


Prevalence of amblyopia among the children of Saudi Arabia: A systematic review, 1990–2020



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Background: Amblyopia is the leading cause of visual impairment in children and as such poses a public health problem. Prevalence studies are required to determine the magnitude of visual impairment because of amblyopia. Although there are studies that reported the prevalence of amblyopia in some regions, there are no studies of pooled prevalence of amblyopia in Saudi Arabia. Structured and province-specific studies for Saudi Arabia are thus needed to understand the prevalence and risk factors for amblyopia.

Aim: To use a literature review to estimate the pooled prevalence of amblyopia among children of Saudi Arabia.

Methods: Peer-reviewed articles with data from Saudi Arabian children were extracted between the years 1990 and 2020. The Cochrane Library, PubMed, OVIS, Embase and Google Scholar were used to extract the relevant articles. The paper quality was assessed using a critical assessment tool designed for systematic reviews and from 22 retrieved citations, seven studies were included in this systematic review.

Results: Out of 15 281 pooled children from seven papers, the estimated prevalence of amblyopia was 2.3% (95% confidence interval [CI]: 2.1% – 2.6%). Significant heterogeneity ($p < 0.001$) was found among these studies.

Conclusion: The pooled prevalence of amblyopia among children of Saudi Arabia is approximately 2.3%. This systemic review also demonstrates that there are limited studies that evaluated the prevalence of amblyopia among children of Saudi Arabia and mostly they had a gender bias.

Contribution: This article presents the prevalence of amblyopia among the children of Saudi Arabia and also the variances in the prevalence of amblyopia among the various regions of Saudi Arabia.

Keywords: amblyopia; prevalence of amblyopia; refractive error; anisometropia; strabismus.

Introduction

Amblyopia is usually defined as a vision disorder with reduced best-corrected visual acuity in one or both eyes without any attributable ocular pathology in the visual system.¹ Amblyopia is one of the principal causes of visual impairment (VI) in children globally.^{2,3,4} Clear and sharply focused retinal images in both eyes are crucial for normal visual development. If there is a long-term deviation from this situation because of untreated amblyogenic risk factors that cause defocused images during childhood, this usually leads to amblyopia.^{5,6} Both ocular and non-ocular risk factors can cause amblyopia.

Major ocular risk factors for amblyopia include ocular misalignment (strabismus), stimulus deprivation (cataract, corneal opacities, ptosis and hemangiomas) and uncompensated refractive errors (anisometropia and, for example, aniso-astigmatism). Major non-ocular risk factors for amblyopia include low birth weight, smoking during pregnancy, working in toxic environments, low APGAR score, prematurity and neonatal hospitalisation.⁷ So, it is important to detect and manage these risk factors in children at an early age to prevent vision loss and thereby improve the quality of life.^{8,9}

To ensure appropriate ocular and visual development and to prevent a steady decline in visual acuity, amblyopia identification is crucial at an early age. With proper estimates of the prevalence

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of amblyopia, adequate healthcare strategies can be planned, prioritised and executed to reduce the burden of VI because of amblyopia.^{9,10} It has been shown that the reported prevalence of amblyopia varies with region and age, and, for example, a large systematic review and meta-analysis on the global prevalence of amblyopia indicates that by 2019 there were about 99.2 million people with amblyopia worldwide with a reported prevalence rate of 1.4%, and the prevalence rates were higher in Europe and North America compared with Asia and Africa.¹⁰ The change in prevalence across regions poses a challenge in local burden estimates because it is uncertain whether changes in prevalence estimates are true or driven by demographic, methodological or other factors.

It is reported that the prevalence of amblyopia is approximately 1.2% in Singapore, 1.9% in Australia, 4.7% in Canada and 3% in Pakistan. Although a few studies have estimated the prevalence of amblyopia in school children in specific regions of Saudi Arabia,^{11,12,13,14,15,16,17,18,19,20} there is no single study that estimated the pooled prevalence of amblyopia in Saudi Arabia. Thus this study performed a systematic review of relevant literature to (1) estimate the pooled prevalence of amblyopia among children in Saudi Arabia and (2) assess the differences in prevalence among specific geographic regions of Saudi Arabia.

Objective of the review

The main objective of the study is to estimate the pooled prevalence of amblyopia among children of Saudi Arabia.

Materials and methods

Inclusion criteria

The current study only included articles about children who had amblyopia (Strabismus or refractive disorders were the most common causative factors for the amblyopia).

Context

This study included articles that assessed the prevalence of amblyopia in Saudi Arabia through a pre-school screening programme or via referral to medical centres and clinics.

Participants

Studies on children who had a comprehensive eye examination.

Search strategy

In this systematic review, the search keywords were performed with the Boolean operators (or/and) as shown in Figure 1. Main keywords such as (Prevalence or incidence or rate or Frequency or proportion or epidemiology or distribution) or (Major risk or influencing factors) or (cause or reasons) or (effect or impact) and (amblyopia or refractive error or visual impairment or Anisometropia) and (Saudi Arabia) and (children) were searched in the Cochrane Library,

PubMed, OVIS and Embase. Only studies published between January 1990 and December 2020 were considered. In addition, ProQuest (dissertations and theses) and Google Scholar were used in the search for grey literature. This review was restricted to articles published in the English language only in peer-reviewed journals. Only epidemiological studies with the stated prevalence of amblyopia in children of Saudi Arabia between 1 and 18 years of age were included.

Exclusion criteria

Articles were excluded if (1) they were not conducted in Saudi Arabia and (2) studies that did not assess the prevalence of amblyopia. The study also excluded conference papers, meeting abstracts, editorial discussions and studies without basic data.

Study selection

Following the search, all citations were imported into Endnote X7 software, and duplicates were removed. Two independent colleagues reviewed the titles and abstracts to determine whether papers satisfied the review's inclusion criteria. Two independent reviewers obtained the full texts of potentially eligible studies and thoroughly assessed them against the inclusion criteria. Full-text studies that did not meet the inclusion criteria were excluded. Any disagreements between the reviewers were discussed and resolved or as necessary a third reviewer commented.

Extraction of data

The extracted data included author information, publication year, population (age), study setting and country and prevalence of amblyopia. Any disagreements between the reviewers were resolved through discussion or with the assistance of a third reviewer. The authors of the articles were contacted to obtain any missing data as well as any additional data that were required.

Data synthesis

The pooled estimate of amblyopia in Saudi Arabian children was calculated using MedCalc Statistical Software version 16.4.3 (MedCalc). MedCalc uses the Freeman–Tukey double arcsine transformation with a random-effects model. Forest

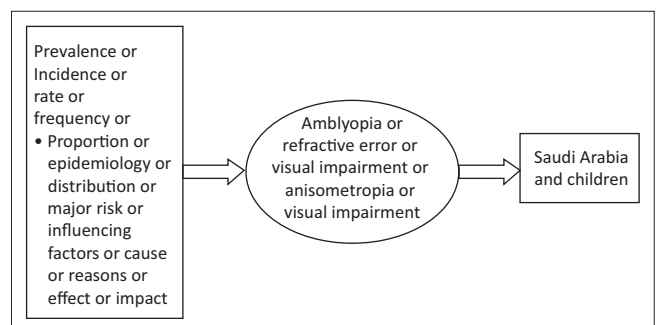


FIGURE 1: Example of Boolean operators used in the search strategy for the current review.

plots were used to show the prevalence proportions among the studies. Heterogeneity of reported prevalence among studies was analysed using a chi-square-based Q test.

Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects.

Results

This systematic literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis criteria from 2009. A total of 22 articles were found for the prevalence of amblyopia in Saudi Arabian children but only seven studies that fulfilled the inclusion criteria were included in the analysis below. The review of the article selection and inclusion process is depicted in the flow chart as presented in Figure 2.

Methodological quality

The 10-item checklist devised by Munn et al. for prevalence studies was used to assess the methodological quality of the qualifying studies.²¹ Study design, study population, location, number of subjects with amblyopia and number of children with different forms of amblyopia were all retrieved from each study.

All seven studies were cross-sectional, school-based investigations. However, there were considerable disparities in sample size, age group and methods for ocular refraction. Table 1 summarises the qualitative assessment of the seven studies according to Munn’s criteria.²¹ Among the included studies that reported the prevalence of amblyopia in children, there was significant heterogeneity especially in terms of gender, sample size, prevalence and subgroup analysis (Cochran’s Q-test, $p < 0.001$; $I^2 = 95.1\%$).

Comprehensive eye examinations in all seven studies were carried out by optometrists or ophthalmologists.

The characteristics of these studies are presented in Table 2. The prevalence for each study is indicated with a forest plot (see Figure 3).

Out of the total of 15 281 children from the seven studies, the estimated pooled prevalence of amblyopia was 2.3% (95% confidence interval [CI]: 2.0% – 2.6%). Of the seven studies, only one study¹¹ provided the prevalence rates for both boys (2.0%) and girls (1.9%). Five studies^{11,16,17,19,20} provided information about type of amblyopia. Among these studies, refractive amblyopia was most common (65.1%), followed by strabismus amblyopia (29.4%) and then other causes (5.5%). Two studies^{11,16} provided prevalence for unilateral amblyopia and bilateral amblyopia at 3.1% and 3.6%, respectively.

Discussion

The current study involves a systematic review of prevalence of amblyopia in Saudi Arabian children, aged 1–18 years.

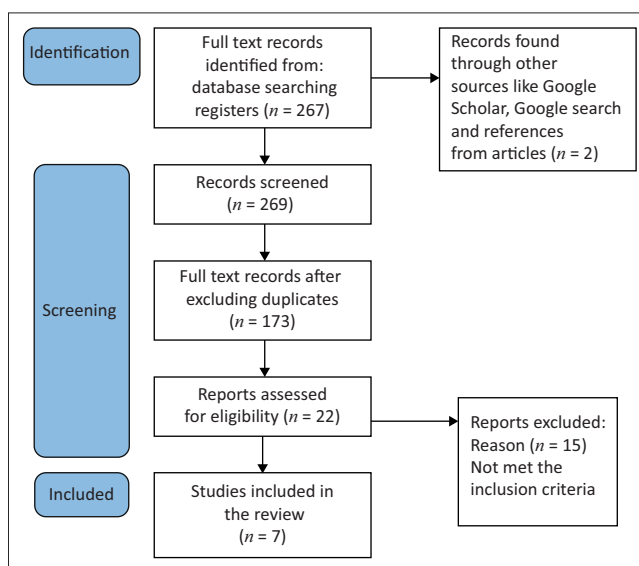


FIGURE 2: The Preferred Reporting Items for Systematic Reviews and Meta-Analysis flow diagram showing the summary of study selection and the inclusion process.

TABLE 1: Quality evaluation of included studies according to Munn’s criteria.

Study and year	Sample representation of the target population?	Appropriateness of participants recruitment	Sample size adequacy	Details of study subjects and setting description	Data analysis with sufficient coverage of the identified sample?	Objective standard criteria used for measurement of the condition?	Condition measured reliably?	Appropriate statistical analysis?	All-important confounding factors/subgroups/ differences identified and accounted for?	Were subpopulations identified using objective criteria?
Aldebasi ¹¹ (2015)	√	√	√	√	√	√	√	√	√	√
Bardisi et al. ¹⁹ (2002)	×	√	×	√	√	√	√	√	√	×
Mubarak ¹⁴ (1992)	√	√	√	√	√	√	√	√	×	×
Abolfotouh et al. ¹³ (1994)	√	√	√	√	√	√	√	√	×	×
Al-Tamimi et al. ²⁰ (2015)	×	√	√	√	×	√	√	√	√	√
Al-Rowaily ¹⁸ (2010)	√	√	×	√	√	√	√	√	×	×
Al Wadaani et al. ¹⁷ (2013)	√	√	√	√	√	√	√	√	√	×

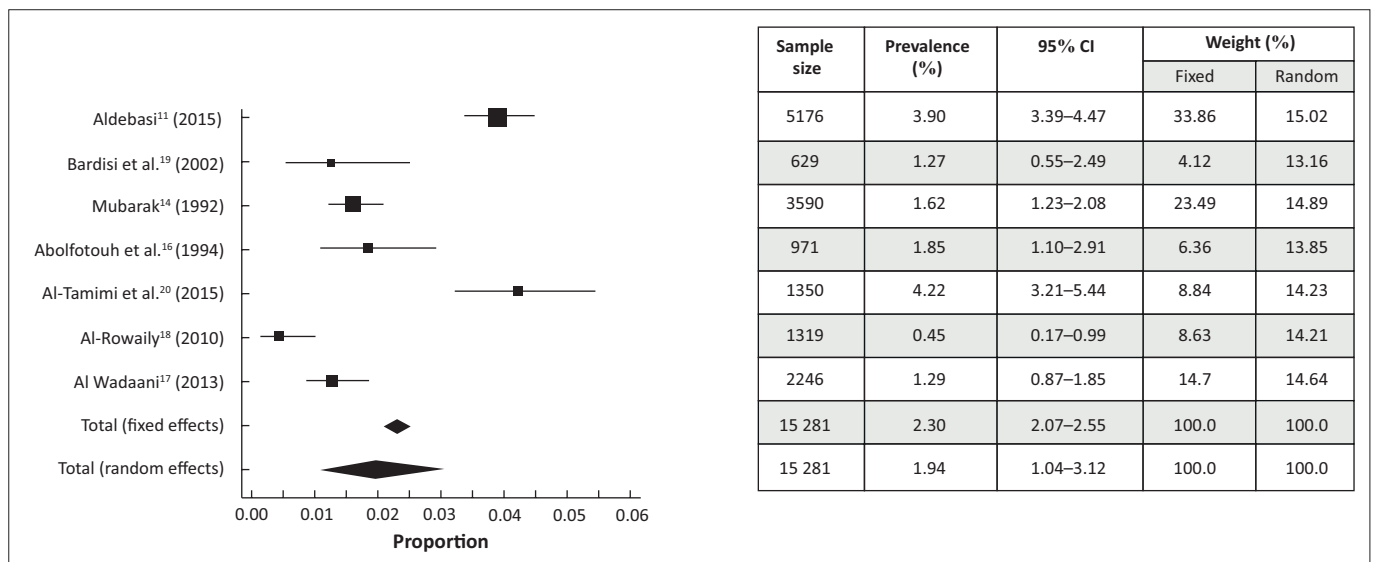
Source: Adapted from Munn Z, Moola S, Riitano D, Lisy K. The development of a critical appraisal tool for use in systematic reviews addressing questions of prevalence. Int J Health Policy Manag. 2014;3(3):123–128. <https://doi.org/10.15171/ijhpm.2014.71>

TABLE 2: Important characteristics of the seven studies included in this review.

Study and year	Sample type	Gender	Type of study	Province	Sample size	Population of the province	Ages (years)		Number of amblyopes	Definition of amblyopia (VA)	Type of amblyopia	%
							Range	Mean \pm s.d.				
Aldebasi ¹¹ (2015)	Primary schools	Male and Female	Cross-sectional	Qassim	5176	1 423 935	6–13	9.53 \pm 1.88	202	< 6/9§	Refractive Strabismus	94.6 5.4
Bardisi et al. ¹⁹ (2002)	Nursery (pre) schools	Male	Cross-sectional	Jeddah	629	3 097 600	3–5	4.2 \pm 0.5	8	< 6/9§	Refractive Strabismus	75.0 25.0
Mubarak ¹⁴ (1992)	Elementary schools	Male	Cross-sectional	Albaha	3590	476 172	6–18	†	58	< 6/9§	Majority were refractive	‡
Abolfotouh et al. ¹⁶ (1994)	Schools	Male	Cross-sectional	Asir	971	2 211 875	6–12	8.8 \pm 1.34	18	< 6/9§	Refractive Strabismus Other	39.0 33.3 27.7
Al-Tamimi et al. ²⁰ (2015)	Children hospitals	Male	Cross-sectional	Dammam	1350	4 900 325	1–15	7.6 \pm 3.4	57	†	Refractive Strabismus	47.0 53.0
Al-Rowaily ¹⁸ (2010)	Schools	Male	Cross-sectional	Riyadh	1319	8 216 284	4–8	†	6	†	Not provided	‡
Al Wadaani ¹⁷ (2013)	Schools	Male	Cross-sectional	Alhasa	2246	4 900 000	6–14	9.48 \pm 2.31	29	< 6/9§	Refractive Strabismus	70.0 30.0

VA, visual acuity.

†, not mentioned; ‡, details not provided; §, after best correction.



CI, confidence interval.

FIGURE 3: Forest plot showing the prevalence of amblyopia from various studies conducted in Saudi Arabia. Extended lines indicate 95% confidence intervals as found in the seven studies. The corresponding weight and proportionate prevalence of each study are summarised in the table on the right side of the figure.

This is the first systemic review on prevalence of amblyopia among children of Saudi Arabia. The pooled prevalence (2.3%) suggests about 23 children in 1000 are affected with amblyopia in Saudi Arabia. The prevalence of amblyopia in Saudi Arabia is higher than the global prevalence reported by Fu et al.,¹⁰ and it is also noted that the prevalence of amblyopia in Saudi children is higher than for countries like Singapore (1.2%) and Australia (1.9%) but lower than for Canada (4.7%) and Pakistan (3%). The prevalence of amblyopia in Saudi Arabia varies according to region and ranges from 0.45% to 4.3%. It is also important to note that there were no studies that reported the prevalence of amblyopia in densely populated provinces like Makkah and Al-Madina where there are also differences in socio-economic and demographic differences. Additionally, qualitative analysis of the studies shows that only one study¹¹ fulfilled Munn's criteria for good-quality studies and included both male and female children. The remaining

six studies included here had various limitations such as (1) the type of amblyopia was not mentioned and/or not analysed, (2) females were not included and (3) sample size was not formally calculated.

Other possible limitations of this review include (1) timelines of the published articles were from 1990 to 2020, which might not represent the precise prevalence at the current point in time, (2) age groups are from 1 to 18 years, which is a wide age range and (3) there was insufficient information as to identification of possible non-ocular causes of amblyopia. Hence the prevalence of amblyopia in Saudi Arabian children reported in this study cannot be generalised, and it should be interpreted with caution as there was a gender bias (mostly male children), a sample size bias and other limitations as mentioned above. Well-structured, province-specific, population-based studies without gender bias and with optimally calculated sample

sizes are needed to better understand the prevalence and risk factors for amblyopia in Saudi Arabian children (and, to some extent, elsewhere).

Anisometropia affects 3.7%–7.0% of children in Saudi Arabia and is a primary risk factor for unilateral amblyopia.^{17,22} Uncompensated refractive error is another important risk factor for amblyopia and Alghamdi in his systemic review on refractive error in Saudi Arabia reported that the overall prevalence of uncorrected refractive error is 16.9%, which is significantly large.²³ Apart from this, Qanat et al. reported that the estimated prevalence of strabismus with paediatric ocular illness subjects was 11.8% in Saudi Arabia.²⁴ From these studies,^{17,22,23,24} it can be observed that the risk factors that cause amblyopia in Saudi Arabia children are very high and possibly could be because of two factors. Firstly, Saudi Arabia's absence of effective nationwide vision screening programmes for youngsters. While vision screening is part of pre-school requirements, it appears that this function is not fully enforced, as most children begin school without having their eyes examined by optometrists or ophthalmologists.²⁵ Secondly, according to various reports, the public in Saudi Arabia has little awareness or knowledge about refractive errors and other visual or ocular illnesses.^{26,27} Additionally, according to Aldebasi et al., only 33.4% of elementary school pupils regularly wear their spectacles.¹¹

Recommendations

It is important to do regular ocular and vision screenings for refractive errors in children at the community level, and such screenings should be integrated into school health programmes with public awareness campaigns. Attempts to ensure that the spectacle corrections are used as required and that any cultural barriers to compliance addressed are necessary to prevent any further increase in amblyopia and/or other ocular anomalies.

Conclusion

Over the last three decades, few studies have reported prevalence of amblyopia among Saudi Children. From seven studies that were identified, the pooled prevalence for amblyopia among the children (< 18 years) of Saudi Arabia is approximately 2.3%. Further studies are needed in the appropriate directions to facilitate improved understanding of the prevalence and risk factors for amblyopia.

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Competing interests

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Author's contributions

Manuscript is conceptualised, analysed and written by N.K.C.

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Data availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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