The prevalence of amblyopia in 7–9-year-old schoolchildren in Mashhad

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ABSTRACT

Background: To determine the prevalence of amblyopia in schoolchildren aged 7–9 years old in Mashhad, Iran.

Methods: This was a cross-sectional, community-based study with schoolchildren aged 7–9 years old. We randomly selected 20 of 189 elementary schools (three schools per district; 10 male-segregated and 10 female-segregated schools) from a proportional combination of public schools across Mashhad. Basic vision exams were performed. If amblyopia was suspected, children underwent supplementary vision exams. The diagnostic criterion for amblyopia was a best corrected visual acuity (BCVA) in one or both eyes equal to or worse than 20/40 or an interocular difference of more than two lines in BCVA without any significant organic pathology.

Results: A total of 2831 children were included in the study. All children were examined comprehensively by an optometrist, and amblyopia was detected in 49/2831 (1.7% [95% CI, 1.22—2.18]). Of the 49 children with amblyopia, 20 (40.8%) were amblyopic in the right eye, 9 (18.4%) in the left eye, and 20 (40.8%) in both eyes. Twenty-four (49%) were first graders, 15 (30.6%) were second graders, and 10 (20.4%) were third graders. The most prevalent subtype of amblyopia was anisometropic amblyopia (57.1%, [95% CI, 43.24—70.96]).

Conclusions: Considering the prevalence of amblyopia among schoolchildren aged 7–9 years old (1.7%), timely detection of amblyopia through preschool screening programs is essential for early treatment or prevention of further visual impairment during childhood.

KEY WORDS

amblyopia, prevalence, elementary school, preschool children, Iran, Mashhad, diagnostic screening program

INTRODUCTION

Amblyopia is defined as a non-organic loss of bilateral or unilateral best-corrected visual acuity (BCVA). It is reversible if is diagnosed timeously and managed properly [1]. A recently published meta-analysis reported that the worldwide prevalence of amblyopia in children is 4.3%. In a subgroup analysis, the prevalence rate was estimated to be highest in the USA and Europe (5.57% and 4.57%, respectively) and lowest in Asia and Africa (3.80% and 0.71%, respectively) [2]. BCVA equal to or worse than 20/40 (Snellen equivalent 6/12; logarithm of the minimal angle of resolution [logMAR] score 0.3) in one or both eyes has been suggested as a clinical cut-off level for the diagnosis of amblyopia in some studies [3, 4], while others have used a clinical cut-off level of 20/30

(Snellen equivalent 6/9; logMAR score 0.17) or worse[5-7]. An additional criterion is the interocular difference in visual acuity of two or more lines, without any pathological cause [8, 9].

Unfortunately, late diagnosis and inappropriate management of amblyopia at preschool ages can lead to difficulties in learning and educational ability in schoolchildren, and may lead to permanent social problems [10-12]. Considering this issue, one of the most important objectives of the World Health Organization is to raise population awareness concerning visual disorders, such as amblyopia and refractive error during childhood [13]. Preschool screening plays an important role in the early diagnosis and appropriate management of amblyopia, to prevent permanent visual disorders [14], as treatment at an older age may affect the outcome [15, 16]. To formulate an appropriate strategy for the early diagnosis of amblyopia [17], it is essential to specify the prevalence of this disorder in children.

The aim of current study was thus to determine the prevalence rate of amblyopia in 7-9-years-old children in Mashhad, Iran.

METHODS

This was a cross-sectional, community-based study, performed in a single school calendar year (2015-2016), on 7-9-year-old schoolchildren, from seven educational districts of Mashhad city, Iran. The study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences, and all procedures adhered to the principles of the Declaration of Helsinki. Written informed consent was obtained from the parents or legal guardians of all the patients, prior to conducting any examinations.

Amblyopia was diagnosed based on the following criteria: BCVA in one or both eyes equal or worse than 20/40 (Snellen equivalent 6/12; logMAR score 0.3) or an interocular difference of more than two lines in best-corrected visual acuity without any significant organic pathology (designated as the conventional criterion) [18].

The students in the first, second, and third grades of elementary school, in a single school calendar year (2015-2016), were selected using cluster random sampling. We aimed to select schools such that students of all socio-economic status levels and cultural diversity could uniformly participate. Using cluster sampling, we randomly selected 20 of 189 elementary schools (three schools per district, 10 male-segregated, and 10 female-segregated schools) from a proportional combination of public schools throughout Mashhad. To ensure balance between the all-boy and all-girl schools, we randomly chose two schools in district 3. The exclusion criteria were parental unwillingness to participate in the study and intolerably poor cooperation of the child during examination. One subject was excluded due to parents' unwillingness. To minimize the probability of ethnic diversity we excluded immigrant students. Additionally, mentally challenged students were excluded from the study.

Initially, basic vision examinations including measurement of uncorrected and corrected visual acuity with a tumbling E-chart at a distance of 6 m, cover testing with an appropriate near (40 cm) and distance (6m) accommodative target, and fundus examination by means of direct ophthalmoscopy (Keeler Practitioner, Windsor, UK). Students who had a BCVA equal to or worse than 20/30 (Snellen equivalent 6/9; LogMAR score 0.17) in each eye, or an interocular VA difference of more than two lines, who were not suffering from any pathology of the ocular media and retina, were suspected of having amblyopia and underwent further supplementary visual tests.

Supplementary visual tests, including objective cycloplegic refraction using a Heine β-200 retinoscope (HEINE Optotechnik, Herrsching, Germany) and MSD trial lenses (MSD Meniscus Trial Lenses, Busto Arsizio, Italy), which were refined by subjective cycloplegic refraction, and a more precise measurement of BCVA following optimal optical correction, was conducted for all children suspected of having amblyopia. To achieve cycloplegia, one drop of 1% cyclopentolate eye drops (Cyclogyl; Alcon Laboratories, Fort Worth, TX, USA) was instilled three times in each eye, at an interval of 10 min.

Data were analyzed using IBM SPSS Statistics software (version 20.0; IBM Corp., Armonk, NY, USA). We utilized descriptive data analyses, and the prevalence rates of the study were estimated in percentages and 95% confidence intervals (CIs). The design effect of a cluster random sampling approach was considered and adjusted for in the calculation of standard errors.

RESULTS

Between November 2015 and February 2016, 2831 children aged 7-9 years attending elementary schools in seven education districts of Mashhad were examined. The 2831 students were almost equally distributed across three grades: 971 (34.3%) were from grade 1, 925 (32.7%) from grade 2, and 935 (33%) from grade 3. Of the participants, 1670 (59%) and 1161 (41%) were boys and girls, respectively.

Table 1. Prevalence of amblyopia among 2831 screened 7-9-year-old schoolchildren in Mashhad, Iran

Variable	Value
Non-amblyopic, n (%), (95% CI)	2782 (98.3), (97.82–98.78)
Amblyopia, n (%), (95% CI)	49 (1.7), (1.22–2.18)
Right eye with amblyopia n (%)	20 (40.8)
Left eye with amblyopia, n (%)	9 (18.4)
Both eyes with amblyopia, n (%)	20 (40.8)
Grade 1 Elementary School, n (%)	24 (49.0)
Grade 2 Elementary School, n (%)	15 (30.6)
Grade 3 Elementary School, n (%)	10 (20.4)

Abbreviations: BCVA, best corrected visual acuity; n, number; CI, confidence interval. Note: diagnostic criteria of study for amblyopia was BCVA < 20/40 or interocular difference of BCVA > 2 lines.

Table 2. Frequency of the causes of amblyopia and type of refractive error in 49 students with amblyopia among 2831 7-9-year-old schoolchildren in Mashhad, Iran

Type of amblyopia	n (%), (95% CI)
Anisometropic	28 (57.1), (43.24–70.96)
Isoametropic	17 (34.7), (21.37–48.03)
Strabismic	2 (4.1), (-1.45–9.65)
Stimulus-deprivation	2 (4.1), (-1.45–9.65)
Type of refractive error	**n (%)**
Mixed Astigmatism, n (%)	17 (34.7)
Myopia + Myopic Astigmatism, n (%)	15 (30.6)
Hyperopia + Hyperopic Astigmatism, n (%)	15 (30.6)
Myopia, n (%)	1 (2.05)
Hyperopia, n (%)	1 (2.05)

Abbreviations: n, number; %, percentage; CI, confidence interval. Note: the diagnostic criterion for amblyopia used in this study was Best corrected visual acuity (BCVA) < 20/40 or interocular difference of BCVA > 2 lines.

All students were examined comprehensively by an experienced optometrist. Using the diagnostic criteria of this study, amblyopia was detected in 49/2831 students, indicating a prevalence of 1.7% (95% confidence interval [CI]: 1.22–2.18). Table 1 shows the prevalence of amblyopia in 7-9-year-old schoolchildren in Mashhad based on the diagnostic criteria of BCVA < 20/40 or interocular difference of BCVA > 2 lines. Most participants with amblyopia were from grade 1 (49%), and in more than 80% of students with amblyopia, either the right eye or both eyes were affected.

Table 2 shows the prevalence of the four subtypes of amblyopia and the frequency of refractive errors among students with amblyopia. Essentially, we found no cases of mixed (strabismic/anisometropic) amblyopia. Among the 49 amblyopic students, the most prevalent subtype of amblyopia was anisometropic amblyopia. The prevalence of the four subtypes of amblyopia in order of frequency was 1%, 0.6%, 0.07%, and 0.07% for anisometropic amblyopia, isoametropic amblyopia, strabismic amblyopia, and deprivation amblyopia, respectively. Among the 49 amblyopic students, the most prevalent subtype of refractive error was mixed astigmatism.

DISCUSSION

BCVA less than 20/40 or an interocular difference of BCVA of more than two lines was considered as the clinical cut-off level for the diagnosis of amblyopia in this study. The results revealed that the prevalence of amblyopia in the first three grades of elementary school was 1.7% (95% CI, 1.22-2.18).

Besides the criteria applied and the study population, the method of screening differs greatly between countries [19-23]. Some countries utilize only visual acuity tests for screening amblyopia, whereas others only consider amblyopia risk factors, such as anisometropia, as a screening tool [21, 24-26]. Most countries use customary visual acuity charts, which lack precise internal and external reproducibility [22, 27, 28]. These issues cause inaccurate estimates of the prevalence of amblyopia [28]. Table 3 summarizes the information regarding previous studies conducted on the prevalence of amblyopia in several cities in Iran. The reported prevalence rates may differ because of the abovementioned factors [3, 5-7, 29-34].

Table 3. Community-based studies on the prevalence of amblyopia in Iran

Author (Year of Publication)	Place of study	Sample Size (n)	Prevalence of Amblyopia (%)
Fotouhi et al. (2004) [29]	Tehran	4565	2.7
Shahrirari et al. (2007) [30]	Zahedan	5446	2.2
Jamali et al. (2009) [3]	Shahroud	815	1.7
Yekta et al. (2010) [6]	Shiraz	2638	2.29
Faghihi et al. (2011) [5]	Mashhad	2510	1.9
Hashemi et al. (2014) [7]	Seven cities	3675	1.88
Moradabadi et al. (2014) [31]	Bandar Abbas	16599	1.01
Rajavi et al. (2015) [32]	Tehran	2410	2.3
Yekta et al. (2016) [33]	Mashhad	3701	0.41
Yekta et al. (2017) [34]	Dezful	1375	2.7
Current study	**Mashhad**	**2831**	**1.7**

Abbreviations: n, number; %, percentage.

The findings of the present study are strongly in agreement with the findings of a study conducted by Jamali et al. [3] in Shahroud, which could be attributed to the fact that both studies used the same diagnostic criteria for amblyopia (BCVA less than 20/40 and interocular difference of more than two lines).

Our results revealed a higher rate of amblyopia in the right eye (40.8%) than in the left eye (18.4%) in children with unilateral amblyopia. This result was in contrast with some reports that found that the left eye is more affected in unilateral amblyopia [3, 35, 36].

In a population-based study in Mashhad, Faghihi et al. found that the causes of amblyopia, in decreasing order, were anisometropic amblyopia, isometropic, mixed (strabismic/anisometropic), and strabismic amblyopia [37]. Likewise, we found anisometropic and isoametropic amblyopia as the first two common causes, while the strabismic type was the least common. However, there were no cases of strabismic/anisometropic amblyopia, and two students with deprivation amblyopia accounted for 4.1% of amblyopic patients [37]. In contrast, the total prevalence of amblyopia was 1.7% in our study, whereas a previous study reported a 4.6% prevalence rate. This difference could arise from a wider age range (3-90 years of age) in Faghihi et al. ʼs study [37], in contrast to the narrow age range (7-9 years of age) in this study.

A limitation of the current study was the selection of participants only from the first three grades of elementary school. Other limitations were its cross-sectional design and lack of follow-up for the treatment and management of patients with amblyopia. Therefore, our findings should be cautiously generalized to society. Future longitudinal studies with a wider range of participants, including students from all grades, and pre-school children could provide more reliable findings for health policymakers to manage this reversible cause of blindness.

CONCLUSIONS

Considering the prevalence of amblyopia in our study participants (1.7%), the importance of timely detection of amblyopia for early treatment or prevention of further visual impairment during childhood, by implementing preschool screening programs, is essential.

ETHICAL DECLARATIONS

Ethical approval: The study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences, and all procedures adhered to the principles of the Declaration of Helsinki. Written informed consent was obtained from the parents or legal guardians of all patients prior to the examination.

Conflict of interests: None.

FUNDING

None.

ACKNOWLEGMENTS

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