A 40-Year Forecast of the Demographic Shift in Primary Open-Angle Glaucoma in the United States

Thasarat S. Vajaranant, Shuang Wu, Mina Torres, and Robit Varma

Glaucoma remains a leading cause of blindness worldwide. Currently, primary open-angle glaucoma (POAG), the most common type, affects 60.5 million people. Because of the aging of the world population, one estimate shows that the number of persons with glaucoma will increase to 79.6 million in 2020. An earlier meta-analysis conducted in 2003–2004 estimated that the number of persons with POAG in the United States would increase from 2.22 million in 2000 to 3.35 million in 2020. This meeting report presents a 40-year forecast of the number of persons with POAG in the United States, based on data from prevalence studies performed in the United States and from more recent population-based studies. Our forecast estimates a significant demographic shift in the number of persons with POAG in the United States. In addition, we highlight factors influencing this shift—particularly, sex and racial disparities—and we outline geographic variations in the number of persons with POAG in the United States.

The number of persons aged 40 years and older with POAG in the United States was calculated. Details of our methodology are provided elsewhere. For purposes of this meeting report, we provide a summary of the methodology here. For estimating the number of persons with POAG in the United States from 2011 to 2050, we applied age, sex, and racial and ethnic prevalence rates from selected population-based studies to U.S. population estimates from the U.S. Census. As recommended by the U.S. Census, our analyses were based on a 2008 updated version of population estimates and the 2009 updated version of population projections of the 2000 U.S. Census. Because it is unclear whether prevalence rates of POAG from studies performed outside the United States are applicable to the United States, we selected, when possible, studies that were performed in the United States only and chose not to use the pooled prevalence rates from the previously published meta-analysis. The primary criterion for study selection was that the data be from the most recent prevalence studies in the United States. Studies were included if POAG was defined on the basis of an assessment of the optic nerve, visual fields, or both. Intraocular pressure could not be used to define POAG. The detailed information on different diagnostic criteria and reasons to include or exclude each U.S. population-based study are available in our recent report. Studies used in this estimate include the Baltimore Eye Survey for non-Hispanic whites and African Americans, the Los Angeles Latino Eye Study (LALES) for Hispanics, and the Singapore Eye Study for Chinese Americans. The reasons to exclude other population-based studies in the United States were as follows: (1) The method for screening individuals did not include visual fields and so may have led to an underestimation of the prevalence of POAG (Framingham Eye Study); (2) IOP was included in the diagnostic criteria for POAG (Beaver Dam Eye Study); (3) the sample was restricted to those aged 73 years and older, and detailed criteria for optic nerve assessment such as vertical cup-to-disc ratio and symmetry for the diagnosis of POAG were not available (Salisbury Eye Evaluation); and (4) the use of statistically based criteria to define glaucomatous optic nerve damage may not provide an accurate estimate of the prevalence of POAG in Hispanics (Proyecto VER). Because there were no population-based data for Asian Americans in the United States, we included a recent population survey of Chinese residents in Singapore. This study was selected for two reasons: First, most Asians in the United States are Chinese. Second, we chose the Singapore study rather than recent prevalence studies in China because Americans and Singaporeans have similar socioeconomic characteristics, including similar income and life expectancy and have comparable governmental subsidized medical insurance. For other minorities, including American Indians, Native Alaskans, and Native Hawaiians and other Pacific Islanders, we used an unweighted pooled prevalence rate, modeled by a meta-analysis conducted by the Eye Disease Prevalence Research Group (EDPRG).

Our analysis estimates that there will be a substantial increase in the number of persons with POAG in the United States, from 2.71 million in 2011 to 7.32 million in 2050. By age group, the highest proportion will continue to be contributed by those aged 70–79 years (31% in 2011 vs. 32% in 2050). By sex, the estimated number of women to men affected by POAG will decrease from 2011 (women: 1.43 million; men: 1.28 million) to 2050 (women: 3.68 million; men: 3.64 million). By race and ethnicity, the highest proportion of the number of persons with POAG will shift from non-Hispanic whites (44%) in 2011 to Hispanics (50%) in 2050. The single largest demographic group shift will be from non-Hispanic white women in 2011 (24.7%) to Hispanic men in 2050 (25.4%). Figure 1 presents the estimated number of persons affected by POAG in the United States by sex and race or ethnicity from 2011 to 2050.

Factors Associated with Demographic Shifts

Age

Overall, the U.S. population aged 60 years and older is expected to increase significantly in the next four decades, primarily because of the aging of the “baby boomer” generation (those born between 1946 and 1964) and the increased longevity of the population. Since the prevalence of POAG rises significantly in persons 60 years of age and older, regard-
less of race or ethnicity\(^2,6-8,17-20\), the number of persons with POAG is also estimated to increase significantly.\(^3\)

**Sex**

There is no clear consensus on a sex predilection for POAG.\(^2,20,21\) Currently, more women than men are affected by the disease in the United States because of their longer life expectancy (80.8 years on average for women versus 75.7 years for men)\(^15,16\). In the next 40 years, this discrepancy in life expectancy between the sexes is expected to decrease, with a greater increase in life expectancy in men than in women. The specific impact of this reduction in the disparity in life expectancy on the number of persons with POAG will be a reduction in the difference between women and men from 11% in 2011 to 1% in 2050.

**Race and Ethnicity**

Previous reports often emphasize the high prevalence of POAG in African Americans and Hispanics.\(^6,7,20\) Although prevalence is high in those groups, the total number of non-Hispanic whites with POAG is highest, given their representation in the U.S. population. Our analysis suggests that, currently, non-Hispanic whites comprise most persons with POAG in the United States and that the single largest demographic group with POAG is non-Hispanic white women. In the next few decades, however, the demographic group contributing the largest number of persons with POAG will shift from non-Hispanic white women to Hispanic men for several reasons. First, the gap in life expectancy between women and men is expected to narrow.\(^16\) Second, Hispanics are the fastest growing U.S. minority group (37% growth for Hispanics versus 5% growth for non-Hispanic population groups combined).\(^3\) Third, there is a higher prevalence of POAG in Hispanics than in non-Hispanic whites—overall, 4.7% versus 1.7%.\(^6,7\)

According to the census, the rapid growth of the U.S. Hispanic population is mainly due to the high fertility rate and the long life expectancy of the Hispanic immigrants who arrived from 1970 to 1980 and not from current international immigration.

To test the robustness of our estimates, we performed a sensitivity analysis in which we used pooled prevalence rates from the LALES and Proyecto VER (a population-based study of Hispanics in Arizona that was excluded in the primary analysis because a statistically based definition of glaucomatous optic nerve damage was used that may have underestimated the prevalence of POAG). The pooled prevalence rate from both the LALES and the Proyecto VER yields fewer persons with POAG (−19% in 2010 and −15% in 2050). However, irrespective of which prevalence is used, in 2011, non-Hispanic whites contributed the largest proportion of persons with POAG and in 2050, Hispanics contributed the largest proportion.

**GEOGRAPHIC DISTRIBUTION OF POAG FROM 2011 TO 2050**

The three states with the highest density of persons with POAG in 2011 and with the projected highest density in 2050 were New Mexico, Texas, and Florida. However, our forecast estimates that, although the states will remain the same, the density of the number of persons with POAG in these states will double, from 2.5% to 3% in 2011 to 5% to 6% in 2050. The underlying population in these states is primarily non-Hispanic whites, especially elderly non-Hispanic whites and Hispanics.

Given these high densities, both currently and in the future, attention should be directed toward these states for a higher yield from population-based glaucoma screening and intervention programs.
Acknowledgments

The authors thank Joanne Katz, James Tielsch, and Tien Wong for providing data for POAG prevalence rates from the Baltimore Eye Survey and a population survey of Chinese residents in the Tanjong Pagar district, Singapore.

References