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Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050

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Purpose: Myopia is a common cause of vision loss, with uncorrected myopia the leading cause of distance vision impairment globally. Individual studies show variations in the prevalence of myopia and high myopia between regions and ethnic groups, and there continues to be uncertainty regarding increasing prevalence of myopia.

Design: Systematic review and meta-analysis.

Methods: We performed a systematic review and meta-analysis of the prevalence of myopia and high myopia and estimated temporal trends from 2000 to 2050 using data published since 1995. The primary data were gathered into 5-year age groups from 0 to ≥100, in urban or rural populations in each country, standardized to definitions of myopia of −0.50 diopter (D) or less and of high myopia of −5.00 D or less, projected to the year 2010, then meta-analyzed within Global Burden of Disease (GBD) regions. Any urban or rural age group that lacked data in a GBD region took data from the most similar region. The prevalence data were combined with urbanization data and population data from United Nations Population Department (UNPD) to estimate the prevalence of myopia and high myopia in each country of the world. These estimates were combined with myopia change estimates over time derived from regression analysis of published evidence to project to each decade from 2000 through 2050.

Results: We included data from 145 studies covering 2.1 million participants. We estimated 1406 million people with myopia (22.9% of the world population; 95% confidence interval [CI], 932−1932 million [15.2%−31.5%]) and 163 million people with high myopia (2.7% of the world population; 95% CI, 86−387 million [1.4%−6.3%]) in 2000. We predict by 2050 there will be 4758 million people with myopia (49.8% of the world population; 3620−6056 million [95% CI, 43.4%−55.7%]) and 938 million people with high myopia (9.8% of the world population; 479−2104 million [95% CI, 5.7%−19.4%]).

Conclusions: Myopia and high myopia estimates from 2000 to 2050 suggest significant increases in prevalences globally, with implications for planning services, including managing and preventing myopia-related ocular complications and vision loss among almost 1 billion people with high myopia. *Ophthalmology 2016;123:1036-1042 © 2016 by the American Academy of Ophthalmology. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).*

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In 2010, it was estimated that uncorrected refractive error was the most common cause of distance vision impairment, affecting 108 million persons, and the second most common cause of blindness globally.[1] The economic burden of uncorrected distance refractive error, largely caused by myopia, was estimated to be US$202 billion per annum.[2] There is a substantive economic argument for eliminating uncorrected myopia and other refractive errors.[3]

However, myopia brings further vision challenges because high myopia increases the risk of pathologic ocular changes such as cataract, glaucoma, retinal detachment, and myopic macular degeneration, all of which can cause irreversible vision loss.[4] In some communities with a high prevalence of myopia, myopic macular degeneration has been found to be the most frequent cause of irreversible blindness.[5] Myopic macular degeneration has been found to cause 12.2% of vision impairment in Japan (approximately 200 000 people).[6]

There remain 2 major gaps in the literature. First, individual studies suggest wide variation in the prevalence of myopia between different regions and ethnic groups.[7] For example, the prevalence of myopia is more than 2 times higher among East Asians than similarly aged white persons.[8] Second, the prevalence of myopia in different countries seems to be increasing, and most dramatically among younger people in East Asia.[8] The combination

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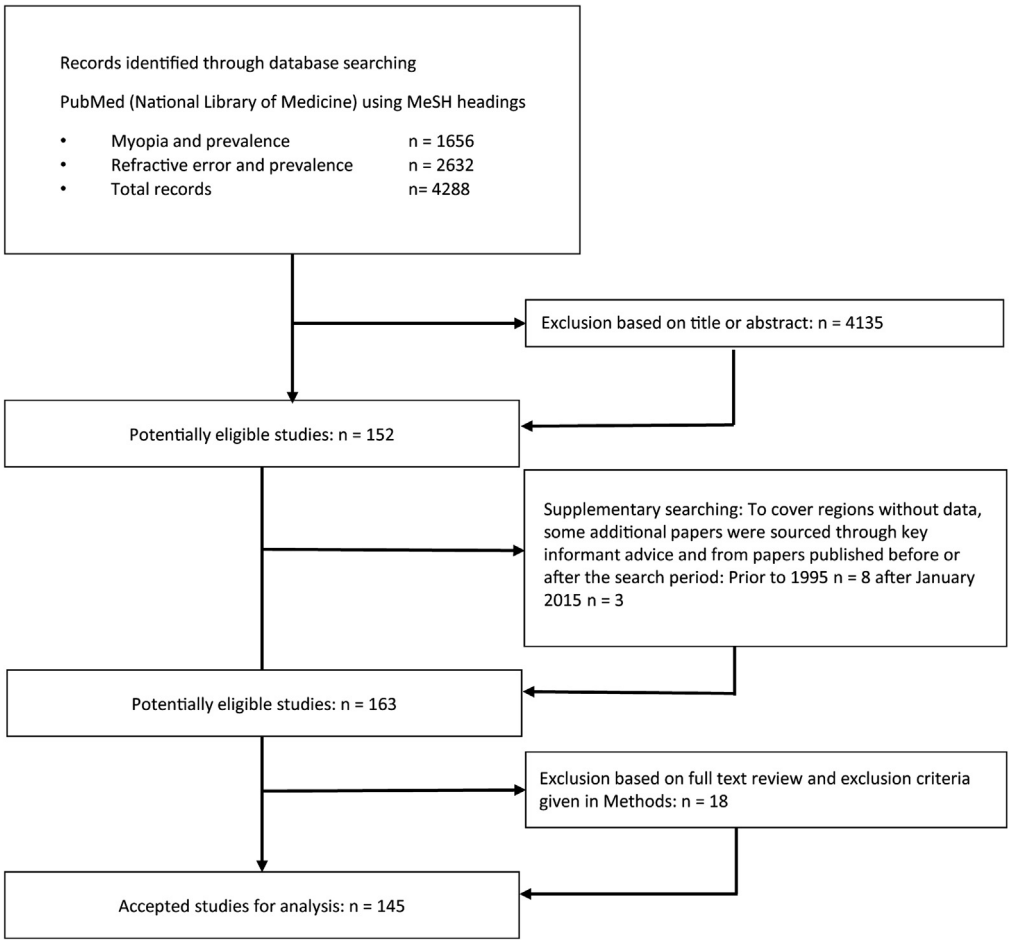

Figure 1. Flow diagram summarizing the systematic search and review process for identifying myopia prevalence evidence globally. MeSH = medical subject headings.

of vision impairment from uncorrected myopia and irreversible vision loss from myopia-related complications make accurate global estimates of the prevalence and temporal trends critical for planning care and services. However, there are no precise estimates of the global prevalence of myopia or for projected temporal changes over the next few decades.

Methods

Studies, Databases, and Data Organization

We performed a systematic search and review of the prevalence of myopia and high myopia using data published since 1995, summarized in Figure 1. We searched PubMed (National Library of Medicine) on January 10, 2015, for publications using the following MeSH (Medical Subject Heading) terms: *myopia* AND *prevalence* and *refractive error* AND *prevalence*. The search was restricted to articles published after January 1, 1995, and was performed on all available articles regardless of the original language of publication. The search yielded 1656 and 2632 articles relating to myopia and refractive error, respectively. The abstract of each publication was reviewed and articles that were population-based surveys were included. Surveys were excluded if they did not specify the number of eligible participants or participation rate, or if data were from a specific population that could not be generalized to the population as a whole. We rejected 8 articles that did not specify a definition of myopia. To cover regions without data, some additional articles were sourced through key informant advice and from reference lists of articles found through PubMed. A full list of the 145 studies is included in Appendix 1 (available at www.aaojournal.org).

Country-specific population data for each decade from 2000 through 2050, in 5-year age groups from 0 to ≥100, were drawn mostly from the United Nations World Population Prospects.[9] Population data from the United States Census Bureau were used for a small number of low-population states omitted from the available United Nations data.[10]

Studies have suggested that myopia rates differ in urban compared with rural communities that are otherwise similar.[11,12] We therefore obtained separate urban and rural myopia prevalences where possible and disaggregated country-level populations into urban and rural numbers sourced from the United Nations World Urbanization Prospects.[13]

Countries were grouped into the 21 Global Burden of Disease (GBD) regions.[1] The country-specific urban and rural population data were combined with the corresponding prevalence data in each 5-year age group to calculate the number of people with