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Abstract

Background: The recent increase in myopia is a major public health concern worldwide, including in the Eastern Mediterranean Region (EMR).

Aim: To provide data on the prevalence of myopia among school-age children in the EMR.

Methods: This study was conducted using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) protocol. We searched the Web of Sciences, Scopus, Index Medicus for the Eastern Mediterranean Region, ProQuest, PubMed, and Medline for studies on the prevalence of myopia in the EMR published from January 2000 to May 2022. The data were analysed using MedCalc version 19.6.1 and myopia was defined as refractive error ≥ 0.50 D. The overall pooled prevalence of myopia was estimated using a random-effects model and its associated 95% confidence intervals.

Results: The meta-analysis included 27 quality-assessed studies from 13 countries among 51 111 school-age children. The overall pooled prevalence of childhood myopia from 2000 to 2022 was 5.23%, which was significantly higher among females than males (4.90% vs 3.94%). The prevalence of myopia was significantly higher among children aged 11–17 years than among those aged 5–10 years (7.50% vs 3.90%). There was a higher prevalence of myopia with cycloplegic refraction than noncycloplegic refraction (5.95% vs 3.73%). There was highly significant heterogeneity between the studies.

Conclusion: Prevalence of myopia among school-age children in the EMR was high, particularly among older children, and it was more common among females. Early intervention to slow myopia progression is essential in the EMR to protect children from irreversible vision loss.

Keywords: myopia, school-age children, refractive error, visual impairment, vision loss, global health, Eastern Mediterranean

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Introduction

The current increase in myopia among school-age children is a major public health concern worldwide. This could be because of the significant amount of time that children spend in near-vision activities such as reading and using computers or smartphones (1–3). Recent studies have indicated that genetic and environmental factors, such as time spent outdoors, are the main reasons for the high prevalence of myopia in East Asia (3, 4). Holden et al. (5) reported that ~1.4 billion individuals had myopia in 2000, and it is expected that by 2050 the number would have increased to 4.8 billion. Gilmartin revealed in 2004 that almost 1 in 6 of the world's inhabitants had myopia (6). This high prevalence of myopia poses a significant burden globally, with a considerable unmet need for correction of poor vision, particularly in developing countries (7).

Myopia is a leading cause of avoidable visual impairment in developed countries among adults

and children and the most common cause of treatable blindness in poor nations (8,9). Recent global estimates showed that > 90% of persons with refractive errors live in developing countries, and myopia remains the leading cause (10, 11). In response to this concern, the global initiative to eliminate preventable visual impairment is focused on the cause, prevalence, prevention and treatment of 5 eye diseases, including refractive errors (11, 12). Untreated myopia is the leading cause of ocular morbidity among children and adults, and it has reached an epidemic level in some regions, such as East Asia (13).

The Eastern Mediterranean Region (EMR) comprises 22 nations and territories, with a total population of 597 million. The estimated prevalence of visual impairment, blindness and low vision in the region in 2012–2014 was 8.2%, 12.5% and 7.6%, respectively (14, 15). Accurate information about the prevalence and causes of childhood visual impairment is crucial for developing a well-coordinated approach to identify and treat promptly the underlying causes (16). Consequently, this systematic review and meta-analysis aimed to estimate the prevalence of myopia among school-age children in the EMR.

Methods

Search strategy and quality assessment of studies

This study used the PRISMA framework (Preferred Reporting Items for Systematic reviews and Meta-Analyses) (17). We searched Web of Sciences, Scopus, Index Medicus for the Eastern Mediterranean Region, ProQuest, PubMed and Medline for studies on the prevalence of myopia in the EMR published from January 2000 to May 2022. The quality of each included study was assessed using the worksheet developed by Downs and Black, and each selected article was evaluated and scored on a 10-item scale (Table 1) (18). This review was limited to articles published in English, available online, in peer-reviewed journals, and mentioning the prevalence of myopia in the EMR. The MeSH search terms were: (Prevalence OR rate OR incidence OR frequency OR proportion OR distribution OR epidemiology) AND myopia AND children. In addition, for several repetitions of these search terms used AND/OR in the EMR (Afghanistan, Bahrain, Djibouti, Egypt, Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, State of Palestine, and the United Arab Emirates).

Inclusion and exclusion criteria

Inclusion criteria were: articles published between January 2000 and May 2022; studies assessing the prevalence of myopia among male and female children aged 5–17 years; epidemiological studies that used an observational cross-sectional design; studies with a clear description of the method used for data collection, such as sampling method; studies that reported the technique used for measuring refractive error (cycloplegic or noncycloplegic refraction), in addition to objective or subjective refraction; and studies that mentioned the benchmarks for defining myopia as spherical equivalent ≥ 0.50 D of myopia. Exclusion criteria

were: editorial discussions, conference papers, meeting abstracts, articles without basic data gathering, and retrospective hospital-based studies.

Data extraction

The title and abstract of each selected article were carefully assessed by the author, and the following information was extracted: first author's name; year of publication; country of study; study subjects' characteristics (age, sample size); technique used for refractive error measurement (cycloplegic or noncycloplegic); benchmarks for defining myopia; and prevalence of myopia (Table 1).

Data analysis

The meta-analysis was conducted using MedCalc version 19.6.1. The study data were entered individually from a predesigned format that recorded the author's name, date of publication, study population, mean age, sample size, method for assessment of refraction, and prevalence of childhood myopia. Heterogeneity among studies was assessed using a Q statistic that was distributed as $\chi 2$ under the assumption of homogeneity of effect sizes, and I2 index (0–75%,) which represented none to high heterogeneity. The analysed data presented the prevalence of myopia among children by age, gender and refraction method and the corresponding weight for each study. The overall pooled prevalence of myopia was estimated using a random-effects model and its associated 95% confidence intervals (CIs). P

Results

Study characteristics

The literature search identified 12 705 articles. After removing duplicates, we reviewed the titles of 6457 articles. We excluded 6350 articles after reading their abstracts because they did not meet the inclusion criteria, and we excluded 80 articles after reading their full texts because the required information could not be extracted. The final meta-analysis included 27 quality-assessed studies from 13 countries (Table 1). Publication years were 2007–2021, and the overall sample size of the studies was 51 111 children with a mean age of 10.52 (1.93) years.

Prevalence of myopia among school-age children in the EMR

The overall pooled prevalence of myopia in the EMR was 5.23% (95% CI: 4.0–7.0%; P Table 2). Ten of the reviewed studies reported a higher prevalence of childhood myopia and 17 reported a lower prevalence than the pooled estimate across the EMR. The study conducted by Hussam et al. (42) showed the highest prevalence (19.6%) of myopia, among Iraqi children in Baghdad (95% CI: 17.0–22.0%), whereas Fotouhi et al. 2011 (39) reported the lowest prevalence, among Iranian children (0.41%, 95% CI: 0.0– 1.0%). The pooled prevalence estimates of myopia in this review were similar to the study by Kandi and Kandi (43), (5.18%, 95% CI: 4.0–7.0%) among children in the United Arab Emirates.

Prevalence of myopia by gender among school-age children in the EMR (2000–2022)

Prevalence of myopia was highly significantly different between male and female children (P Table 3
). The prevalence of myopia among females was comparable with the overall pooled estimate of 5.23% and the prevalence among males was lower.

Prevalence of myopia by age of school-age children in the EMR (2000–2022)

The pooled estimated prevalence of myopia among children aged 5–10 years was 3.90% (95% CI 2.0–5.0%), which was highly significantly lower than among children aged 11–17 years (7.50%, 95% CI 5.0–10.0%) (P = 0.001) (Table 4). The younger children had a lower pooled prevalence of myopia than the overall pooled estimation of 5.23%, whereas older children showed a higher pooled prevalence. Among children aged 5–10 years, the highest prevalence of myopia was reported in Somalia (22) (7.87%, 95% CI: 5.0–10.0%) and Saudi Arabia (34) (7.67%, 95% CI: 5.0–10.0%). The lowest prevalence was in Egypt (20) (0.85%, 95% CI: 0.0–1.0%). Among children aged 11–17 years, the highest prevalence of myopia was in Jordan (36) (15.54%, 95% CI: 14.0–17.0%), and the lowest prevalence was in Egypt (20) (2.21%, 95% CI: 1.0–3.0%).

Childhood myopia prevalence by refraction technique among school-age children in the EMR

Studies that used cycloplegic refraction reported a higher prevalence of myopia among school-age children (5.95%, 95% CI: 4.0–8.0%) than studies that used noncycloplegic refraction (3.73%, 95% CI: 3.0–5.0%) (Table 5). Meta-analysis showed highly significant heterogeneity between both groups of studies that used cycloplegic and noncycloplegic refraction (P

Discussion

Our meta-analysis provided recent prevalence estimates of childhood myopia in the EMR using data from 27 studies from 13 countries in 2000–2022. The benchmark for defining myopia used in this study was spherical equivalent ≥ 0.50 D. The overall prevalence of myopia among children across the EMR was 5.23%, and there were differences within and between countries. There was highly significant heterogeneity between the studies. The highest prevalence of myopia was in Iraq (42) and Jordan (36), and the lowest was in the Islamic Republic of Iran (39) and Saudi Arabia (33). In the United Arab Emirates, the prevalence of myopia was similar to the overall estimation (43).

Some countries, such as Saudi Arabia, reported variation in the prevalence of myopia among children of 9% (23), 7.67% (34), 2.50% (38) and 1.1% (33). Among Iranian children, the lowest prevalence of myopia was 0.41% (39) and the highest 4.4% (25). The present study showed highly significant differences in the prevalence of childhood myopia across the region, which is consistent with a previous study (46) that indicated significant variation among countries, even within the same geographic region. The regional and national variations in prevalence of myopia could be due to differences in environmental and genetics factors, criteria for defining myopia or techniques for assessing refractive error (some studies used dry refraction and others wet refraction). Thus, our analysis only included studies that defined myopia as spherical equivalent ≥ 0.50 D, and we calculated the prevalence of myopia for studies that used cycloplegia and noncycloplegia separately.

The overall pooled prevalence of myopia among school-age children in the EMR is slightly higher than children in the WHO/AFRO Region (47), which may be related to the variation in the hereditary tendency to the development of myopia (48). EMR includes some countries in Africa and Asia. In this review, most of the studies were from countries in Asia, which may reflect the heterogeneity among the findings and high prevalence of myopia. The high prevalence of childhood myopia may be a result of children spending a lot of time studying and reading, and more recently, increased use of computers and other smart devices. There was a highly significant difference in prevalence of myopia between male and female children (3.94% vs 4.90%). This is similar to the situation among WHO/AFRO children, who showed a higher prevalence among females, but the difference was not significant (47). Some authors have attributed the higher prevalence of myopia among females to different ages of onset of maturity between the sexes, or to females spending less time outside than males (21, 49). In children aged 5–10 years, the prevalence of myopia was highly significantly lower than in older children aged 11–17 years (3.90% vs 7.50%). This demonstrates a trend for increased development of myopia with age, which agrees with previous studies (8, 21, 50). This increase in prevalence of myopia may be a result of the development of the eyeball or an increase in near-sight activities such as reading and writing in school.

This study revealed that studies that used cycloplegic refraction reported a significantly higher prevalence of myopia among children than studies that used noncycloplegic refraction, which is inconsistent with earlier studies (21, 47). Dry refraction overestimates the prevalence of myopia and gives an unreliable assessment of the relationship between myopia risk factors; therefore, wet refraction is considered the gold standard for assessing myopia (52, 53). Only 9 of the 27 studies in our meta-analysis measured refractive error by the noncycloplegic method, and the rest used cycloplegia, which may explain the high prevalence of myopia in the latter. This higher prevalence of myopia with cycloplegia than noncycloplegia disagrees with most previous studies. This could have been a methodological bias in our study sample: 18 of the studies reported using cycloplegia. This may have resulted in a high prevalence of myopia with wet refraction.

This review had some limitations that were related to the nature of the study. These included variations in the study methods. Some studies had a large sample size and others a small sample size, which may have yielded over- or underestimation of the prevalence of myopia. Several studies were excluded from the review because they used different techniques or different age groups, which reduced the number of articles included. Our review did not examine the trend in the prevalence of myopia among children in the EMR because of the limited number of studies. Some countries had many studies, and others had none to assess the prevalence of myopia in children. This study did not explore the various factors affecting the epidemiology of myopia. Despite these limitations, our systematic review and meta-analysis estimated the pooled prevalence of childhood myopia in the EMR and how it differed with gender, age and refraction method.

Conclusion

The prevalence of myopia among children in the EMR was high, particularly among older children, and slightly more common among females. More studies are required using standardized methods in different regions where there is a lack of information on the prevalence of myopia. Early interventions to slow progression of myopia are essential in the EMR to protect children from irreversible vision loss during adulthood.

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Analyse systématique et méta-analyse de la prévalence de la myopie chez les enfants d'âge scolaire dans la Région de la Méditerranée orientale

Résumé

Contexte : L'augmentation récente des cas de myopie est un problème majeur de santé publique dans le monde entier, y compris dans la Région de la Méditerranée orientale.

Objectif : Fournir des données sur la prévalence de la myopie chez les enfants d'âge scolaire dans la Région de la Méditerranée orientale.

Méthodes : La présente étude a été menée selon le protocole PRISMA (lignes directrices pour la rédaction d'analyses et de méta-analyses systématiques). Nous avons effectué des recherches dans Web of Sciences, Scopus, Index Medicus pour la Région de la Méditerranée orientale, ProQuest, PubMed et Medline pour les études sur la prévalence de la myopie dans la Région qui ont été publiées entre janvier 2000 et mai 2022. Les données ont été analysées au moyen de la version 19.6.1 de MedCalc et la myopie a été définie comme un défaut de réfraction supérieur ou égal à 0,50 D. La prévalence globale groupée de la myopie a été estimée à l'aide d'un modèle à effets aléatoires et des intervalles de confiance à 95 % qui y sont associés.

Résultats : La méta-analyse a porté sur 27 études, dont la qualité a été évaluée, réalisées dans 13 pays auprès de 51 111 enfants d'âge scolaire. Entre 2000 et 2022, la prévalence globale groupée de la myopie chez l'enfant était de 5,23 %, ce qui était significativement plus élevé chez les filles que chez les garçons (4,90 % contre 3,94 %). Cette prévalence était significativement plus élevée chez les enfants âgés de 11 à 17 ans que chez ceux âgés de 5 à 10 ans (7,50 % contre 3,90 %). De plus, elle était plus élevée avec la réfraction cycloplégique qu'avec la réfraction non cycloplégique (5,95 % contre 3,73 %). L'hétérogénéité entre les études était hautement significative.

Conclusion : La prévalence de la myopie chez les enfants d'âge scolaire dans la Région de la Méditerranée orientale était élevée, en particulier chez les enfants plus âgés, et elle était d'autant plus fréquente chez les filles. Une intervention précoce visant à ralentir la progression de la myopie est essentielle dans la Région pour protéger les enfants contre une perte de vision irréversible.

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