



Review

Global and regional estimates of prevalence of refractive errors: Systematic review and meta-analysis

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Abstract

Purpose: The aim of the study was a systematic review of refractive errors across the world according to the WHO regions.

Methods: To extract articles on the prevalence of refractive errors for this meta-analysis, international databases were searched from 1990 to 2016. The results of the retrieved studies were merged using a random effect model and reported as estimated pool prevalence (EPP) with 95% confidence interval (CI).

Results: In children, the EPP of myopia, hyperopia, and astigmatism was 11.7% (95% CI: 10.5–13.0), 4.6% (95% CI: 3.9–5.2), and 14.9% (95% CI: 12.7–17.1), respectively. The EPP of myopia ranged from 4.9% (95% CI: 1.6–8.1) in South-East Asia to 18.2% (95% CI: 10.9–25.5) in the Western Pacific region, the EPP of hyperopia ranged from 2.2% (95% CI: 1.2–3.3) in South-East Asia to 14.3% (95% CI: 13.4–15.2) in the Americas, and the EPP of astigmatism ranged from 9.8% in South-East Asia to 27.2% in the Americas. In adults, the EPP of myopia, hyperopia, and astigmatism was 26.5% (95% CI: 23.4–29.6), 30.9% (95% CI: 26.2–35.6), and 40.4% (95% CI: 34.3–46.6), respectively. The EPP of myopia ranged from 16.2% (95% CI: 15.6–16.8) in the Americas to 32.9% (95% CI: 25.1–40.7) in South-East Asia, the EPP of hyperopia ranged from 23.1% (95% CI: 6.1%–40.2%) in Europe to 38.6% (95% CI: 22.4–54.8) in Africa and 37.2% (95% CI: 25.3–49) in the Americas, and the EPP of astigmatism ranged from 11.4% (95% CI: 2.1–20.7) in Africa to 45.6% (95% CI: 44.1–47.1) in the Americas and 44.8% (95% CI: 36.6–53.1) in South-East Asia. The results of meta-regression showed that the prevalence of myopia increased from 1993 (10.4%) to 2016 (34.2%) ($P = 0.097$).

Conclusion: This report showed that astigmatism was the most common refractive errors in children and adults followed by hyperopia and myopia. The highest prevalence of myopia and astigmatism was seen in South-East Asian adults. The highest prevalence of hyperopia in children and adults was seen in the Americas.

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Keywords: Myopia; Hyperopia; Astigmatism; Meta-analysis

Introduction

Refractive errors are the most common ocular problem affecting all age groups. They are considered a public health challenge. Recent studies and WHO reports indicate that refractive errors are the first cause of visual impairment and the second cause of visual loss worldwide as 43% of visual

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impairments are attributed to refractive errors.¹ In a review study, Naidoo et al² showed that uncorrected refractive errors were responsible for visual impairment in 101.2 million people and blindness in 6.8 million people in 2010.

Refractive errors also affect the economy of different societies.^{3,4} According to a study by Smith et al,⁴ uncorrected refractive errors result in an annual economy loss of \$269 billion worldwide. According to this report,⁴ this index was \$121.4 billion in individuals above 50 years.

A review of the literature and medical databases reveals that many studies have been conducted on the epidemiology of refractive errors across the world since 1990.^{5,6} Although numerous studies report the prevalence of refractive errors every year, many new articles are published on the epidemiology of these errors annually due to their importance and prevalence.

Although recent studies^{7,8} suggest an increase in the prevalence of myopia due to lifestyles changes, differences in ethnic groups, measurement methods, definitions of refractive errors, and age groups of the participants hinder a definite conclusion regarding the pattern of the distribution of refractive errors worldwide.

The distribution of refractive errors is not equal in different countries. A high prevalence of myopia in East Asian countries is a common finding in most previous studies.⁷ However, there are some controversies regarding hyperopia. Although some studies have shown a high prevalence of hyperopia in Europe and western countries, it is difficult to make a conclusion since most of these studies were conducted on the elderly, and the high prevalence of hyperopia in this age group is a normal finding due to lens changes. Considering the diversity of the results and use of different definitions and measurement techniques, we decided to evaluate the prevalence of refractive errors across the world in this meta-analysis. Moreover, the status of refractive errors in the world is presented according to the WHO regions in this report.

Methods

The present meta-analysis was conducted according to the Preferred Reporting Item for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.⁹

Search strategy

To extract articles from 1990 to 2016 on the prevalence of refractive errors for this meta-analysis, international databases including Medline, Scopus, Web of Sciences, Embase, CABI, CINAHL, DOAJ, and Index Medicus for Eastern Mediterranean Region-IMEMR were searched. The literature was reviewed using a combination of words like population (children, student, adult, and related MeSH terms), outcome [refractive error, myopia, hyperopia, astigmatism, spherical equivalent (SE), cylinder power], and study design (prevalence, ratio, cross-sectional, survey, descriptive, and epidemiology). A search strategy was developed for MEDLINE which then used for other databases. Table 1 presents the

Table 1

Search strategy for MEDLINE (MeSH, Medical Subject Headings).

1: Refractive errors [Text Word] OR Refractive errors [MeSH Terms]
2: Myopia [Text Word] OR Myopia [MeSH Terms]
3: Hyperopia [Text Word] OR Hyperopia [MeSH Terms]
3: Astigmatism [Text Word] OR Astigmatism [MeSH Terms]
4: Spherical equivalent [Text Word] OR Spherical equivalent [MeSH Terms]
5: Cylinder power [Text Word] OR Cylinder power [MeSH Terms]
6: 1 OR 2 OR 3 OR 4 OR 5 OR 6
7: Pediatric [Text Word] OR pediatric [MeSH Terms]
8: Children [Text Word] OR children [MeSH Terms]
9: Student [Text Word] OR Student [MeSH Terms]
10: Adolescent[Text Word] OR Adolescent[MeSH Terms]
11: Adult [Text Word] OR Adult [MeSH Terms]
12: 7 OR 8 OR 9 OR 10 OR 11
13: Prevalence [Text Word] OR Prevalence [MeSH Terms]
14: Frequency [Text Word] OR Frequency [MeSH Terms]
15: Cross-Sectional [Text Word] OR Cross-Sectional [MeSH Terms]
16: Descriptive [Text Word] OR Descriptive [MeSH Terms]
17: Survey [Text Word] OR Survey [MeSH Terms]
18: 13 OR 14 OR 15 OR 16 OR 17
19: 6 AND 12 AND 18

details of the search strategy. In addition, the reference lists of all searched studies and reviews were evaluated to find similar studies.

Study selection

After an extensive search, all studies were entered into EndNote X6. Duplicate articles were identified and removed using the duplicates command. Relevant articles were selected in three phases. In phases 1 and 2, the titles and abstracts of the studies were screened, and irrelevant articles were excluded. In phase 3, the full texts of the studies were carefully evaluated. All three phases were conducted by two interviewers independently (S.M. and F.J.). It should be noted that the reviewers were blind to the process of article selection.

The two reviewers had 81% agreement in finding similar studies and 88.7% agreement in data collection. In the remaining 11.3%, the results were evaluated by a third reviewer (M.P.), and the required data were extracted.

Data extraction and assessment of study quality

The title and abstract of each article was carefully evaluated by 2 reviewers, and data such as the first author's name, publication date, study location (country), study design and characteristics, participants' characteristics (age, sex, sample volume), definitions used for the prevalence of refractive errors, and the prevalence of refractive errors (myopia, hyperopia, and astigmatism) were extracted. The quality of the selected articles was evaluated by the 2 reviewers using the STROBE checklist that contains 22 questions on the methodologic aspects of descriptive studies including the sampling method, study variables, and statistical analysis. The quality assessment results were classified into low quality (less than 15.5), moderate quality (15.5–29.5) and high quality (32–46). Low quality studies were excluded from the meta-analysis.

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