

## Amblyopia Prevention Screening Program in Northwest Iran (Ardabil)

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**How to cite this article:** Ojaghi H, Moghaddar R, Ahari SS, Bahadoram M, Amani F. Amblyopia prevention screening program in Northwest Iran (Ardabil). *Int J Prev Med* 2016;7:45.

### ABSTRACT

**Background:** The aim of this study was to evaluate the results of amblyopia screening in Ardabil Province in three examination levels by kindergarten teacher, optometrist, and ophthalmologist.

**Methods:** In a cross-sectional study, the results of the national amblyopic prevention program in 2–6 years old children in Ardabil Province were investigated in 2012. The results pertained to the examinations of children participating in this research were collected in the national approved forms. The data were entered into the computer and were analyzed using statistical methods in SPSS 18.

**Results:** Around 38,844 children (51.7%) out of 75173 with 2–6 years old qualified children participated in the screening program in Ardabil Province. In the first stage of screening, 1068 children (33.1%) are visually impaired in one eye and 2160 children (66.9%) are visually impaired in two eyes. In the second stage, the results related to the examinations by optometrists indicated that the prevalence of refractive errors, strabismus, and others were 70%, 27.8%, and 2.2%, respectively. Refractive errors problem was most prevalent in Ardabil city (72.6%). The prevalence of refractive errors, strabismus, and other reasons in amblyopic children was 51.3%, 23.9%, and 24.8%; respectively.

**Conclusions:** The present investigation showed that coverage of amblyopia screening program was not enough in Ardabil Province. To increase the screening accuracy, standard instruments and examination room must be used; more optometrists must be involved in this program and increasing the validity of obtained results for future programming.

**Keywords:** Amblyopia, Ardabil, children, prevention, screening, strabismus


## INTRODUCTION

Amblyopia is a condition resulting from unilateral or seldom bilateral reduction of best-corrected visual

acuity (also referred to as corrected distance visual acuity). There is no structural abnormality in the eye and no unusual vision pathways. Amblyopia signifies a failure of normal neural development in the immature visual system. Abnormal visual experiences in early life are considered to be the cause of amblyopia. These include:

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- Strabismus
- Refractive error: Anisometropia or high bilateral refractive errors (isometropia)
- Visual deprivation.<sup>[1]</sup>

With respect to this point, one of goals of the World Health Organization (WHO) in vision 2020 program is increasing public knowledge about ocular diseases in the childhood and eye care level in diseases such as amblyopia and refractive errors.<sup>[2]</sup> Visual disorders are one of the health problems which have recently been of particular interest by the WHO. High prevalence of visual disorders in developing countries of Africa and Asia is not due to the inability of ophthalmoscopy staff in medical diagnosis, but the major problem is inability of national health care systems in providing appropriate prevention methods and treatment. About 90% of blind and low-sighted people live in developing countries of Africa and Asia and 80% of these cases are preventable and curable.<sup>[3]</sup>

Amblyopia is particularly considered one of priorities in prevention programs until 2020 to prevent visual impairment. The first years of life are very important in developing visual acuity and stereopsis. Refractive errors or strabismus can lead to distorted visual acuity which can place a substantial burden on the affected child.<sup>[4]</sup> Amblyopia develops during childhood caused by abnormal visual experience; thus, it is an acquired defect.<sup>[5]</sup> Amblyopia is dim vision that occurs in a lazy eye that generally develops as a result of strabismus, media opacity, isometropia, and significant refractive errors, such as high astigmatism, hyperopia, or myopia.<sup>[6]</sup>

The prevalence of amblyopia varies from 2% to 4% in general population. Since visual pathways evolve during the 5<sup>th</sup> and 6<sup>th</sup> years of life, visual reduction will remain for whole life if it is not detected and treated during early childhood; whereas, the treatment will be successful if the visual impairment is detected in this time. Therefore, all screening and preventive services should be provided during early childhood.<sup>[7,8]</sup>

Researchers are conflicted about the proportion of amblyopia in Iran. A range of about 2.4–3.1% has been mentioned for the population of Iranian amblyopia. Growing research has shown the link between amblyopia and increased lifetime risk of visual impairment as well as quality of life.<sup>[9]</sup>

Ocular defects affecting visual system development at early years of age lead to irreversible decrease in the visual function called lazy eye (amblyopia),<sup>[10,11]</sup> and the early recognition through screening and referring the suspected cases as well as the treatment intervention can improve the visual condition<sup>[12]</sup> and it is only through early diagnosis and treatment that we can improve visual outcomes.<sup>[13]</sup>

Children, unlike adults, can usually function normally without correcting mild to moderate myopia or astigmatism and a fairly large amount of hyperopia. Children with strabismus are able to use one eye for vision, so there is no complaint or report from most of them.<sup>[4]</sup> There should be adequate eye care services that provide children before entering school with proper diagnostic test and therapeutic measures so that they can prevent future complications by detecting these types of visual impairments early on.

At present, the amblyopia screening program which has been proved to reduce the ocular diseases in several studies<sup>[14]</sup> has been started in Iran since 1995 using E chart board in three examination levels by kindergarten teachers, optometrist, and ophthalmologist in urban and rural areas. In this screening program, 11,000,000 children have been screened and 300,000 children have been suspected and finally, 89,000 amblyopic children have been recognized and treated. Nevertheless, the common screening examination among preschool children is not adequate and hinders the early recognition and treatment of considerable number of children suffering amblyopic vision defects.<sup>[4]</sup> One of the goals in 2010 was to cover at least 80% of the population and to treat all suspected children for 100%. Meanwhile, the opportunity to offer amblyopia prevention services is limited to this age range. In this study, the results of amblyopia screening in Ardabil Province in three examination levels by kindergarten teacher, optometrist, and ophthalmologist were evaluated in comparison with the previous researches done in Ardabil Province and other provinces as well as other countries.

## METHODS

At the present study, the results of the national amblyopic prevention program in 2–6 years old children in Ardabil Province in 2012 were investigated. Subjects Ardabil Province, located in the Northwestern Iran, is a mountainous land with an area of nearly 18,000 km<sup>2</sup> and a population of 1.2 million persons, 46% living in urban areas. The provincial distribution of population and geographical position and the related towns are illustrated in Figure 1. All 2–6 years old children participating in annual amblyopic screening program in Ardabil Province were studied. The qualified population for screening (All 2–6 years old children living in Ardabil Province) was estimated by Ardabil Registration Office 75137 which was used as the basic population for calculating the percentage of screening coverage.

### The summary of amblyopia prevention national program

The welfare state as a governmental organization and a part of health system in Iran deals with two important areas namely rehabilitation and social service and

disability prevention. The amblyopia screening, as one of duties of prevention sector in this organization, has been started in Iran since 1996 following the goal of promotion of children’s life quality. This program ran in some limited areas for 2 years and was extended to whole country in the 3<sup>rd</sup> year and the covered qualified population has been growing during these years. The amblyopia prevention program is run by the welfare state every November and all 2–6 years old children registered or unregistered in nursery schools and kindergartens are visually examined. In the first stage of screening, the trained kindergarten teachers test the children’s eyesight. Afterward, the suspected cases are referred to the second stage of the screening done by optometrists. The examination in both the first and second stages is carried out in fixed or itinerant way. All children examined in the second stage would be referred to the third stage (ophthalmologists) if they needed more specialized examination. The algorithm of amblyopia in Iran is displayed in Figure 2.

The permission of kindergartens in Iran is issued by the welfare state and all kindergarten teachers are trained through speeches and workshops annually before starting the vision screening. People are informed about

commencement of screening through media and notices. All children registered in kindergartens and those children whose parents take them to the centers are screened by kindergarten teachers and these kindergartens provide the list of children who suffer visual impairment and contact with their parents and refer them to the optometrist cooperating with program. The children who do not go kindergarten must refer to the visual assessment centers and participate in the screening program.

**Examinations**

The examination in the first stage of screening: The children were examined using Snellen chart in 6 m distance. If their visual acuity was less than (7/10) (20/30) or light reflexes in two eyes were not symmetrical proved by projecting light into the center of eyes from a light source, they would be recognized as suspected cases and would be referred to the optometrists in the second stage.

The examination in the second stage of screening by optometrist: Following conditions lead to diagnose problem as the amblyopia:

- The visual acuity less than (20/30) in each eye or vision difference for more than two lines between two eyes after removing refractive defects and eye organic defects
- If the child did not respond to the visual examination for any reasons, fixations, and maintenance would be used. In case eyes did not suffer fixations and maintenance, the problem would be regarded amblyopia
- If the child suffered strabismus, the strabismus was fixed in one eye that eye will be diagnosed as amblyopia. If fixation and maintenance were used in turns for each eye with cover test, there is usually no amblyopia.

If child did not respond to the vision test but the cycloplegic refraction indicated following degrees, it would be suspected as amblyopia:

- Astigmatism  $\geq 2.5$  diopter in both eyes and astigmatism difference  $\geq 1.5$  diopter between eyes

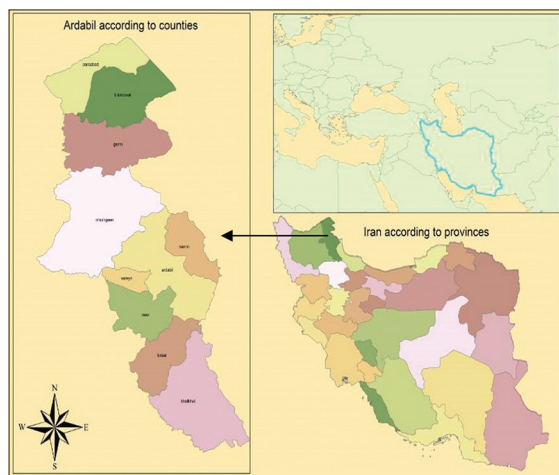


Figure 1: Geographical position of the studied area

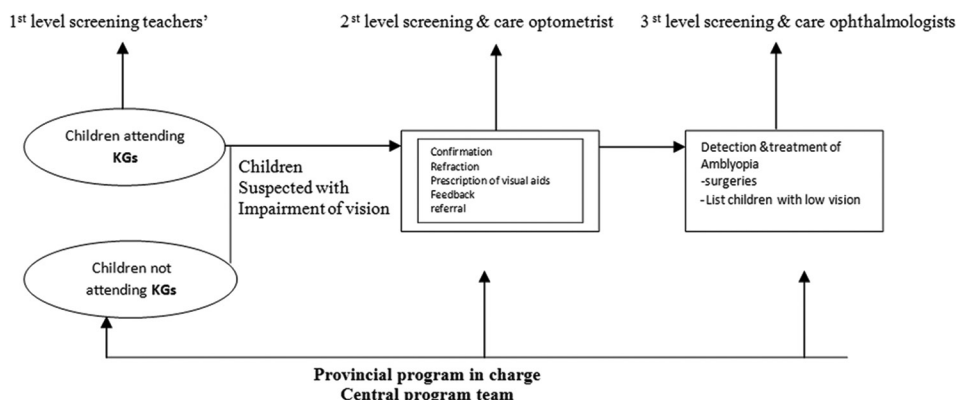


Figure 2: Flowchart showing levels of vision screening of 2–6 years old children in Iran

- Hyperopia  $\geq +4.5$  diopter in both eyes and hyperopia difference  $\geq +1.5$  diopter between eyes
- Myopia  $\geq 5$  diopter in eyes or myopia difference  $\geq 3$  diopter between eyes.

If an infant is not able to fix vision on objects or follow them by the age of 3–4 months, a number of causes must be considered. Ophthalmic (pregeniculate) causes of visual impairment include corneal and lenticular opacities, glaucoma, retinal anomalies or dystrophies, and optic nerve anomalies. Other causes of reduced visual attention include delayed visual maturation and cerebral visual impairment (i.e., postgeniculate visual impairment).

When an infant or child presents with poor vision, the workup is predicated on localizing the visual dysfunction. It is helpful to classify disorders causing visual impairment in infants as delayed visual maturation or pregeniculate or retrogeniculate visual dysfunction (cerebral visual impairment).

In fact, amblyopia is created by ocular organic causes and visual impairment is created by ocular and nonocular organic such as neurologic causes. In this study, we have done cycloplegic refraction for all infants. Visual impairment can be created by all nonstructural causes (strabismus, refractive), structural, ocular organic, and neurologic causes but amblyopia is a part of visual impairment which has only created by nonstructural causes. About the different accuracy among the teachers, the optometrists, and the ophthalmologists, teachers are trained so that they can diagnosed reduce visibility through the vision with the Snellen chart, as well as strabismus and then refer to optometrist.

Optometrists are trained to be able to diagnosis refractive errors, rate, and type of strabismus, and refer cases with structural and organic disorders to the ophthalmologist. Ophthalmologists are people who are aware of all of the above.

**Data management and analysis**

The results pertained to the examinations of children participating in this research were collected in the national approved forms. The data were entered into the computer and were analyzed using SPSS 18 (Statistical Package for Social Science (SPSS)) by descriptive statistical methods such as table, frequency, percentage, and statistical tests. The significant level was set at  $P < 0.05$ .

**RESULTS**

Around 38,844 children (51.7%) out of 75,173 with 2–6 years old qualified children participated in the screening program doing by kindergartens in Ardabil Province in 2011. They ranged in age from 2 to 6 and the mean age was 4. In total, 1112 people (2.8%) did not

cooperate with the kindergarten teachers, so they were excluded. The most number of coverage was reported in Nir town (1395 people, 93.5%) and the least number of qualified participants was reported in Ardabil city (15,286, 42.2%) [Table 1].

Among 38,844 children examined by kindergarten teachers, 19,535 participants (53.3%) were female and 19,305 participants (50.1%) were male which means that there is no significant relationship between gender and the screening coverage in province and all related towns. Among 38,844 children examined by kindergarten teachers, 3228 children (8.3%) were suspected to suffer visual impairment. The most prevalence of visual impairment in the first stage of screening was observed in Khalkhal town (322 people, 13.2%) and the least prevalence was observed in Parsabad (159 people, 2.9%) [Table 2].

Among 3228 children suspected to suffer visual impairment in the first stage of screening, 1699

**Table 1: The frequency of qualified children participated in the amblyopia screening program in 2011 by towns**

Towns	The number of 2-6 years old qualified children	The number of children examined in the first stage of screening (%)	The percentage of examination coverage
Ardabil	34,554	15,286 (39.4)	42.2
Germi	5330	3107 (8)	58.3
Meshkin Shahr	9431	5874 (15.1)	62.3
Parsabad	10,425	5473 (14.1)	52.5
Namin	3736	2246 (5.8)	60.1
Khalkhal	5240	2433 (6.3)	46.4
Bilasevar	3363	2060 (5.3)	61.3
Nir	1492	1395 (3.6)	93.5
Kosar	1597	970 (2.5)	60.7
Total (province)	75,173	38,844	51.7

**Table 2: The number of suspected children examined by kindergartens by towns**

Towns	The number of children examined by kindergartens (%)	The number of children suspected by kindergartens (%)	Suspicion percentage
Ardabil	15,286 (39.4)	1534 (47.5)	10.1
Germi	3107 (8)	195 (6.1)	6.3
Meshkin Shahr	5874 (15.1)	576 (17.8)	9.8
Parsabad	5473 (14.1)	159 (4.9)	2.9
Namin	2246 (5.8)	146 (4.5)	6.5
Khalkhal	2433 (6.3)	322 (10)	13.2
Bilasevar	2060 (5.3)	79 (2.4)	3.8
Nir	1395 (3.6)	122 (3.8)	8.7
Kosar	970 (2.5)	95 (2.9)	9.8
Total (province)	38,844	3228	8.3

participants (52.6%) were female and 1529 participants (47.4%) were male. Male and female suffering in different town is displayed in Figure 3.

In first stage of screening, 1068 children (33.1%) are visually impaired in one eye and 2160 children (66.9%) are visually impaired in two eyes. The most prevalence of one-eye visual impairment is in Khalkhal town (4.9%) and the least prevalence of one-eye visual impairment was observed in Parsabad town (1.2%). Two-eye impairment was most prevalent in Khalkhal town (8.3%) and least prevalent in Parsabad town (1.7%). 3025 participants (93.7%) examined by kindergarten teachers were referred to optometrists but 203 children (6.3%) avoided referring to the optometrist with highest number reported in Germi town (54 cases [27.7%]).

Among 3025 children examined by optometrists, 2075 children (68.6%) were diagnosed to be visually impaired which in 37.3% suffered refractive errors [Figure 4]. The prevalence of amblyopia, refractive errors, and strabismus were 1.9%, 2.9%, and 0.9%, respectively.

In the second stage of screening, among 2075 children examined by optometrists, 1160 children (55.9%) were diagnosed to be visually impaired. The results related to the examinations by optometrists indicated that the prevalence of refractive errors, strabismus, and others were 70%, 27.8%, and 2.2%, respectively. Refractive errors problem was the most prevalent in Ardabil city (72.6%) and the least prevalent in Parsabad town (48.5%) [Table 3].

Among 580 amblyopic children diagnosed by optometrists, 300 cases were female (51.7%) and 280 cases were male (48.3%) so that the amblyopic prevalence in girls and boys was 1.5% and 1.4%, respectively. However, in Khalkhal town, the amblyopic prevalence in boys (43, 3.4%) was almost double the degree in girls (19, 1.6%).

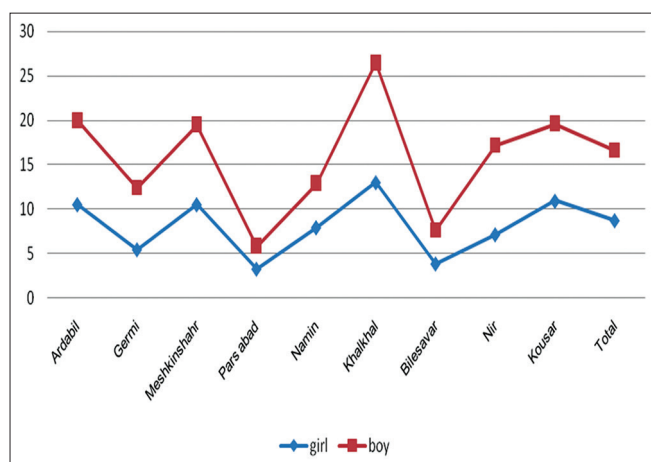


Figure 3: The prevalence of visual impairment in 2–6 years old children examined by kindergarten teachers separated by gender in towns

Among 3025 children examined by optometrists, 145 participants (12.5%) were referred to the ophthalmologists. The highest number of visiting by ophthalmologists was from Parsabad town (42, 26.6%) [Table 4].

Among 145 children referred to the ophthalmologists, 77 cases were female (53.1%) and rest cases were male.

Table 3: Degree of visual impairments in children examined by optometrists separated by towns

Towns	Amblyopia n (%)	Refractive errors n (%)	Strabism n (%)	Others n (%)
Ardabil	427 (73.6)	310 (72.6)	110 (25.8)	7 (1.6)
Germi	13 (2.2)	9 (69.2)	4 (30.8)	-
Meshkin Shahr	46 (8)	31 (67.4)	14 (30.4)	1 (2.2)
Parsabad	33 (5.7)	16 (48.5)	14 (42.4)	3 (9.1)
Khalkhal	43 (7.4)	29 (67.4)	12 (27.9)	2 (4.7)
Bilesevar	4 (0.7)	2 (50)	2 (50)	-
Nir	14 (2.4)	9 (64.2)	5 (35.7)	-
Total (1160)	580 (50)	406 (35)	161 (27.8)	13 (2.2)

Table 4: The frequency of referring children to the ophthalmologists from optometrists by towns

Towns	Number of children examined by optometrists (%)	Children referred to the ophthalmologists (%)	
		Number	Coverage rate
Ardabil	1404 (46.4)	34 (23.4)	2.4
Germi	141 (4.7)	21 (14.5)	14.9
Meshkin Shahr	566 (18.7)	24 (16.6)	4.2
Parsabad	158 (5.2)	42 (29)	26.6
Namin	146 (4.8)	-	-
Khalkhal	317 (10.5)	23 (15.9)	7.3
Bilasevar	79 (2.6)	1 (0.7)	1.3
Nir	121 (4)	-	-
Kosar	93 (3.1)	-	-
Total	3025 (100)	145 (100)	12.5

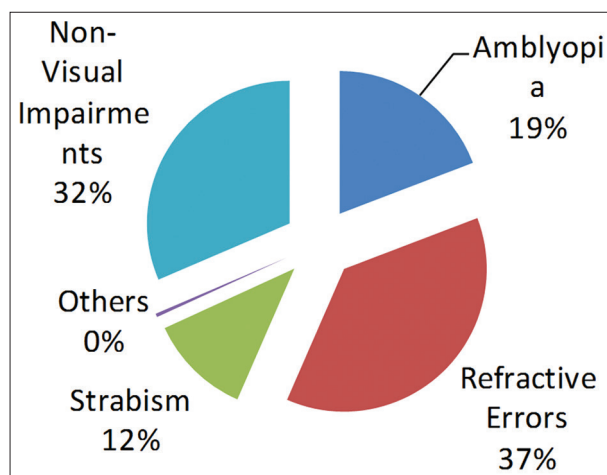


Figure 4: Visual impairments in children examined by optometrists

Degree of amblyopic prevalence in children examined by ophthalmologists was 109 children (75.2%) which in 68 children (62.4%) suffered amblyopia in one eye and 41 children (37.6%) suffered amblyopia in two eyes. The frequency of one-eye amblyopia in the right eye and left eye was 51.5% and 48.5%, respectively. Among 109 children diagnosed to suffer amblyopia by the ophthalmologists, 61 cases were female (56%) and rest cases were male and there was no significant difference. The prevalence of amblyopia resulting from refractive errors, strabismus, and other reasons in amblyopic children was 56 (51.3%), 26 (23.9%), and 27 (24.8%) children, respectively.

The final prevalence of amblyopia, refractive errors, and strabismus in our study confirmed by ophthalmologists were 0.14%, 0.074%, and 0.034%; respectively. The final prevalence of amblyopia in boys and girls were 0.12% and 0.17%; respectively.

## DISCUSSION

The extent of qualified children coverage for amblyopia screening in Iran has been increasing since the emergence of this program so that it has been raised from 28.2% in 1999 to 66.2% in 2005;<sup>[15]</sup> however, the coverage extent is not same in all provinces, for example, the coverage extent has been reported 26% in Sistan and Baluchestan Province while it was 98% in Elam.<sup>[16]</sup> At the present study, the extent of qualified 2–6 years old children coverage for amblyopia screening in Ardabil was 51.7% and in towns; it was varied from 35.7% to 76.7% which is lower than national average in 2002, 2003, 2004, and 2005. Due to lack of cooperation of children; at the first stage of screening, 1112 participants (2.8%) were not covered. This screening failure has been reported <2% in another study and has slight effect on positive and negative predictive value of screening.<sup>[10]</sup> The coverage extent in urban and rural areas was 38.1% and 71.6%, respectively which indicated a significant difference. This difference can be justified by this fact that the patients refer to optometrist and ophthalmologist easily in urban areas and, on the other hand, the control and examination of patients are easier and possible in rural areas because of limited number of patients. However, there was no significant difference between children's gender and coverage extent.

The prevalence of visual impairment (suspected case) in the children examined by kindergarten teachers was 8.3% which was ranged 2.9–13.2% in the towns. The prevalence had been reported 7.21% in a similar study in Ardabil Province in 1998–2001. The prevalence of visual impairment among the children examined by the kindergartens was 8.7% for girls and 7.9% for boys which indicated no significant difference between two sexes. At the present study, the prevalence of one-eye and

two-eye visual impairment at the first stage of screening was 2.7% and 5.6%, respectively. The investigation of the results related to amblyopic screening in Ardabil Province in 1998–2001 proved that the frequency of referring to optometrist reported to be 12.7%<sup>[15]</sup> while at the present study, it was 8.3%. This fact suggests that the kindergarten teachers have been more skillful and experienced in the recent years. In the above-mentioned research, 13.26% of children did not refer to optometrist while 6.3% of children avoided optometrist in this study which in the range of varieties was oscillating from 0.7% to 27.7% in the towns. The referring of girls and boys were 8.2% and 7.4%, respectively. The referral from optometrists to ophthalmologists was 57.8% in the previous study but the referral of this study reported 4.8% (i.e. 145 children were referred by optometrists out of 3025 examined children) with 4.8% girls and 4.7% boys and there was no significant difference. Considering this point that there was a reduction in the number of referral from optometrists to ophthalmologists, it might be argued that this was the result of increasing experience of optometrists in recent years since the program has been run annually. The degree of visual impairment in children examined by optometrists reported 68.6%. Many studies have been done about the prevalence of amblyopia and the related factors in different age ranges (students, soldiers, the military, university students) in Iran and other places in the world in recent years<sup>[8-14]</sup> the prevalence of amblyopia has been reported with a broad range of 0.8–4.6% resulting from following reasons: First, the visual criterion which researcher chooses to diagnose amblyopia; second, the selection of the population which is examined to find out the reason of amblyopia; and third, the age range of the investigated population.

In the studied age range of the present research, that is, 2–6 years old children, the amblyopic prevalence was 1.25% according the research done by Khandekar *et al.* based on national statistics in 2005.<sup>[16]</sup> The amblyopic prevalence in school children of Shahrud has been reported 1.7%.<sup>[4]</sup> The amblyopic prevalence in American and African-American children has been <0.2%.<sup>[17]</sup> The results of the present investigation suggest 1.5–1.8% amblyopic prevalence which is in moderate level in comparison with other areas of country and is consistent with national prevalence and previous researches done in Ardabil.<sup>[15]</sup>

The present study and many other studies done on amblyopia showed that there was no statistically difference between the extents of amblyopic prevalence and gender.<sup>[2,4,6,8,9,12]</sup> The investigation of the results pertaining to amblyopic screening in 1998–2001 indicated that there was no significant difference between amblyopia and gender.<sup>[4]</sup> The present study revealed that the amblyopic prevalence in girls and boys was 1.5% and 1.4%, respectively,

and the difference was not significant echoing the results obtained in other researches done previously. The prevalence of uncorrected refractive errors and strabismus has been reported as major reasons for amblyopia in the country and abroad differently. The prevalence of refractive errors and strabismus in school children of Shahrud has been reported 3.6% and 1.7%, respectively.<sup>[4]</sup> The study on 6–71-month-old American and African-American children explored that the prevalence of refractive errors and strabismus was 3.3% and 1.2%, respectively.<sup>[17]</sup> Khandekar *et al.* stated that the prevalence of refractive errors and strabismus in Iran has been 3.8% and 0.39%, respectively.<sup>[16]</sup> In the present study, the prevalence of uncorrected refractive errors and strabismus was 0.074% and 0.034%, respectively, based on the results of examinations by optometrists and ophthalmologists. The prevalence of uncorrected refractive errors is consistent with results of the study done by Khandekar *et al.*, but the prevalence of strabismus is higher than Khandekar's. The present investigation showed that the prevalence of one-eye and two-eye amblyopia, based on the results related to final diagnosis of ophthalmologists, were 0.09% and 0.05%, respectively and the frequency distribution of one-eye amblyopia in the right eye and left eye was 52.8% and 47.2%, respectively.

The prevalence of amblyopia with 0.14% in this study lower than other studies doing in another places,<sup>[5,18-23]</sup> but rate of coverage is lower than other places. The prevalence of one-eye and two-eye amblyopia, based on the results related to diagnosis of ophthalmologists, was 0.09% and 0.05%, respectively.

## CONCLUSIONS

The present investigation showed that coverage of amblyopia screening program was not enough in Ardabil Province. To increase the screening accuracy, standard instruments and examination room must be used; more optometrists must be involved in this program and increasing the validity of obtained results for future programming.

## Recommendations

- To increase the screening accuracy, the standard instruments and examination room must be used, and more optometrists must be involved in this program
- The continual training during the year through the media as well as publication and distribution of educational brochures for families and conducting the educational meetings for parents to inform them about the necessity of cooperation in screening
- Through the improvement of referral, especially referring from kindergartens to optometrists and

from optometrists to ophthalmologists, children will hardly ever give up the program.

## Acknowledgements

The results of this study financially supported by Ardabil University of Medical Sciences, and we thank the Welfare Organization of Ardabil for providing the data of this project. This project is registered in Ardabil Faculty of Medicine with Number 0373.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

**Received:** 06 May 15 **Accepted:** 15 Dec 15

**Published:** 01 Mar 16

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