

Epidemiology of myopia among schoolchildren in Southern Morocco and the role of behavioral factors

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摩洛哥南部学龄儿童近视流行病学及行为因素研究

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摘要

目的:评估摩洛哥南部小学生近视患病率及其相关行为影响因素。

方法:开展一项基于学校的横断面研究,纳入 598 名 7-13 岁学生(女生 49.00%,男生 51.00%;平均年龄 10.07±1.81 岁)。采用散瞳验光检测屈光状态,等效球镜度(SE)≤-0.50 D 为近视。通过结构化问卷收集课后屏幕使用时长、近距离用眼距离、户外活动时间及近视家族史等行为变量。采用 Pearson 相关系数分析等效球镜度与各行行为变量之间的关联。采用卡方检验分析分类变量间的关联性。**结果:**近视患病率为 12.21%。等效球镜度与屏幕使用时间($r=-0.333, P<0.01$)、近距离工作视物距离($r=0.369, P<0.01$)及户外活动时间($r=0.129, P<0.01$)显著相关。近视家族史与近视存在显著关联($\chi^2=15.32, P<0.001$)。近视患病率随年级升高而上升,但男女学生近视率无显著差异。**结论:**可干预的行为因素与学龄儿童近视显著相关。养成

良好用眼习惯(增加户外活动时间、保持合适用眼距离、减少长时间近距离用眼)有助于预防近视发生、延缓近视进展。本研究结果支持在校园环境中采取公共卫生干预措施,推广视力保健。

关键词:儿童近视;患病率;行为因素;屏幕使用时长;户外活动;摩洛哥

Abstract

• **AIM:** To assess myopia prevalence and associated behavioral factors among primary schoolchildren in southern Morocco.

• **METHODS:** A cross-sectional school-based study of 598 students ages 7-13 y (49.00% girls, 51.00% boys; mean age 10.07±1.81 y). Refractive status was assessed using cycloplegic autorefraction, and myopia was defined as a spherical equivalent (SE) ≤ -0.50 diopters. Behavioral variables, including after-school screen time, near-work viewing distance, outdoor activity, and family history of myopia, were collected through structured questionnaires. Associations between SE and behavioral variables were evaluated using Pearson's correlation coefficient. Categorical associations were assessed using the Chi-square test.

• **RESULTS:** The prevalence of myopia was 12.21%. SE was significantly correlated with screen time ($r=-0.333, P<0.01$), near-work viewing distance ($r=0.369, P<0.01$), and outdoor activity ($r=0.129, P<0.01$). Family history of myopia was significantly associated with myopia ($\chi^2=15.32, P<0.001$). Prevalence of myopia increased with higher school grade, but there was no significant difference between boys and girls.

• **CONCLUSION:** Modifiable behavioral factors are significantly associated with myopia among schoolchildren. Healthier visual habits (such as increasing outdoor time, establishing appropriate viewing distance, and minimizing prolonged near work) can help prevent the onset of and delay the progression of myopia. The results support the use of public health approaches designed to promote visual hygiene in school settings.

• **KEYWORDS:** childhood myopia; prevalence; behavioral factors; screen time; outdoor activity; Morocco
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INTRODUCTION

Myopia has become one of the most rapidly increasing visual disorders among children worldwide. By 2050, projections suggest that nearly half of the global population may be affected, with certain highly urbanized regions in East Asia reporting prevalence exceeding 80%^[1-3]. Although the prevalence remains relatively lower in Africa and the Middle East, several studies indicate a rising trend, particularly in urban environments characterized by intensive near work and reduced outdoor exposure^[4-5].

The development of myopia results from an interaction between genetic predisposition and environmental or behavioral factors. Children with one or two myopic parents are at substantially greater risk of developing myopia, reflecting a strong hereditary influence^[6-8]. Prolonged near work and short reading distance have consistently been associated with an increased risk of myopia development^[9-11]. In addition, excessive use of digital screens has been linked to earlier onset and faster progression of myopia, particularly in post-COVID studies^[12-14]. Conversely, increased exposure to natural daylight and time spent outdoors appear to exert a protective effect, potentially through dopamine-mediated inhibition of axial elongation^[15-17]. Recent systematic reviews and longitudinal studies further highlight the growing role of digital device use in myopia development^[13-16].

Beyond refractive error itself, progressive myopia represents a major public health concern due to its association with sight-threatening complications such as glaucoma, retinal detachment, and myopic maculopathy^[18]. Recent evidence further indicates that increased time spent outdoors may help reduce myopic shift and the risk of myopia onset in children^[19]. In Morocco, epidemiological data on refractive errors among school-aged children are still limited, particularly in southern regions and smaller urban settings where population-based studies are scarce.

Understanding local prevalence patterns and associated behavioral determinants is essential for developing targeted preventive strategies.

This study investigates the prevalence of myopia among children aged 7–13 y in southern Morocco and examines key behavioral risk factors, including screen exposure, near-work distance, outdoor activity, and family history, with the aim of informing future school-based interventions and public health policies.

PARTICIPANTS AND METHODS

Ethical Approval The study was approved by the Biomedical Research Ethics Committee of Oujda (CERBO), under approval number 51/2023. The research was conducted in accordance with the principles of the Declaration of Helsinki^[20]. Written authorization was obtained from the school administration. Parents/guardians were informed about the screening through the school, and no objection to their child's participation was recorded. Verbal assent was obtained from the participating children before each examination. All collected data were strictly anonymized.

Study Design and Subjects We carried out a cross-sectional study in December 2024 in a public primary school in Biougra, located in the southern part of Morocco. A total of 598 children aged 7 to 13 y were recruited. Participation was voluntary. Children regularly enrolled at the school were eligible for inclusion. Participants presenting ocular or systemic conditions likely to affect visual function (*e. g.*, marked hyperopia, high astigmatism, diabetes) were excluded to minimize confounding, in accordance with recommended practices in pediatric ophthalmic epidemiology^[21].

Definition of Myopia and Ophthalmic Examination Accurate refractive assessment was performed using cycloplegic autorefraction. Two instillations of 1% cyclopentolate were administered, followed by a 30-minute interval before measurement^[22]. Refractive evaluation was conducted using a Huvitz HRK-7000A autorefractometer. Three consecutive measurements were obtained for each eye, and the spherical equivalent (SE) of the right eye was used for analysis. Myopia was defined as a SE of ≤ -0.50 diopters (D)^[3].

Data Collection on Behavioral Factors A structured questionnaire was developed to assess behavioral variables commonly investigated in childhood myopia epidemiological studies (screen time, outdoor activity, and near-work habits) and was pilot-tested to ensure clarity and comprehension^[10]. A total of four behavioral indicators were assessed: daily hours spent outdoors, daily after-school screen time, working distance during a standardized near-reading task, and parental myopia (defined as one or more myopic parents). Measurements were performed three times and averaged to improve reliability.

Statistical Analysis Data were collected and analyzed using SPSS Statistics (version 19.0; IBM Corp., Armonk, NY, USA). Participant characteristics were summarized using descriptive statistics (mean $\pm$ standard deviation for continuous variables and frequencies with percentages for categorical variables). The prevalence of myopia was calculated and stratified by age, sex, grade level, and family history. Pearson's correlation coefficient was used to evaluate associations between SE and behavioral variables. Assumptions of normality and linearity were verified prior to applying Pearson's correlation. Variables with $P < 0.20$ in univariate analysis were entered into the multivariable linear regression model to identify independent predictors, in accordance with established statistical modeling principles^[23]. Correlation strength was interpreted as weak (0.10–0.29), moderate (0.30–0.49), or strong (≥ 0.50), according to established guidelines^[24]. Statistical significance was defined as $P < 0.01$.

RESULTS

Characteristics of the Study Population The study included 598 children (49.00% girls, 51.00% boys) with a mean age of 10.07 ± 1.81 y (range: 7–13 y). Students were distributed across all primary school grades, from Grade 1 to

Grade 6. Participants reported an average daily outdoor time of 2.63 ± 0.55 h (range: 0–4 h) and an average after-school screen time of 1.36 ± 0.68 h (range: 0–12 h). The average near-work viewing distance was 30.88 ± 3.52 cm (range 20–35 cm). For children with myopia ($n=73$), the mean SE in the right eye was -2.80 ± 1.24 D.

The distribution pattern of myopia and prevalence The prevalence of myopia overall was 12.21% (73/598 students). Among myopic students, 53.00% were girls and 47.00% were boys, but the difference was not statistically significant (Chi-square test: $\chi^2=0.84$, $P=0.36$).

Myopia prevalence varied across educational levels, with the highest proportions observed in Grade 4 (33.00%) and Grade 6 (22.00%) (Figure 1). An increasing trend in prevalence was observed with age (Figure 2).

Family History of Myopia A total of 16.39% of children (98/598) reported a family history of myopia. Children with a myopic parent were significantly more likely to be myopic ($\chi^2=15.32$, $P<0.001$). Specifically, 34.20% of myopic children had at least one myopic parent, compared with 13.50% of non-myopic children.

Associations with Behavioral Factors Pearson’s correlation was used to examine associations between behavioral variables and SE. Screen time showed a moderate negative correlation ($r=-0.333$, $P<0.01$), indicating that longer screen exposure was associated with more negative SE values. Working

distance demonstrated a moderate positive correlation ($r=0.369$, $P<0.01$), suggesting that shorter near-work distances were associated with more negative SE values. Time spent outdoors showed a weak but statistically significant positive correlation ($r=0.129$, $P<0.01$), indicating that greater outdoor exposure was associated with less negative SE values.

Multivariable Risk Factor Analysis Variables independently associated with SE in the multivariable model included working distance ($\beta=0.312$, $P<0.001$), and screen time ($\beta=-0.285$, $P<0.001$) that were then followed by family history ($\beta=-0.198$, $P=0.002$) and outdoor time ($\beta=0.145$, $P=0.008$). The model accounted for 28.7% of variance for SE [$R^2=0.287$, $F(4,593)=59.43$, $P<0.001$].

DISCUSSION

This study provides updated epidemiological data on myopia among children living in a small urban town in southern Morocco, with an overall prevalence of 12.21%. This rate is higher than previously reported Moroccan estimates (6.10%)^[5] and may suggest a gradual upward trend. Although the prevalence remains considerably lower than that observed in highly urbanized East Asian countries (60.00%–80.00%)^[1,3], it nonetheless represents a meaningful public health concern in this setting.

The observed increase compared with earlier Moroccan data may reflect evolving visual habits, greater academic demands, and increased exposure to digital devices. Similar trends have been described internationally, particularly in urban environments where lifestyle changes influence visual behavior.

Behavioral factors were significantly associated with SE in our sample. Shorter near-work distance and longer screen exposure were both linked to more negative SE values. These findings align with previous international studies showing that prolonged near work contributes to both the onset and progression of myopia^[9–11]. The moderate association between working distance and SE ($r=0.369$) is comparable to results from the Anyang Childhood Eye Study, where closer viewing distance was identified as an independent risk factor^[11].

Screen exposure also demonstrated a moderate correlation with SE. Recent Meta-analyses indicate that extended use of digital devices may increase myopia risk through sustained accommodative demand, reduced blink rate, and altered visual contrast exposure^[12,14]. Given the increasing integration of digital tools in education, this association is particularly relevant for school-aged children.

Time spent outdoors showed a weak but statistically significant protective association. This finding is consistent with biological evidence suggesting that exposure to natural light stimulates retinal dopamine release, which may inhibit axialelongation^[15–17]. While children in smaller urban areas may traditionally spend more time outdoors than those in large metropolitan cities, ongoing modernization and digitalization could gradually reduce outdoor activity levels over time.

Family history of myopia was significantly associated with myopia ($\chi^2=15.32$, $P<0.001$), supporting the well-

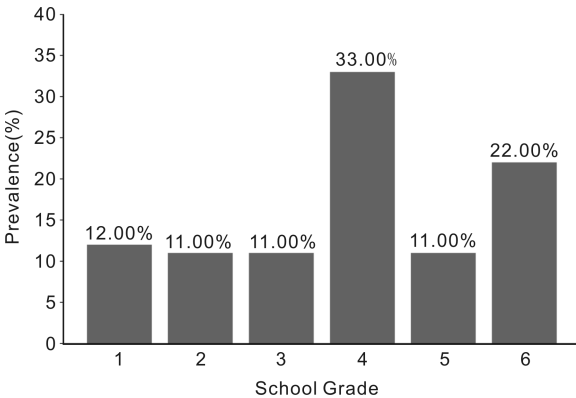


Figure 1 Distribution of myopia by school grade (Levels 1–6) Bar chart illustrating the variation in myopia prevalence across educational levels, with the highest prevalence observed in Grade 4 (33.00%) and Grade 6 (22.00%).

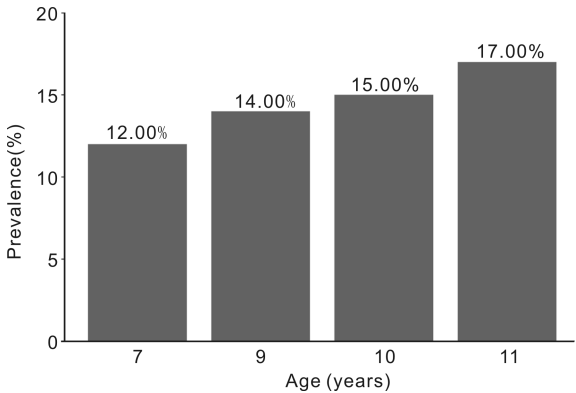


Figure 2 Prevalence of myopia by age group Bar chart showing the distribution of myopia according to age, with increasing prevalence in older age groups.

established role of genetic predisposition in myopia development. Previous studies have shown that children with one or two myopic parents have an increased risk of developing myopia^[6-7]. This finding reinforces the multifactorial nature of myopia, involving both genetic susceptibility and environmental exposure.

No significant sex difference in myopia prevalence was observed. This finding is consistent with reports from similar Moroccan populations but contrasts with some East Asian studies, where higher prevalence among girls has been attributed to differences in academic pressure and outdoor activity patterns. In the present setting, comparable daily routines between boys and girls may partly explain the absence of sex disparity.

From a public health perspective, each additional diopter of myopia has been shown to increase the lifetime risk of sight-threatening complications, underscoring the importance of early preventive strategies^[25]. School-based visual hygiene interventions could include promoting regular outdoor activity, maintaining adequate reading distance, optimizing classroom lighting, and encouraging structured breaks during near work, such as the 20-20-20 rule, in line with international recommendations for myopia control^[26]. Early behavioral intervention remains essential to reduce the future burden of high myopia and its associated complications.

Limitations There are several limitations in this study. Due to the cross-sectional design, causal relationships cannot be established. First, although cycloplegic refraction was used, some measurement variability may persist. Second, the behavioral variables were based on self-report and may be subject to recall bias or inaccuracies, particularly regarding screen time. Third, the study was limited to a single small urban school, which may reduce the generalizability of our findings to other regions of Morocco, including rural areas or larger urban centers. Future research involving larger, more diverse samples and longitudinal cohorts would provide a more comprehensive understanding of myopia progression and regional variability across the country.

The present study represents an initial cross-sectional investigation conducted in a small urban setting in southern Morocco, where epidemiological data on childhood myopia remain limited. In this context, our findings provide important baseline information from a region that is currently underrepresented in the scientific literature. Future research in Morocco should expand to multicenter studies including urban, rural, and suburban populations to better understand regional variations in myopia prevalence and associated risk factors. Longitudinal follow-up studies incorporating objective parameters such as axial length measurements and environmental exposure assessments may further improve understanding of the progression and determinants of childhood myopia. From a public health perspective, strengthening school-based vision screening programs and promoting outdoor activities among children may contribute to early detection and prevention of myopia progression.

Myopia among schoolchildren in southern Morocco appears to be associated with modifiable behavioral factors, including prolonged near work, increased screen exposure, and limited outdoor activity. Although the prevalence observed in this small urban setting remains lower than that reported in highly urbanized East Asian regions, it reflects evolving visual habits and warrants attention. Preventive strategies at the school level, such as promoting outdoor activities, encouraging appropriate reading distances, and fostering healthy digital practices, may help reduce future risk. Strengthening collaboration among families, educators, and healthcare professionals, alongside routine school-based screening programs, could contribute to reducing the long-term burden of childhood myopia in Morocco.

Authors' contributions: Elhassane Benhim: Study design, data analysis, manuscript writing; Soumaya Boujemaa: Data collection; Farida Bentayeb: Optical examinations; El Merabet Youssef: Statistical analysis supervision; R'hma Adhiri: Critical revision of the manuscript

Conflicts of Interest: Benhim E, None; Boujemaa S, None; Bentayeb F, None; Youssef EM, None; Adhiri R, None.

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