopia and strabismus are considered as the most serious visual problems in children.<sup>5</sup>

Early diagnosis and treatment of amblyopia and strabismus at young ages results in good treatment outcomes.<sup>6</sup> After very young children, schoolchildren are one of the important population groups that can be affected by amblyopia and strabismus. Although many affected individuals are diagnosed and treated through vision screening programs worldwide, many of such patients are missed in some countries due to the low sensitivity of such screening tests; therefore, in addition to screening programs, the percentage of the affected students needs to be determined through research studies. Different reports of amblyopia and strabismus are published worldwide every year.<sup>2-4,7-12</sup> Moreover, due to the serious nature of these two conditions in children, various studies have evaluated their treatments methods as well.<sup>13,14</sup> These two conditions, in addition to causing visual problems for children and students, may result in psychological disturbances, seclusion and even a decline in the school's performance of the affected children. To date, several studies have evaluated visual and binocular vision problems in different age groups in Iran<sup>4,5,15-20</sup> However, in these studies amblyopia and strabismus in schoolchildren have been addressed.

Based on the Shiraz study, we already know the prevalence of amblyopia and strabismus as 2.29% and 2.02% respectively.<sup>17</sup> Although according to the Shiraz study, these two major entities do not affect a significant percentage of the students, it is prudent to conduct further studies to better determine the prevalence of strabismus and amblyopia due to ethnic, racial, economic and social differences.

In this regard, we performed a cross-sectional study on the schoolchildren of the city of Bojnourd, South of Khorasan Province. In this study, refractive errors, binocular vision problems and amblyopia were

comprehensively evaluated. The current report, which is based on this study, presents the prevalence of amblyopia and strabismus in Bojnourd.

The findings of this study, besides adding to the existing knowledge regarding Iran, can serve as a reliable database for further research on amblyopia and strabismus in the Middle East. The results of this investigation can be used in refractive errors and binocular vision managements and also planning for eye healthcare and future preventive programs.

## Methods

In 2010, randomized stratified cluster sampling was used in a cross-sectional study on elementary and junior high school students in the city of Bojnourd. In this study, multistage random cluster sampling was performed. Bojnourd has 2 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 chosen from each grade in elementary schools and highschools which we considered as clusters.

At each school, an appropriate room was chosen for the examinations in the first step. The room was controlled for suitable light conditions, no light reflection from the Snellen chart and required distance between the person and the chart (4 meters). Unwillingness of the parents/guardians or the students to participate in the study, contraindication to cycloplegic refraction, any ocular disease such as Media Opacity, congenital abnormalities and retinal lesions were regarded as exclusion criteria. The students entered the examination room in alphabetical order and were interviewed before examination and their grade, education level of their parents and some economic factors were recorded. Also, the history of ophthalmic examinations, wearing glasses and near vision activity was documented.

All ophthalmic examinations in this study carried out by a skilled and experienced optometrist and began with ophthalmoscope. Then, if no ocular disease was noted, distance

visual acuity of the subject measured with and without present spectacle using the Snellen chart at 4m. Autorefractometer performed using the Topcon RM8800 auto-refractometer (Topcon Corporation, Japan) and the results of five consecutive acquisitions for each eye were printed out and the mean value was checked with retinoscope (Heine Beta 200, Optotechnic, Germany) and the trial lenses (MSD, Italy), first testing the right eye and then the left eye of the subject. Refinement of sphere, cylinder and axis was performed until the best distance visual acuity. Then, the students received; 3 cycloplegic refraction drops of cyclopentolate 1% were instilled at 5-minute intervals and after 40 minutes, autorefractometer was performed for 5 times and the results were checked with retinoscope before documentation.<sup>21</sup> If there was difference between the results of autorefractometer and the retinoscope, the retinoscopy values were recorded.

Cover-uncover test was performed twice at distance and near for investigating strabismus with and without correction. To control the accommodation and the fixation, asking the subject to look at a letter from the line above the visual acuity of the weaker eye. After that, different types of detected strabismus were recorded for analyzing.

First, unilateral cover test was performed to reveal any type of strabismus and then, alternate cover test was performed for investigating and measuring other ocular deviations at distance and near. Prism bar was used for measuring the angle of deviations in this study.

Amblyopia was defined as best corrected visual acuity (BCVA)  $^{20}/_{30}$  or less or 2-line interocular optotype acuity differences with no pathology.

### **Ethical issues**

A written informed consent was obtained from the participants 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 protocol of the study.

### **Results**

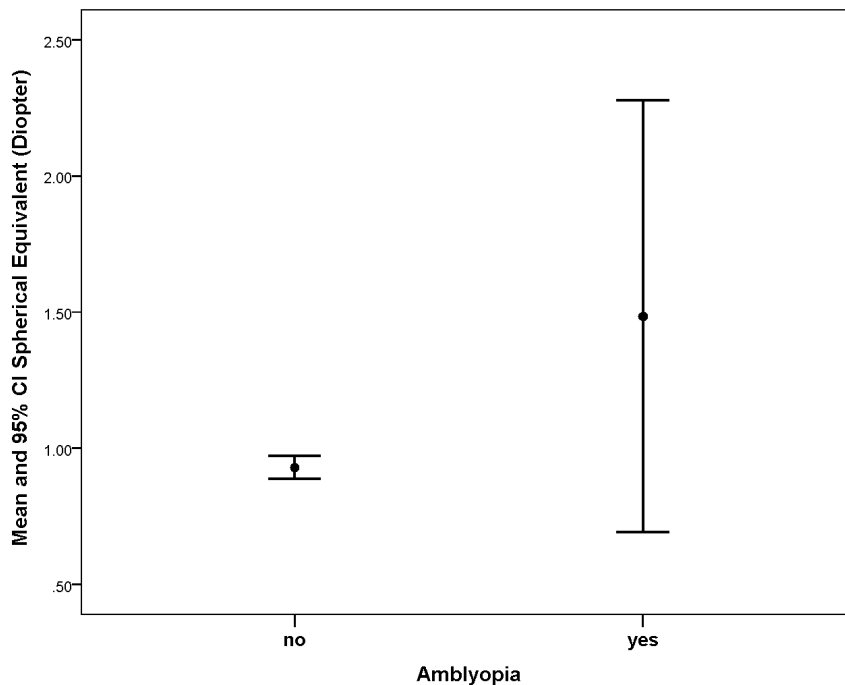
Of 2,020 selected students, 1,551 participated in the study (response rate: 76.7%). Of the participants, 41.5% (n=643) were males. The mean age of the students was  $11.2 \pm 2.4$  years (range: 6-17 years) and 2.3% of them were amblyopic (95% CI: 1.6-3.1). The prevalence of amblyopia was 2% in boys (95% CI: 0.9-3.1) and 2.5% in girls (95% CI: 1.5-3.6); logistic regression showed no significant difference in the prevalence of amblyopia between genders ( $P=0.508$ ). The prevalence of amblyopia was 3.9% in 7-year-old students but significantly decreased to 1.9% in 15-year-old participants. Although the trend of the decrease of amblyopia with age was not linear,  $\chi^2$  for trend confirmed that the prevalence of amblyopia decreased with age ( $P=0.032$ ). Table 1 demonstrates the prevalence of amblyopia in different age groups.

The reason for amblyopia was anisometropia in 35.3%, strabismus in 20.6%, isoametropia in 29.4% and aniso-strabismic amblyopia in 14.7% of the participants. Of amblyopic individuals, 61.1% had astigmatism, 41.7% had hyperopia and 8.3% had myopia. Hyperopia and astigmatism were significantly more prevalent in amblyopic patients ( $P<0.001$ ). Figure 1 shows mean spherical equivalent in amblyopic and non-amblyopic students. As this figure shows, amblyopic students had more hyperopic spherical equivalents ( $P<0.001$ ).

The prevalence of strabismus was 2% in our students (95% CI: 1.3-2.7). The prevalence of astigmatism was 2.4% in female (95% CI: 1.4-3.4) and 1.4% in male students (95% CI: 0.5-2.3) but the difference was not significant ( $P=0.160$ ). We found no significant relationship between age and strabismus ( $P=0.668$ ) (Table 1). The type of deviation in students with strabismus was exotropia in 67.7%, esotropia in 25.8% and Vertical in 6% of the students.

**Table 1.** The prevalence of amblyopia by age in schoolchildren of Bojnourd in 2011

Age (year)	Amblyopia Prevalence	Strabismus Prevalence
7	3.9	0.7
8	1.4	2.1
9	3.1	3.8
10	5.4	3.6
11	1.3	0.6
12	2.9	2.1
13	0.9	1.8
14	0.5	2.0
15	1.9	1.0



**Figure 1.** Mean and 95% confidence interval of spherical equivalent in amblyopic and non-amblyopic participant

## Discussion

According to the literature review, the current report is the third report on the status of amblyopia and strabismus in Iranian students.<sup>4,15</sup> The previous reports were based on Shiraz and Shahroud studies. Our information about these two visual problems in Middle Eastern children and students is also limited to few studies.

The prevalence of amblyopia in our study was 2.3%. As Table 2 shows, the prevalence of amblyopia ranges from 0.1% to 5% in different populations. The findings of our study showed that the prevalence of amblyopia was

intermediate in Bojnourd students; this finding is rather similar to the results of previous studies conducted in Shiraz and Shahroud<sup>4,15</sup> and suggests that the rate of amblyopia is relatively high in our schoolchildren and should be identified and managed.

However, some countries have reported lower prevalence rates of amblyopia in school age of children as compared to our finding and the results of Shahroud and Shiraz studies (Table 2).

One of the previously conducted studies showed that preschool screening at 37

months to detect amblyopia could result in a better management.<sup>22</sup> According to these studies, although the prevalence of amblyopia was intermediate in our students, the outcome of treatment would improve with screening at younger ages and fewer students would be detected at these ages. Even at older ages,<sup>23-25</sup> amblyopia is considered to be a risk factor for visual impairment and affects students' education. Therefore, prevention of amblyopia can avert visual impairment in older individuals. As mentioned earlier, the prevalence of amblyopia decreased with age; this finding has been noted in some other reports as well.<sup>4</sup>

We noted no correlation between gender and amblyopia; this correlation has already been evaluated in a number of studies<sup>4,9,26</sup> and therefore, it is important to pay attention to amblyopia in both genders.

The most prevalent type of amblyopia in our study population was anisometropic; this finding has also been reported by several studies,<sup>3,4,9,24,27</sup> although some have reported strabismus as the most common cause of amblyopia. For example Robaei et al<sup>28</sup> reported that strabismus was the most common cause of amblyopia in Australian children while studies conducted in East Asia (Table 2) have mostly determined anisometropia as the major cause. It seems that non-correction of refractive errors, specially anisometropia, accounts for the higher prevalence of anisometropic amblyopia in these regions. This type of amblyopia can be prevented through correction of refractive errors in childhood. Moreover, as mentioned earlier, the proportion of isoametropic individuals in amblyopia was more than strabismic individuals which testified to non-correction of refractive errors in these children in childhood. However, it should be noted that in countries with higher prevalence rates of strabismic amblyopia, most of the affected children have overt strabismus and therefore can be easily identified by their parents; as a result, amblyopia can be prevented through surgery to align the eyes in childhood but it's more difficult to control and less responsive to treatment comparing to refractive amblyopia. In this study, astigmatism and hyperopia were the most common causes of refractive error in amblyopic students. Most previous studies have reported hyperopia as the most common

cause of amblyopia.<sup>29</sup> It seems that non-formation of a clear retinal image in individuals with hyperopia and astigmatism is the main reason for this finding. With respect to the aforementioned findings, among children with refractive errors, hyperopic children (spherical equivalent >3) should receive special attention.

The prevalence of strabismus was 2% in our study which was intermediate as compared to other studies; it was higher than the rate reported by Dezful<sup>5</sup> study but rather similar to that of Shiraz study.<sup>4</sup> However, as Table 3 shows, most studies have reported the prevalence of strabismus to be around 2% which is similar to our finding. Although the prevalence of strabismus was not as considerable as some ocular conditions like refractive errors, it requires prompt intervention since the affected children are prone to amblyopia and Binocular problems and cosmetic-related psychological disturbances. Exotropia was the most common type of strabismus in Bojnourd students. However, different studies have reported different results; in Shiraz study,<sup>4</sup> similar to ours, exotropia was the most common type while esotropia was the most common type of strabismus in Dezful<sup>5</sup> students.

Results of different studies suggest that in the Middle East and East Asia,<sup>30</sup> exotropia is more common while esotropia is more common in countries like Canada, England, Finland, the US and Australia.<sup>31-34</sup> It seems that ethnicity is one of the important factors affecting the type of strabismus in each region. There are contradictory reports regarding the correlation of strabismus with age and gender.<sup>3,4,8,9,11,12</sup> We noted correlation between strabismus and age and gender but some studies have reported that strabismus is more prevalent in girls and have noted a decrease in its prevalence with age.

One of the limitations of this study was the lack of extension of the results to the whole schoolchildren of Iran. The result of this investigation was according to the definition and criteria of the previous studies and was a basic study concerning amblyopia in schoolchildren of zone one of the north of Iran.

**Table 2.** Prevalence of amblyopia in preschool and schoolchildren from other studies

Place	Diagnostic criteria	Age	Prevalence (%)
Baltimore <sup>35</sup>	Physician's diagnosis	Elementary school	3.9
Haifa (Israel) <sup>35</sup>	VA <20/40 or >1-line difference	1-2 yrs	2.6
Hispanic/Latino <sup>35</sup>	VA <20/30 or >2-line difference	6 to 72 month	2.6
Mexico <sup>35</sup>	VA <20/40	12-13 yrs	2.5
Cambridge <sup>35</sup>	VA <6/9 or >1-line difference	5.5 yrs	2.5
This study	VA <20/30 or >2-line difference	6-17 yrs	2.29
Shiraz (Iran) <sup>4</sup>	VA <20/30 or >2-line difference	7-17 yrs	2.29
Taiwan <sup>35</sup>	Physician's diagnosis	3-6 yrs	2.2
Australia <sup>26</sup>	Unilateral, bilateral *	6-72 month	1.9
Abha (Saudi Arabia) <sup>35</sup>	6/9 or worse	Elementary school	1.85
Kathmandu (Nepal) <sup>35</sup>	VA <20/40	10-15 yrs	1.8
Australia <sup>35</sup>	VA <20/40 or >2-line difference	6 yrs	1.8
Shahrood, (Iran) <sup>15</sup>	VA <20/40 or >2-line difference	6 yrs	1.7
African American <sup>35</sup>	VA <20/30 or >2-line difference	6 to 72 month	1.5
African <sup>35</sup>	VA <20/40	10-18 yrs	1.2
Singapore <sup>9</sup>	Unilatera**	6 to 72 yrs	1.19
Denmark <sup>35</sup>	VA <20/40	2nd-5th grades	1.1
Odense (Denmark) <sup>35</sup>	VA <20/40	12-13 yrs	1.1
Haifa (Israel) <sup>35</sup>	VA <20/40 or >1-line difference	1-2 yrs	1
Sultanate (Oman) <sup>35</sup>	VA <20/40	6-12 yrs	0.9
Saskatoon (canada) <sup>35</sup>	VA <20/40	grade 1	0.8
Japan <sup>35</sup>	Not available	6-12 yrs	0.2
Japan <sup>35</sup>	Not available	6-12 yrs	0.14
Australia <sup>35</sup>	Physician's diagnosis	4-12 yrs	0.02

\* Unilateral: 2-line difference in reduced visual acuity between the 2 eyes, bilateral: bilateral reduced visual acuity with either bilateral visual axis obstruction or significant bilateral ametropia  
\*\* 2-line difference between eyes with visual acuity < 20/30 in the worse eye  
VA: Visual acuity

**Table 3.** Prevalence of strabismus in different studies

Author	n	Age	Prevalence (%)
Drover <sup>36</sup>	946	mean 4.2	4.3
Chew <sup>33</sup>	39227	7 yrs	4.2
MePEDSG <sup>3</sup>	3007	6-72 yrs (African American)	2.5
Lu <sup>37</sup>	1084	6-14 yrs	2.49
MePEDSG <sup>3</sup>	3007	6-72 yrs (Hispanic/Latino)	2.4
Williams <sup>38</sup>	7825	7 yrs	2.3
Yekta <sup>4</sup>	2683	7-17 yrs	2.02
This study	1551	5-15 yrs	2.0
Matsuo <sup>12</sup>	86531	6-12 yrs	1.28
Jamali <sup>15</sup>	815	6 yrs	1.2
Chia <sup>9</sup>	3009	6-72 month	0.8
Al Faran <sup>39</sup>	3521	School age	0.5

n: sample size

## Conclusion

In our study, the prevalence of amblyopia and strabismus was rather similar to other studies conducted in Iran. Although the prevalence of amblyopia and strabismus is not considerable, early diagnosis and correction of refractive

errors can significantly reduce the prevalence of amblyopia since a major part of amblyopia is due to non-correction of refractive errors. The most common type of strabismus in our study was exotropia.

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