



Review

The prevalence of amblyopia in Iran: A systematic review

Maryam Chegeni ^a, Narges Khanjani ^{b,*}, Pardis Rahmatpour ^c, Mahin Ahmadi Pishkuhi ^d,
Nafiseh Abdolalian ^e

^a Department of Epidemiology, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran

^b Neurology Research Center, Kerman University of Medical Sciences, Kerman, Iran

^c Social Determinants of Health Research Center, Guilan University of Medical Sciences, Rasht, Iran

^d Noor Research Center For Ophthalmic Epidemiology, Noor Eye Hospital, Tehran, Iran

^e Isfahan University of Medical Sciences, Isfahan, Iran

Received 19 September 2017; revised 7 January 2018; accepted 6 February 2018

Available online 27 March 2018

Abstract

Purpose: The aim of this study was to determine the prevalence of amblyopia in the population of Iran.

Methods: This article is a systematic review. A comprehensive search was conducted in PubMed, Scopus, Science Direct, Ovid, Web of Science, SID, Magiran, with appropriate terms. Information related to the sample size and the prevalence of amblyopia was extracted and summarized in tables. Analysis was performed using STATA software.

Results: From 551 articles that were originally extracted from the databases, 31 articles met the criteria for entering the review. These studies were conducted in different regions of Iran. The prevalence of amblyopia in different regions varied between 0.19 and 3.69%. Study results were heterogeneous ($I^2 = 99.7\%$), and therefore, a meta-analysis was not done.

Conclusions: The prevalence of amblyopia in Iran is very different. In addition to conducting national screenings, it is necessary to report the incidence of amblyopia and its related factors in different parts of the country.

Copyright © 2018, Iranian Society of Ophthalmology. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Keywords: Amblyopia; Systematic review; Iran; Prevalence

Introduction

Amblyopia, or Lazy Eye, is a kind of visual impairment with no physical defect in the eyes or in the optic nerve.¹ While this type of disorder can cause visual impairment or blindness in the absence of timely diagnosis and treatment, with early diagnosis, many of its possible complications are reduced.^{2–5}

When one eye develops naturally and the other eye does not, the lagged eye becomes visually impaired, or in other words, lazy.^{5,6} Although in most cases the defect happens in one eye, bilateral amblyopia is also possible.⁷

Several factors can lead to this defect, including congenital abnormalities in the eye structure such as cataracts, ptosis, strabismus, and refractive problems such as myopia, and astigmatism.^{8–10} Some studies have referred to strabismus as the most common cause of amblyopia.⁸

Amblyopia can cause consequences such as learning impairment and failure in education and communication.¹¹ There is also evidence that, in addition to imposing an economic burden on the society, this disease causes unusual psychological disorders, social anxiety, and inability to perform in group activities.⁶

Conflict of interest: None of the authors has any conflict of interest to declare.

Financial support: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

* Corresponding author. Department of Epidemiology and Biostatistics, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran.

E-mail address: n_khanjani@kmu.ac.ir (N. Khanjani).

Peer review under responsibility of the Iranian Society of Ophthalmology.

<https://doi.org/10.1016/j.joco.2018.02.003>

2452-2325/Copyright © 2018, Iranian Society of Ophthalmology. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

A wide range has been reported for the prevalence of this disorder worldwide, which has been from 0.2 to 6.2.^{12–17} Several studies in different regions of Iran have also reported the prevalence of amblyopia.^{18–37}

Awareness of the prevalence of this type of visual impairment provides the required information for policy makers to plan for timely prevention, diagnosis, and treatment. In this article, we systematically review studies about the prevalence of amblyopia in Iran.

Methods

Search strategy and inclusion criteria

The inclusion criteria were studies which reported the prevalence of amblyopia among an Iranian-based population and diagnosed amblyopia with any screening tool.

Studies were not excluded based on publication status, language, type of screening tool, or etc. In this paper, both English and Persian keywords were used to search for articles. The search was restricted to studies done in Iran.

Studies were identified by searching PubMed, Embase, Web of Science, Scopus, Ovid, SID, Civilica and Magiran.

Conference proceedings were searched in Scopus and Civilica, and dissertations were searched in the Irandoc website. The search was done up to 22 October 2017. It took about one week to do the full search.

The search terms used were Amblyopias; Lazy Eye; Eye, Lazy; Eyes, Lazy; Lazy Eyes; Anisometropic Amblyopia; Amblyopia, Anisometropic; Amblyopias, Anisometropic; Anisometropic Amblyopias; Amblyopia, Developmental; Amblyopias, Developmental; Developmental Amblyopia; Developmental Amblyopias; Amblyopia, Suppression; Amblyopias, Suppression; Suppression Amblyopia; Suppression Amblyopias; Stimulus Deprivation-Induced Amblyopia; Stimulus Deprivation Induced Amblyopia; Amblyopia, Stimulus Deprivation Induced; Amblyopias, Stimulus Deprivation-Induced; Deprivation-Induced Amblyopia, Stimulus; Deprivation-Induced Amblyopias, Stimulus; Stimulus Deprivation-Induced Amblyopias; Prevalence; Incidence; Frequency; Occurrence; Iran. Details about the search strategy and the results can be found in the article [Appendix](#).

All retrieved articles were sent to Endnote, and after that, duplicates were removed. Then based on the title and abstract of the articles, unrelated articles were excluded. Subsequently,

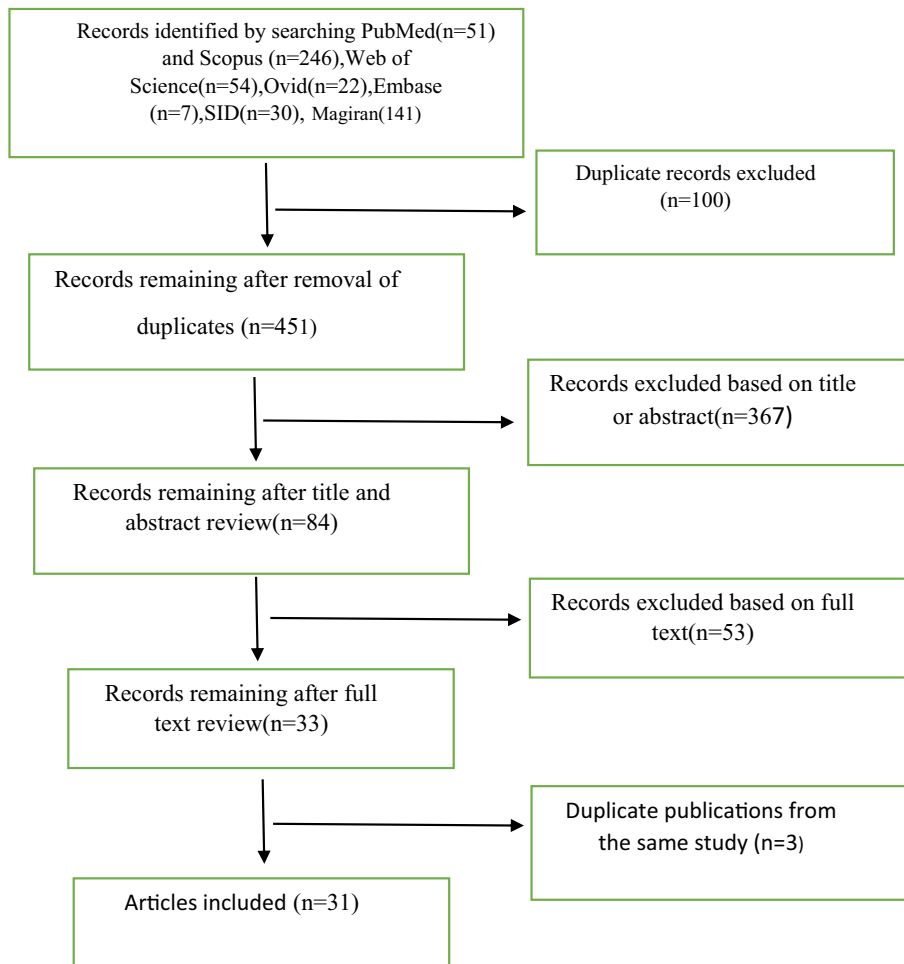


Fig. 1. Flowchart of study selection.

the full text of the remaining articles was downloaded and inspected and irrelevant articles were excluded again.

Screening tools

Clinically, unilateral amblyopia is defined as a 2-line difference in visual acuity (VA) between two eyes, where the eye with the poor eyesight has a rating of $\leq 20/32$, and bilateral amblyopia is a bilateral reduction in VA presentation due to history of either obstruction in the bilateral vision axis or significant bilateral ametropia. The devices used for screening amblyopia include plus-optix photo-screeners (SO4, SO8, SO9) and Esnelen charts (E-chart).³⁸

Data extraction and quality assessment

Extracted data included the first author's name, year of publication, location of studies, sample size, and the

prevalence of amblyopia. Quality assessment was not done as we did not find a widely accepted tool for quality assessment of surveys such as the studies used in this review.³⁹

Statistical analysis

Statistical heterogeneity among studies was assessed with the Q and I^2 statistics.⁴⁰ We assessed the impact of some variables on study prevalence results through meta-regression. Stata (version 12.0) was used for statistical analyses.

Results

Eventually, 31 articles remained in the review. The screening steps and the number of articles excluded in each step are shown in Fig. 1. We found some dissertations that could have been related, but we did not have access to the abstract or full text and therefore could not include them.

Table 1
Summary of studies about the prevalence of amblyopia in Iran.

	First author	Publication year	Cities	Sample Size	Participants	Prevalence (in 10 ²)	Sampling procedure
1	Hashemi et al. ¹⁴	2014	Sari, Birjand, Ardabil, Mashhad, Bandar Abbas, Dezful, Arak, and Yazd	3675	7-year-old	1.88	Cluster sampling
2	Hashemi et al. ¹⁸	2015	Sari, Birjand, Ardabil, Mashhad, Bandar Abbas, Dezful, Arak, and Yazd	4106	7 years	0.89	Multistage randomized cluster sampling
3	Mohammadzadeh et al. ¹⁹	2009	Mashhad	2400	6–7 years	0.19	Cluster sampling
4	Faghihi et al. ²⁰	2011	Mashhad	2150	6–21 years	1.9	Cluster sampling
5	Ostadi Moghaddam et al. ²¹	2015	Mashhad	506	7–22 years	1.2	Cluster sampling
6	Yekta et al. ²²	2016	Mashhad	3654	4–6 years	0.41	Random multistage cluster sampling
7	Ojaghi et al. ²³	2016	Ardabil	38,844	2–6 years	1.9	Not reported
8	Masumi et al. ²⁴	2011	Ardabil	4548	11–17 years	2.63	Not reported
9	Azami et al. ²⁵	2004	Ardabil	8427	3–6 years	1.42	Not reported
10	Ostadi moghadam et al. ²⁶	2008	Mashhad	2150	Schoolchildren	1.9	Random cluster sampling
11	Shakeri et al. ²⁷	2006	Mashhad	2130	7–11 years	0.8	Population proportional size
12	Merat ²⁸	2002	Qazvin	1380	6–9 years	4.3	Not reported
13	Ghasemi ²⁹	2000	Qazvin	510	4–61 years	6.21	Not reported
14	Yekta et al. ³⁰	2010	Shiraz	2638	7–17 years	2.29	Random cluster sampling
15	Yekta et al. ³¹	2010	Shiraz	2683	6–15 years	2.31	Random cluster sampling
16	Fotouhi et al. ³²	2007	Dezful	5544	Schoolchildren	0.91	Random cluster sampling
17	Yekta et al. ³³	2016	Dezful	1375	Schoolchildren	2.7	Multistage cluster sampling
18	Hashemi et al. ³⁴	2011	Tehran	3519	5–86 years	3.69	Multistage (clustering & stratification)
19	Rajavi et al. ³⁵	2015	Tehran	2160	Schoolchildren (Primary)	2.1	Random cluster sampling
20	Rajavi et al. ³⁶	2015	Tehran	2410	7–12 years	2.3	Random sampling
21	Faghihi et al. ³⁷	2012	Varamin	1133	14–18 years	2.1	Random cluster sampling
22	Jamali et al. ⁴⁴	2009	Shahroud	815	6 years	1.7	Random sampling
23	Safari Moradabadi et al. ⁴²	2014	Bandar Abbas	16,599	2–6 years	0.96	Not reported
24	Ouji et al. ⁴⁵	2000	Fasa	1224	Schoolchildren (Primary)	2.28	Systematic random
25	Omidian et al. ⁴⁶	2000	Kermanshah	4533	Schoolchildren (Primary)	0.33	Random cluster sampling
26	Yekta et al. ⁴⁷	2011	Bojnourd	1551	Schoolchildren	2.3	Multistage (clustering & stratification)
27	Sharifi and Heshmat ⁴⁹	2004	Oroumieh	55,000	6–10 years	2.2	Not reported
28	Salehi and Lotfizadeh ⁴⁸	1999	Shahrekord	2000	School children	2.5	Not reported
29	Khandekar et al. ⁴¹	2009	In all provinces of Iran	1,433,540	3–6 years	1.25	Not reported
30	Hamidi et al. ⁴³	2014	Bojnourd	14,061	3–6 years	0.49	Not reported
31	Rafei et al. ³⁸	2017	In all provinces of Iran	24,398,458	3–6 years	0.5	Not reported

The selected studies are summarized in Table 1. These studies were conducted in different parts of Iran, between 1999 and 2017.

All of the papers used in this study were cross-sectional. Most studies were conducted in Mashhad and Ardebil.^{14,18–27} The reported prevalences were very different and varied from 0.19% to 3.69%.

The lowest prevalence of amblyopia (0.19%) was in Mashhad,¹⁹ and the highest prevalence (3.69%) was in Tehran.³⁴ In the Mashhad study, the population under study were children screened before entering school. In the Tehran study, the population under study were people from 5 to 86 years.

The age range of participants in all included studies was between 2 and 86 years.

The main target group in six articles were children up to six years old,^{22,23,25,38,41–43} and in 20 articles, the subjects aged from 6 to 22 years old.^{14,18–21,24,26–28,30,32,33,35,36,44–49} In two articles, the elderly age group was also included.^{29,34} In most cases, cluster sampling was done,^{14,18–22,26,30–33,35,37,46} and in others, random sampling had been used.^{27,34,36,45,47} However, in some articles, the method of sampling was not clearly indicated.^{23–25,28,29,38,41–43,48,49}

The details of each study, based on sample size, place of study, participants, quality, and prevalence of amblyopia is shown in Table 1.

The results of studies done in different cities of Iran and in different years have been shown on a map in Fig. 2. Each column represents a separate study in that city.

The prevalence of amblyopia was highly heterogeneous among the remaining 31 articles ($I^2 = 99.7\%$, Heterogeneity Chi-square = 8136.76, d.f. = 28, $P < 0.001$). According to the Galbraith chart, some studies were outside the 95% confidence range. Since the studies were heterogeneous, calculating the pooled prevalence of amblyopia was not possible.

The relation between amblyopia and two continuous variables, which were the year of publication, and the sample size were investigated by meta-regression, and no significant association was found. The results of the meta-regression analysis are shown in Table 2.

The funnel plot of the included studies can be seen in Fig. 3. The funnel plot is very asymmetric. The reason is more likely the heterogeneity of studies and not selection bias.⁵⁰

Discussion

This study was, as far as we know, the first systematic review article about the prevalence of amblyopia in Iran. The prevalence of amblyopia in Iran was 0.19%–3.9%.

The prevalence of amblyopia in specific populations, such as those referred to medical centers and clinics, and clinical

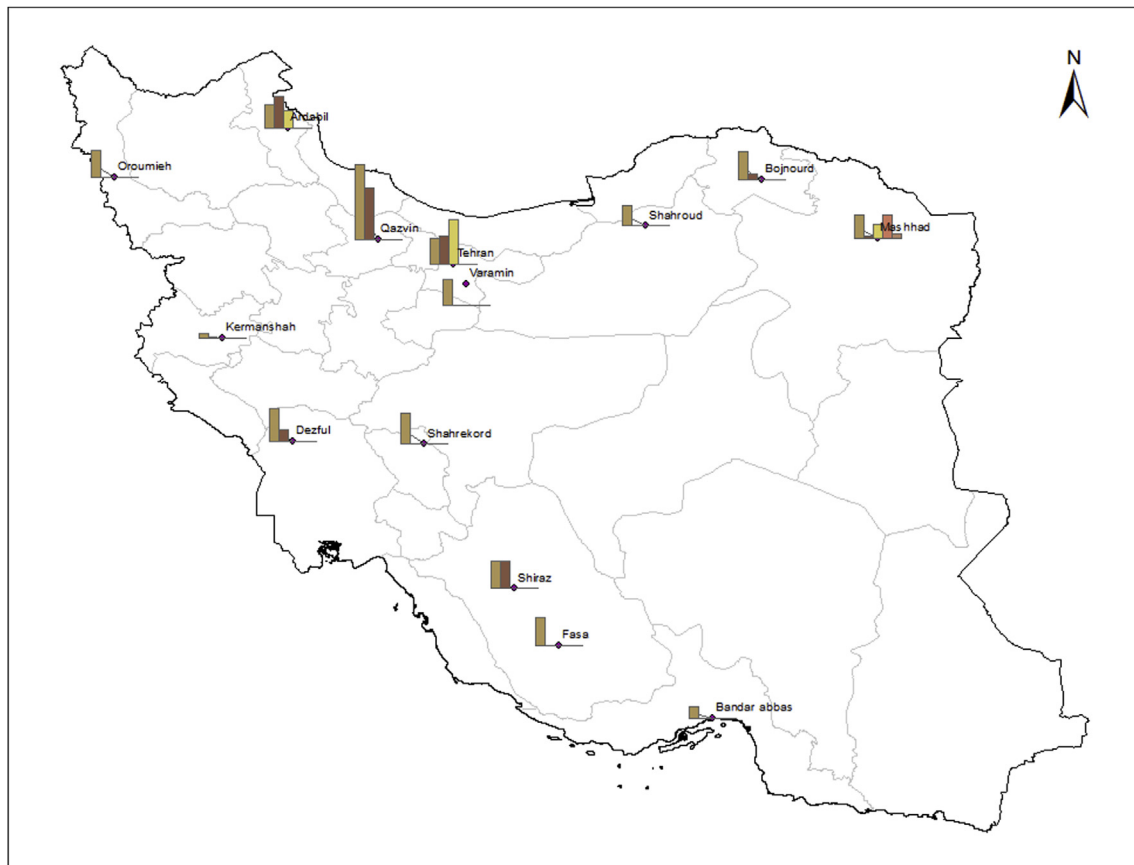


Fig. 2. Geographic distribution of studies about amblyopia in Iran. Each column in each city represents the result of a separate study.

Table 2
Meta-regression analysis on the effect of publication year and sample size on the reported prevalence of amblyopia in Iran.

Variable	Coefficient	Std. Err.	t	P> t	[95% Confidence interval]	
Publication year	0.00002	0.0003359	0.06	0.953	−0.0006706	0.0007105
Sample size	−4.90 e−10	3.64 e−10	−1.35	0.189	−1.24 e−09	2.57 e−10
_Cons	−0.0235327	0.6752437	−0.03	0.972	−1.411516	1.364451

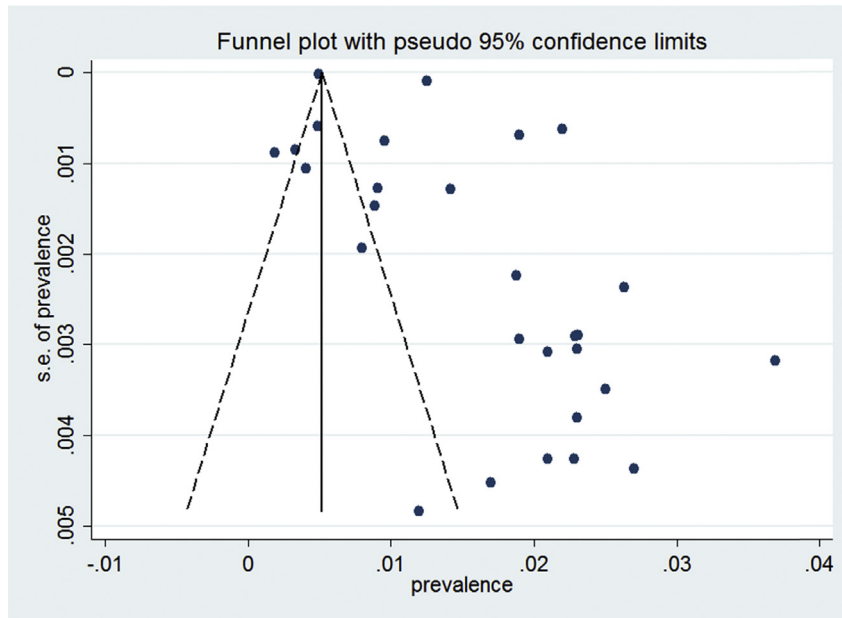


Fig. 3. Funnel plot to access publication bias. Each point represents a separate study.

samples, cannot accurately estimate the prevalence in the general population.⁵¹

In this systematic review, we tried to include all articles that reported the prevalence of amblyopia until October 22, 2017 in any part of Iran, in order to estimate the general prevalence of amblyopia in Iran.

As previously mentioned, amblyopia may exist in both adults and children, but the golden time for diagnosis and treatment of visual impairment is childhood. In this systematic review article, due to the difference in the age ranges of subjects studied in different articles, it was not possible to perform separate analyzes in different age groups.

There are several causes for amblyopia, including congenital abnormalities in the eye structure such as cataracts and ptosis, strabismus, and refractive problems such as myopia, and astigmatism.^{8–10} One of the most common causes is strabismus and anisometropia.⁵²

In this systematic review article, it was not possible to report a pooled prevalence. In general, the reported prevalences in these studies can be divided into three categories. Studies from Dezful (2007),³² Tehran (2011),¹⁸ Mashhad (2009, 2006, 2016),^{19,22,27} Bandar Abbas (2014),⁴² Kermanshah (2000),⁴⁶ Bojnourd (2014),⁴³ and all provinces from 2000 to 2013³⁸ reported the prevalence to be less than 1%.

Studies done in Shahrood (2009),⁴⁴ all provinces (2009),⁴¹ Mashhad (2008, 2011, 2015),^{20,21,26} the seven cities of Ardebil, Birjand, Sari, Mashhad, Bandar Abbas, Dezful, Arak and Yazd (2014),¹⁴ and Ardabil (2004, 2016)^{23,25} reported the prevalence between 1 and 2%; and the third category of articles, from Varamin (2012), Tehran (2015), Shiraz and Dezful (2016, 2010), Ardebil (2011), Oroumieh (2004),⁴⁹ showed a prevalence between 2% and 3%. Only Hashemi et al.'s study from Tehran (2011)³⁴ reported an over 3% prevalence.²⁹

Two studies, one conducted by Khandekar et al.⁴¹ and the other conducted by Rafiei et al.,³⁸ reported results of amblyopia screening in all provinces of Iran. In Khandekar's study conducted in 2006,⁴¹ the prevalence of amblyopia in Iran was 1.25%, and in Rafiei's study, the average prevalence of amblyopia was estimated to be 0.5% and ranged from 0.26% (0.25%–0.27%) to 0.95% (0.93%–0.97%) during 2000–2013.³⁸

Several studies have reported the prevalence of amblyopia in different countries of the world. In a study by Xiao et al. in 2015, the prevalence of amblyopia was reported to be 0.28% among African, 0.35% in Nepali, 0.52% in Malay, 0.62% in Indian, 0.93% in Chinese, and 1.43% in Hispanic children.⁵³ Xiao's study did not show a relation between amblyopia and age or gender.⁵³

Other studies have shown a prevalence of 0.2% in school children aged 7–19 years in Tanzania,⁵⁴ 1.8% in Australian

school children aged 6 years,⁵⁵ 2.8% among adults 30–80 years in a rural Chinese population,⁵⁶ and 3.6% in British children aged 7 years.⁵⁷

In a review about amblyopia published in 2005, the prevalence of amblyopia was in the range of 1.6%–3.6%, and there were no significant ethnic/racial differences in prevalence.⁵⁸ All of these studies confirm the various prevalence of amblyopia in different regions of the world.

In this systematic review, the prevalence has been reported in different parts of Iran, but even in cases where studies had been done in a particular province, the prevalence of amblyopia was variable. Therefore, the prevalence of amblyopia does not seem to have a specific geographical distribution in Iran.

We do not know the reason for this difference in amblyopia prevalence in Iran, and we did not find anything in the literature neither.

It seems like the observed difference among the studies may be due to the populational groups under study, the situation of the research, and the skill of the staff to diagnose amblyopia.

One of the limitations of this study was the lack of information about the prevalence of amblyopia from all provinces across the country separately. The lack of sufficient information in published articles makes it difficult to estimate the overall prevalence. Also, some studies did not report sufficient information about sampling, measuring and diagnostic tools, type of amblyopia, unilateral or bilateral defects, prevalence in gender subgroups, and the probable causes of amblyopia.

Studies on amblyopia in Iran are highly heterogeneous, and according to these studies, the prevalence of amblyopia in Iran is between 0.19 and 3.69%.

Appendix.

Search strategy:

Embase: 7

amblyopias OR 'lazy eye' OR 'eye, lazy' OR 'eyes, lazy' OR 'lazy eyes' OR 'anisometropic amblyopia' OR 'amblyopia, anisometropic' OR 'amblyopias, anisometropic' OR 'anisometropic amblyopias' OR 'amblyopia, developmental' OR 'amblyopias, developmental' OR 'developmental amblyopia' OR 'developmental amblyopias' OR 'amblyopia, suppression' OR 'amblyopias, suppression' OR 'suppression amblyopia' OR 'suppression amblyopias' OR 'stimulus deprivation-induced amblyopia' OR 'stimulus deprivation induced amblyopia' OR 'amblyopia, stimulus deprivation-induced' OR 'amblyopia, stimulus deprivation induced' OR 'amblyopias, stimulus deprivation-induced' OR 'deprivation-induced amblyopia, stimulus' OR 'deprivation-induced amblyopias, stimulus' OR 'stimulus deprivation-induced amblyopias' OR 'visual defects' OR 'refractive eye' AND (prevalence OR incidence OR epidemiology OR occurrence) AND iran

Ovid: 22

1	(amblyopias or "lazy eye" or "Eye, Lazy" or "Eyes, Lazy" or "Lazy Eyes").af.	265
2	("Anisometropic Amblyopia" or "Amblyopia, Anisometropic" or "Amblyopias, Anisometropic" or "Anisometropic Amblyopias" or "Amblyopia, Developmental" or "Amblyopias, Developmental" or "Developmental Amblyopia" or "Developmental Amblyopias").af.	788
3	("Amblyopia, Suppression" or "Amblyopias, Suppression" or "Suppression Amblyopia" or "Suppression Amblyopias").af.	85
4	("visual defects" or "refractive eye").af.	1653
5	(occurrence or epidemiology or incidence or prevalence or frequency).af.	2,249,489
6	Iran.af.	49,267
7	1,2,3,4 (OR)	2656
8	7,5,6(AND)	22

PubMed: 51

((Amblyopia OR "visual impairment" OR "visual disorders" OR "visual defects" OR "refractive eye")) AND (prevalence[Text Word] OR incidence [Text Word] OR frequency[Text Word] OR epidemiology[Text Word]) AND IRAN[Text Word]

Scopus: 246

1	(ALL (amblyopias) OR ALL (lazy eye) OR ALL (eye, lazy) OR ALL (eyes, lazy) OR ALL (lazy eyes))
2	ALL ("Anisometropic Amblyopia") OR ALL ("Amblyopia, Anisometropic") OR ALL ("Amblyopias, Anisometropic") OR ALL ("Anisometropic Amblyopias") OR ALL ("Amblyopia, Developmental") OR ALL ("Amblyopias, Developmental") OR ALL ("Developmental Amblyopia") OR ALL ("Developmental Amblyopias")
3	ALL (amblyopia, suppression) OR ALL (amblyopias, suppression) OR ALL (suppression amblyopia) OR ALL (suppression amblyopias) OR ALL (stimulus deprivation-induced amblyopia) OR ALL (stimulus deprivation induced amblyopia)
4	ALL (amblyopia, stimulus deprivation-induced) OR ALL (amblyopia, stimulus deprivation induced) OR ALL (amblyopias, stimulus deprivation-induced amblyopia, stimulus) OR ALL (deprivation-induced amblyopia, stimulus) OR ALL (deprivation-induced amblyopias, stimulus) OR ALL (stimulus deprivation-induced amblyopias)
5	ALL ("refractive eye") OR ALL ("visual defects") OR ALL ("visual disorders") OR ALL ("visual impairment")
6	TITLE-ABS-KEY (iran)
7	(ALL (prevalence) OR ALL (incidence) OR ALL (frequency) OR ALL (epidemiology) OR ALL (occurrence))

Web of Science: 54

TOPIC: ((Amblyopia OR Amblyopias OR “Lazy Eye” OR “Eye, Lazy” OR “Eyes, Lazy” OR “Lazy Eyes” OR “Anisometropic Amblyopia” OR “Amblyopia, Anisometropic” OR “Amblyopias, Anisometropic” OR “Anisometropic Amblyopias” OR “Amblyopia, Developmental” OR “Developmental Amblyopia” OR “Amblyopias, Developmental” OR “Developmental Amblyopias” OR “Amblyopia, Suppression” OR “Amblyopias, Suppression” OR “Suppression Amblyopia” OR “Suppression Amblyopias” OR “Stimulus Deprivation-Induced Amblyopia” OR “Stimulus Deprivation Induced Amblyopia” OR “Amblyopia, Stimulus Deprivation-Induced” OR “Amblyopia, Stimulus Deprivation Induced” OR “Amblyopias, Stimulus Deprivation-Induced” OR “Deprivation-Induced Amblyopia, Stimulus” OR “Stimulus Deprivation-Induced Amblyopias” OR “refractive eye” OR “visual defects” OR “visual disorders” OR “visual impairment”)) AND **TOPIC:** ((incidence OR prevalence OR frequency OR OCCURENCE)) AND **TOPIC:** ((IRAN))

SID: 29

Amblyopia, Lazy Eye, Prevalence

Magiran: 141

Amblyopia

References

- Ikuomenisan SJ, Musa KO, Aribaba OT, Onakoya AO. Prevalence and pattern of amblyopia among primary school pupils in Kosofe town, Lagos state, Nigeria. *Niger Postgrad Med J.* 2016;23(4):196.
- Pascual M, Huang J, Maguire MG, et al. Risk factors for amblyopia in the vision in preschoolers study. *Ophthalmology.* 2014;121(3):622–629.e1.
- Khalaj M, Barikani A, Ebrahimi M. Prevalence of color vision deficits in patients with amblyopia. *J Mazandaran Univ Med Sci.* 2017;26(144):88–97.
- Buch H, Vinding T, La Cour M, Nielsen NV. The prevalence and causes of bilateral and unilateral blindness in an elderly urban Danish population. The Copenhagen city eye study. *Acta Ophthalmol.* 2001;79(5):441–449.
- Rahi JS, Logan S, Timms C, Russell-Eggitt I, Taylor D. Risk, causes, and outcomes of visual impairment after loss of vision in the non-amblyopic eye: a population-based study. *Lancet.* 2002;360(9333):597–602.
- Siddiqui AH, Raza SA, Ghazipura A, et al. Analysis of association between type of amblyopia and gender at a tertiary care hospital in Karachi. *JPMA.* 2016;66(5):545–548.
- Taylor K, Powell C, Hatt SR, Stewart C. Interventions for unilateral and bilateral refractive amblyopia. *Cochrane Database Syst Rev.* 2012;(4), CD005137.
- Koo EB, Gilbert AL, VanderVeen DK. Treatment of amblyopia and amblyopia risk factors based on current evidence. *Semin Ophthalmol.* 2017;1–7. Taylor & Francis.
- Groenewoud JH, Tjiam AM, Lantau VK, et al. Rotterdam Amblyopia Screening Effectiveness Study: detection and causes of amblyopia in a large birth cohort. *Investig Ophthalmol Vis Sci.* 2010;51(7):3476–3484.
- Force UPST. Vision screening for children 1 to 5 years of age: US preventive services task force recommendation statement. *Pediatrics.* 2011;127(2):340–346.
- Umphred DA, Lazaro RT, Roller M, Burton G. *Neurological Rehabilitation-E-book.* Elsevier Health Sciences; 2013.
- Richards MD, Goltz HC, Wong AM. Alterations in audiovisual simultaneity perception in amblyopia. *PLoS One.* 2017;12(6), e0179516.
- Alarepe AT, Balogun M, Okoye O, Ulaikere M, Oderinlo O. Amblyopia in rural Nigerian school children. *Niger J Ophthalmol.* 2017;25(1):36.
- Hashemi H, Yekta A, Jafarzadehpur E, et al. The prevalence of amblyopia in 7-year-old schoolchildren in Iran. *Strabismus.* 2014;22(4):152–157.
- Chia A, Dirani M, Chan YH, et al. Prevalence of amblyopia and strabismus in young Singaporean Chinese children. *Investig Ophthalmol Vis Sci.* 2010;51(7):3411–3417.
- Friedman DS, Repka MX, Katz J, et al. Prevalence of amblyopia and strabismus in white and African American children aged 6 through 71 months: the Baltimore Pediatric Eye Disease Study. *Ophthalmology.* 2009;116(11):2128–2134.e2.
- Barry J, König H. Test characteristics of orthoptic screening examination in 3 year old kindergarten children. *Br J Ophthalmol.* 2003;87(7):909–916.
- Hashemi H, Nabovati P, Dadbin N, et al. The prevalence of ptosis and its association with amblyopia and strabismus in 7-year-old schoolchildren in Iran. *Strabismus.* 2015;23(3):126–131.
- Mohammadzadeh A, Derakhshan A, Ahmadshah F, Amiri R, Esmaeli H. Prevalence of visual impairment in low birth weight and normal birth weight school age children. *Iran J Pediatr.* 2009;19(3):271–276.
- Faghihi M, Ostadimoghaddam H, Yekta AA. Amblyopia and strabismus in Iranian schoolchildren, Mashhad. *Strabismus.* 2011;19(4):147–152.
- Ostadimoghaddam H, Mirhajian H, Yekta A, et al. Eye problems in children with hearing impairment. *J Curr Ophthalmol.* 2015;27(1):56–59.
- Yekta A, Hashemi H, Ostadimoghaddam H, et al. Strabismus and near point of convergence and amblyopia in 4–6 year-old children. *Strabismus.* 2016;24(3):113–119.
- 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.
- Masumi R, Ojaghi H, Masumi N, Jafarzadeh S. Prevalence and causes of amblyopia among middle school students in Ardabil City during 2004. *J Ardabil Univ Med Sci.* 2011;11(1):67–75.
- Azami A, Sadeghieh S, Ojaghi H, Amani F, Barak M. Amblyopia screening in Ardabil Province, 1998–2001. *J Ardabil Univ Med Sci.* 2003;3(4):7–12.
- Ostadi Moghaddam H, Fotouhi A, Khabazkhoob M, Heravian J, Yekta A, Javaherforoushzadeh A. Prevalence of amblyopia in school children in Mashhad. *Bina J Ophthalmol.* 2008;13(3):289–294.
- Shakeri MT, Banaee T, Farazi A, Farazi E. A study of the causes of impaired vision and primary school students in Mashhad in 2005–2006. *Med J Mashhad Univ Med Sci.* 2006;49:299–304.
- Merat H. Prevalence of amblyopia in school age children in Qazvin. *J Qazvin Univ Med Sci.* 2002;21:54–58.
- Ghasemi M. Prevalence of amblyopia in Bou-an eye clinic. *J Qazvin Univ Med Sci.* 2000;15:21–25.
- Yekta A, Fotouhi A, Hashemi H, et al. The prevalence of anisometropia, amblyopia and strabismus in schoolchildren of Shiraz, Iran. *Strabismus.* 2010;18(3):104–110.
- Yekta A, Dehghani C, Ostadi Moghaddam H, et al. The prevalence of visual problems in school children, Shiraz, Iran. *Iran J Epidemiol.* 2010;6(3):8–18.
- Fotouhi A, Hashemi H, Khabazkhoob M, Mohammad K. The prevalence of refractive errors among schoolchildren in Dezful, Iran. *Br J Ophthalmol.* 2007;91(3):287–292.
- Yekta A, Hashemi H, Norouzirad R, et al. The prevalence of amblyopia, strabismus, and ptosis in schoolchildren of Dezful. *Eur J Ophthalmol.* 2016;27(1):109–112.
- Hashemi H, Khabazkhoob M, Yekta A, Mohammad K, Fotouhi A. Prevalence and risk factors for anisometropia in the Tehran eye study, Iran. *Ophthalmic Epidemiol.* 2011;18(3):122–128.

35. Rajavi Z, Sabbaghi H, Baghini AS, Yaseri M, Sheibani K, Norouzi G. Prevalence of color vision deficiency and its correlation with amblyopia and refractive errors among primary school children. *J Ophthalmic Vis Res.* 2015;10(2):130.
36. Rajavi Z, Sabbaghi H, Baghini AS, et al. Prevalence of amblyopia and refractive errors among primary school children. *J Ophthalmic Vis Res.* 2015;10(4):408–416.
37. Faghihi M, Ostadimoghaddam H, Fatemi A, Heravian J, Yekta A. The prevalence of refractive errors, strabismus and amblyopia in schoolboys of Varamin, Iran, in 2010. *Iran J Ophthalmol.* 2012;24(2):33–39.
38. Rafiei M, Rivakani F, Torabi L, Alaeddini F, Safiri S. Community-based amblyopia screening program for early detection in Iran: a repeated cross-sectional study from 1996 to 2013. *Public Health.* 2017;142:196–200.
39. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology [STROBE] statement: guidelines for reporting observational studies. *Gac Sanit.* 2008;22(2):144–150.
40. Higgins JP, Green S. *Cochrane Handbook for Systematic Reviews of Interventions.* John Wiley & Sons; 2011.
41. Khandekar R, Parast N, Arabi A. Evaluation of 'vision screening' program for three to six-year-old children in the Republic of Iran. *Indian J Ophthalmol.* 2009;57(6):437.
42. Moradabadi AS, Ghanbarnejad A, Bani-Hashemi A, et al. Amblyopia screening in children in Bandar Abbas (Iran) during 2011–2012. *Electron Physician.* 2014;6(3):906–911.
43. Hamidi A, Jalalifar S, Yaghubi M, Akaberi A, Ghuparanlu M. The prevalence of amblyopia in children aged 3-6 in bojnurd 2014. *J North Khorasan Univ Med Sci.* 2014;6(3):572.
44. Jamali P, Fotouhi A, Hashemi H, Younesian M, Jafari A. Refractive errors and amblyopia in children entering school: Shahrood, Iran. *Optom Vis Sci.* 2009;86(4):364–369.
45. Oujji N, Pasalar M, Fazel M, Nekouee F, Oujji N. Prevalence of visual disturbances in primary school children in Fasa, 1999-2000. *Armaghan Danesh.* 2005;9(4):17–24.
46. Omidian J, Pourbeazar M, Sheykhi F, Ansari M, Daneshgar F, Ghaderi E. Prevalence of visual impairment in elementary school students in Kermanshah. *J Kermanshah Univ Med Sci.* 2000;2:168–176.
47. Yekta A, Hashemi H, Azizi E, et al. The prevalence of amblyopia and strabismus among schoolchildren in Northeastern Iran, 2011. *Iran J Ophthalmol.* 2012;24(4):3–10.
48. Salehi A, Lotfizadeh M. Prevalence of Amblyopia in 2000 first year student of the shahr kord city primary schools, Spring and Summer 1999. *J Shahrekord Univ Med Sci.* 1999;1(1):46–53.
49. Sharifi N, Heshmat R. Amblyopia screening in children 6-10 years old. *Med J Tabriz Univ Med Sci Health Serv.* 2004;2:127.
50. Terrin N, Schmid CH, Lau J. In an empirical evaluation of the funnel plot, researchers could not visually identify publication bias. *J Clin Epidemiol.* 2005;58(9):894–901.
51. Noche C, Kagmeni G, Bella A, Epee E. Prevalence and etiology of amblyopia of children in Yaounde (Cameroon), aged 5-15 years. *Sante (Montrouge, France).* 2011;21(3):159–164.
52. Singh A, Rana V, Patyal S, Kumar S, Mishra SK, Sharma VK. To assess knowledge and attitude of parents toward children suffering from strabismus in Indian subcontinent. *Indian J Ophthalmol.* 2017;65(7):603.
53. Xiao O, Morgan IG, Ellwein LB, He M, RESiCS Group. Prevalence of amblyopia in school-aged children and variations by age, gender, and ethnicity in a multi-country refractive error study. *Ophthalmology.* 2015;122(9):1924–1931.
54. Wedner SH, Ross DA, Balira R, Kaji L, Foster A. Prevalence of eye diseases in primary school children in a rural area of Tanzania. *Br J Ophthalmol.* 2000;84(11):1291–1297.
55. Robaei D, Rose KA, Ojaimi E, Kifley A, Martin FJ, Mitchell P. Causes and associations of amblyopia in a population-based sample of 6-year-old Australian children. *Arch Ophthalmol.* 2006;124(6):878–884.
56. Wang Y, Liang YB, Sun LP, et al. Prevalence and causes of amblyopia in a rural adult population of Chinese: the Handan Eye Study. *Ophthalmology.* 2011;118(2):279–283.
57. Williams C, Northstone K, Howard M, Harvey I, Harrad R, Sparrow J. Prevalence and risk factors for common vision problems in children: data from the ALSPAC study. *Br J Ophthalmol.* 2008;92(7):959–964.
58. Simons K. Amblyopia characterization, treatment, and prophylaxis. *Surv Ophthalmol.* 2005;50(2):123–166.