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Prevalence and Factors Associated with Amblyopia among Third- Level Pupils in Al-Wahdah District of Sana'a City, Yemen

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Abstract

Background

Amblyopia is a common, preventable cause of childhood visual impairment, often resulting from uncorrected refractive errors. Early detection enables effective treatment, but data on its prevalence in Yemeni schoolchildren are lacking. This study aimed to assess the prevalence and associated factors of amblyopia among third-level pupils in primary schools in Al-Wahdah District, Sana'a City.

Methods

A cross-sectional study was conducted in 2024 among 400 third-level pupils from five randomly selected primary schools (two public, three private) in Al-Wahdah District. A structured questionnaire was used to collect data on pupils' demographic characteristics (age and gender), type of school (public or private), use of corrective glasses, and family history of visual impairment. All pupils underwent a distance visual acuity screening with a Snellen chart, and those with reduced acuity received further examination with an auto-refractometer to identify refractive errors. Data were analyzed using relevant statistical tests, with significance set at a *P*-value of < 0.05.

Results

The prevalence of amblyopia among third-level pupils was 4% [95% CI: 2.3–6.4]. Most pupils (77.3%) had no refractive error, with astigmatism being the most common refractive error (9% of pupils), followed by myopia (3.7%) and hypermetropia (3.2%). Among the amblyopic pupils, the most frequent refractive errors were astigmatism and hypermetropia with astigmatism, each accounting for 31.2% of cases. Hypermetropia alone was present in 25%, while one pupil (6.3%) had myopia with astigmatism and another (6.3%) had no detectable refractive error. Wearing glasses was significantly associated with amblyopia, with wearers being six times more likely to have the condition (odds ratio = 6, 95% CI: 1.78–20.28; *P* = 0.012). In contrast, no significant association was found between amblyopia and the age and gender of pupils, type of school, or family history of visual impairment.

Conclusion

Amblyopia prevalence among third-level pupils in Sana'a City aligns with global rates and is significantly associated with wearing glasses. Astigmatism and hypermetropia are common among affected children. Differences in amblyopia prevalence do not appear to be associated with pupils' demographics or family history of visual impairment. These findings underscore the significance of implementing school-based vision screening programs to facilitate the early identification and treatment of refractive errors.

1. Introduction

Amblyopia, often referred to as "lazy eye," is a neurodevelopmental disorder caused by disrupted visual development during childhood, potentially leading to visual impairment in one eye or both eyes [1]. It emerges during the developmental phase of the visual pathway and is largely reversible within the first seven to eight years of age [2]. Amblyopia is a major health problem among school children that necessitates early visual screening and intervention programs.

Several studies report that refractive errors, particularly anisometropia, astigmatism, hyperopia, account for the majority of amblyopia cases [1, 3–7]. Amblyopia was found to be prevalent among about 2% of primary school children in Central Cairo, Egypt, with all cases linked to refractive errors [6]. A population-based study in Tehran, Iran, involving primary school children aged 7 to 12 found a 2.3% prevalence of amblyopia [4]. A national prospective screening study conducted among 17,203 first- and second-grade children in northern Jordan found a 2.8% prevalence of amblyopia, primarily due to hypermetropia [7]. A cross-sectional study of primary school children in Qassim Province, Saudi Arabia, found a 3.9% prevalence of amblyopia, predominantly unilateral and mainly caused by anisometropic refractive errors [3]. A study in Gondar, Northwest Ethiopia, found a 4.7% prevalence of amblyopia among school children, with refractive errors as the leading cause [5].

In Yemen, a recent study found that amblyopia was prevalent among 5.3% of adult workers, primarily due to uncorrected refractive errors [8]. Notably, 81.6% of those adults were not using corrective glasses at the time of screening [8]. Moreover, amblyopia was identified as one of the leading causes of uniocular blindness among adults attending an eye care hospital in Sana’a City, Yemen [9]. In a sample of 1104 children attending an eye care center in Sana’a, amblyopia was identified as a contributing cause in 10.4% of unilateral blindness cases and 25.7% of unilateral low vision cases [10], highlighting its significant role in pediatric blindness and visual impairment. Although early detection and appropriate management of amblyopia in school children can significantly improve outcomes and raise awareness, no studies have been encountered on amblyopia among primary school children in Yemen. Therefore, this study aimed to determine amblyopia prevalence and associated factors among third-level pupils enrolled in primary schools in Al-Wahdah District of Sana’a City.

2. Methods

2.1. Study design, population and setting

A cross-sectional study was conducted among third-level pupils from five primary schools (two public and three private) in Al-Wahdah District of Sana’a City in 2024.

2.2. Sample size and sampling method

The sample size was calculated to be 384 using the OpenEpi online calculator (www.openepi.com), assuming a 50% estimated prevalence of amblyopia due to the absence of prior local data, with a 95%

confidence level and a 5% margin of error. To ensure adequate representation, 400 pupils were ultimately enrolled.

A two-stage sampling method was employed. Initially, five schools were randomly selected from the list of schools in the district. Then, children were randomly selected from the school enrollment records of the third-level pupils using simple random sampling.

2.3. Data collection and ophthalmic examination

A structured questionnaire was used to collect data about the demographic characteristics of children (gender and age), type of school (public or private), use of corrective glasses, and family history of visual impairment via face-to-face interviews. In addition, visual acuity was assessed using a standard Snellen chart [11] placed six meter from the school children, under the supervision of a trained optics team. Children who had reduced visual acuity underwent further evaluation using an auto-refractometerto identify refractive errors. Those diagnosed with amblyopia or found to have significant refractive abnormalities were referred for specialist care .

2.4. Data analysis

Data were analyzed using IBM SPSS Statistics, version 25 (IBM Corp., Armonk, NY, USA). The prevalence of amblyopia was reported, along with its 95% confidence interval (CI). Amblyopia association with demographic factors, type of school and family history of visual impairment was tested using the chi-square or Fisher's exact test, along with reporting the odds ratio (OR) of association and its 95% CI.

2.5. Ethical considerations

permissions were obtained from the Ministry of Education in Sana'a and the Al-Wahdah District Office. Verbal consent was obtained from school principals after informing pupils' families in advance, as well as from the students. All data were handled with strict confidentiality, and the privacy of pupils was fully protected

3. Results

3.1. Characteristics of pupils included in the study

Of the 400 pupils included in this study, more than half were females (56.5%), and the majority were aged under 10 years (79.8%), with a mean age of 8.9 ± 0.9 years, and were enrolled in private schools (64.2%). The majority of pupils were not wearing glasses (93%), and 39% had a family history of visual impairment (Table 1).

Table 1
Characteristics of third-level pupils included in the study*

Characteristics	***n***	**(%)**
Gender		
Male	174	(**43.5**)
Female	226	(**56.5**)
Age (years)		
< 10	319	(**79.8**)
≥ 10	81	(**20.2**)
Mean ± SD: 8.9 ± 0.9		
Type of school		
Public	143	(**35.8**)
Private	257	(**64.2**)
Wearing glasses [a]		
No	372	(**93.0**)
Yes	24	(**6.0**)
Family history of visual impairment		
No	244	(**61.0**)
Yes	156	(**39.0**)

* The total number of pupils was 400. SD, standard deviation. [a] 4 missing cases

3.2. Prevalence of amblyopia among third-level pupils

The prevalence of amblyopia among third-level pupils in Al-Wahdah District was 4% (16/400; 95% CI: 2.3–6.4).

3.3. Prevalence of refractive errors among third-level pupils

Table 2 shows that 77.3% of pupils had no refractive errors, and astigmatism was the most common single refractive error among 9% of pupils, followed by myopia (3.7%) and hypermetropia (3.2%). On the other hand, hypermetropia with astigmatism was observed among 4.3% of pupils, and myopia with astigmatism was observed among 2.5% of pupils.

Table 2
Refractive errors among third-level pupils in Al-Wahdah District, Sana'a City, Yemen (2024)*

Condition	*n*	(%)
Normal	309	(**77.3**)
Myopia	15	(**3.7**)
Hypermetropia	13	(**3.2**)
Astigmatism	36	(**9.0**)
Hypermetropia with astigmatism	17	(**4.3**)
Myopia with astigmatism	10	(**2.5**)

* The total number of pupils was 400.

3.4. Distribution of refractive errors among amblyopic and non-amblyopic pupils

Of 16 pupils diagnosed with amblyopia, astigmatism (31.2%) and hypermetropia with astigmatism (31.2%) were the most frequent refractive errors, followed by hypermetropia (25%). Only one amblyopic pupil (6.3%) had myopia with astigmatism, while one pupil (6.3%) showed no refractive error. In comparison, the majority of the 384 non-amblyopic pupils had no refractive errors (80.2%), with lower proportions having astigmatism (8.1%), myopia (3.9%), hypermetropia with astigmatism (3.1%), and hypermetropia and myopia with astigmatism (2.3% each) (Table 3).

Table 3
Distribution of refractive errors among third-level amblyopic and non-amblyopic pupils in Al-Wahdah District, Sana'a City, Yemen (2024)

Refractive error	Amblyopic pupils (*N* = 16)		Non-amblyopic pupils (*N* = 384)	
	n	(%)	n	(%)
Normal	1	(**6.3**)	308	(**80.2**)
Myopia	0	(**0.0**)	15	(**3.9**)
Hypermetropia	4	(**25.0**)	9	(**2.3**)
Astigmatism	5	(**31.2**)	31	(**8.1**)
Hypermetropia with astigmatism	5	(**31.2**)	12	(**3.1**)
Myopia with astigmatism	1	(**6.3**)	9	(**2.3**)

3.4. Factors associated with amblyopia among third-level pupils

Wearing glasses was found to be significantly associated with amblyopia among third-level pupils in Sana'a, where glass wearers were six times more likely to have amblyopia compared to non-wearers (OR = 6, 95% CI: 1.78–20.28; *P* = 0.012). In contrast, gender (*P* = 0.984), age (*P* = 1.000), type of school (*P* = 0.225), and family history of visual impairment (*P* = 0.090) showed no statistically significant association with amblyopia (Table 4).

Table 4
Factors associated with amblyopia among third-level pupils in Al-Wahdah District, Sana'a City, Yemen (2024)

Factor	***N***	**Presence of amblyopia**				***P*-value**
		n	**(%)**	**OR**	**95% CI**	
Gender						
Male	174	7	(**4.0**)	Reference		
Female	226	9	(**4.0**)	1.0	(0.37–2.77)	0.984
Age (years)						
< 10	319	13	(**4.1**)	Reference		
≥ 10	81	3	(**3.7**)	0.9	(0.25–3.26)	1.000
Type of school						
Private	257	8	(**3.1**)	Reference		
Public	143	8	(**5.6**)	1.8	(0.68–5.02)	0.225
Wearing glasses						
No	372	12	(**3.2**)	Reference		
Yes	24	4	(**16.7**)	6.0	(1.78–20.28)	0.012
Family history of visual impairment						
No	244	13	(**5.3**)	Reference		
Yes	156	3	(**1.9**)	0.3	(0.10–1.24)	0.090

4. Discussion

To the best of our knowledge, no published studies assessed amblyopia and its associated factors among pupils in Yemen. The study revealed that 4% of third-level pupils enrolled in public and private schools in Al-Wahdah District in the capital of Yemen were amblyopic, highlighting the need for regular vision screening in a country with limited resources. This finding highlights a gap in early detection and correction of amblyopia, suggesting that a significant proportion of amblyopia cases in childhood remain undiagnosed and untreated, subsequently progressing into adulthood with irreversible visual

impairment. The prevalence of amblyopia among pupils in the present study is consistent with that (5.3%) recently reported among adult workers subjected to ophthalmic examination in a tertiary care hospital in Sana'a [8]. The long-term implications of untreated amblyopia had been emphasized in earlier studies conducted in Sana'a, where untreated amblyopia was identified as one of the leading causes of uniocular blindness among children and adults [9, 10].

The prevalence of amblyopia among pupils in the present study exceeds the global pooled estimate of 1.36%, as reported in a recent systematic review and meta-analysis [12]. However, our finding aligns with the prevalence among primary school children in Saudi Arabia (3.9%) [3] and Gondar town in northwest Ethiopia (4.7%) [5]. Conversely, lower prevalence rates were reported for amblyopia among primary school children in Central Cairo (2%) [6], children entering schools in Iran (1.7%) [13], primary school pupils in Nigeria (1.4%) [14], and school children in India (1.1%) [15]. A number of factors, including disparities in screening methods, population demographics and inconsistent diagnostic definitions, are probably responsible for the observed variation in amblyopia prevalence across different regions [16, 17]. Furthermore, detection rates can be greatly impacted by inequalities in access to vision care services, including regular screening, early detection, and the availability of corrective treatments.

In the present study, astigmatism was the most prevalent single refractive error among pupils (9%), followed by myopia (3.7%) and hypermetropia (3.2%). This finding aligns with that (11.5%) reported for astigmatism among Indian children in Mumbai [18]. Meanwhile, the present study revealed that astigmatism was combined with myopia and hypermetropia in 2.5% and 4.3% of cases, respectively. A recent systematic review and meta-analysis of 38 population-based studies across 11 Middle Eastern countries found that astigmatism is the most prevalent refractive error (13.2%) among children aged 5–17 years, followed by myopia (5.7%) and hyperopia (5.4%) [19].

The present study highlights the significant role of refractive errors in the development of amblyopia among pupils, particularly among pupils with astigmatism (31.2%) and hypermetropia (25%) or both conditions (31.2%). However, no myopia cases were diagnosed among amblyopic pupils. Similarly, astigmatism was identified as the most prevalent refractive error associated with amblyopia risk among Lebanese school children [20]. In contrast, hypermetropia was the most common refractive error (64.5%) leading to amblyopia among first- and second-grade children in the north of Jordan, while myopia was prevalent among 10.4% of amblyopic children [7]. In Saudi Arabia, anisometropic refractive errors accounted for the majority of amblyopia cases (77.7%) among school children, while isoametropic errors were responsible for 16.8% of cases [3]. Unlike the findings of the present study, hyperopia was the leading cause of amblyopia (30.7%) among primary school children in Central Cairo, followed by anisometropia (24.1%), astigmatism (16.7%), and myopia (9%) [6].

The present study revealed a significant association between wearing glasses and amblyopia, where pupils who wore glasses were six times more likely to have the condition than those who did not. This finding suggests that refractive errors requiring optical correction may play a major role in the development of amblyopia within this population. In line with this finding, amblyopia was found to be

significantly higher among Egyptian primary school children wearing glasses in Central Cairo [6], where amblyopia was prevalent among 10% of those wearing glasses compared to 1.5% of non-wearers. Meanwhile, the high likelihood of wearing glasses observed in this study may reflect delayed diagnosis and treatment of refractive errors, leading to persistent amblyopia in pupils. Early detection and management of ametropia can significantly reduce the risk of permanent vision loss due to amblyopia, particularly among preschool- and school-aged children who are at higher risk [21].

The present study found no significant association between amblyopia and pupils' gender, age, type of school (public vs. private), and family history of visual impairment. Likewise, the multi-country Refractive Error Study in Children (RESC) found no significant association between amblyopia and either gender or age among children aged 5–15 years [22]. The lack of a gender-related difference in amblyopia prevalence aligns with findings from several previous studies conducted in different populations [14, 23–25]. This alignment in findings across different contexts strengthens the argument that gender is not a major influencing factor in amblyopia development. However, amblyopia was found to be significantly higher among female primary school children (3.8%) than their male counterparts (0.5%) [6].

The absence of age-related difference in the prevalence of amblyopia in the present study could be attributed to the narrow age range of pupils enrolled in the same level of study. Consistent with the present study, a population-based study among Singaporean-Chinese children also reported no statistically significant variation in amblyopia prevalence across age groups [26], and no significant age-related difference in amblyopia prevalence was found among primary school pupils in Nigeria [14]. Likewise, the Baltimore Pediatric Eye Disease Study reported a slightly higher prevalence among older children in the United States, though the difference was not statistically significant [27]. However, contrasting with the current findings, a study from Saudi Arabia reported a significantly higher prevalence of amblyopia in children aged 10–13 years compared to those aged 6–9 years [3].

Although amblyopia was more prevalent among pupils in public schools (5.6%) compared to those in private schools (3.1%), the difference was not statistically significant. This finding aligns with that reported among Egyptian primary school children in Central Cairo [6], although the prevalence of amblyopia was higher among children in private than public schools (3.1% *vs.* 1%). Conversely, a study conducted in Lebanon found significantly higher referral rates for amblyogenic refractive errors among children attending public schools (27.7%) compared to their private school counterparts (13.6%) [20]. The prevalence of amblyopia was also significantly higher among pupils from public schools compared to private schools in Nigeria [14]. These findings underscore the need for comprehensive school-based vision screening programs, with a particular focus on public schools, to ensure early detection and intervention for amblyopia.

The lack of association between family history of visual impairment and amblyopia among children in the present study is inconsistent with several studies elsewhere [28–30], which have found a higher prevalence of amblyopia among children with a family history of eye-related disorders. In Eastern Europe, a positive family history of amblyopia was found to be significantly associated with amblyopia among

children with refractive errors [29], underscoring the importance of early screening—especially in children with familial history. The inconsistency between the present findings and previous studies may be attributed to several factors. One possible explanation is the dependence on self-reported or unverified family medical history, which might have resulted in incomplete or inaccurate data. Additionally, awareness and knowledge of family eye health may vary across populations, potentially limiting the accuracy of self-reported familial visual impairment.

This study provides insights into the problem of amblyopia among pupils in primary schools in one of Sana'a districts. However, there are a number of limitations that should be considered. First, the cross-sectional nature of the study restricts the ability to establish causal relationships between amblyopia and related factors like refractive errors. Using a cohort study design would provide a clearer understanding of such relationships and how amblyopia changes or improves after management. Second, the study population was limited to third-level pupils within a narrow age range and was conducted in a single district in the city, which may reduce the generalizability of findings to other age groups and other geographic or socio-demographic contexts in Yemen. Therefore, large-scale studies involving pupils from multiple educational levels and districts are recommended. Third, the self-reported data on family history of visual impairment could potentially introduce recall or reporting bias.

5. Conclusion

Amblyopia prevalence among third-level pupils in both public and private schools in Sana'a City aligns with global rates observed in pediatric populations and shows a significant association with wearing glasses. Astigmatism and hypermetropia, whether present separately or concurrently, are common among amblyopic children. Differences in amblyopia prevalence do not appear to be associated with pupils' demographics or family history of visual impairment. These findings underscore the need for school-based vision screening programs to detect and manage refractive errors early, thereby mitigating the impact of amblyopia on the visual acuity of pupils.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of the University of Science and Technology, Sana'a, Yemen (Approval No. 00002849). Permission to conduct the study was also obtained from the Ministry of Education and the Education Office of Al-Wahdah District, Sana'a. Written informed consent was obtained from the parents or legal guardians of all participants prior to data collection. The confidentiality and privacy of participants' information were maintained throughout the study.

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Author Contribution

E.A. and R.E. contributed to data collection, manuscript preparation, the results section, and data interpretation. H.M. participated in developing the study tools and data collection. S.M. contributed to defining the study objectives. A.M. critically reviewed the manuscript. R.G. wrote the discussion section. T.A. and A.A. conceived and designed the study, supervised the research, critically revised the manuscript, and approved the final version. All authors read and approved the final manuscript.

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Data Availability

The study used original data collected from school pupils and analyzed by the authors.

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