Updates on the Epidemiology of Age-Related Macular Degeneration

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Abstract: This meta-analysis reports on current estimates of the prevalence of age-related macular degeneration (AMD) based on a review of recent meta-analyses and literature research. Within an age of 45–85 years, global prevalences of any AMD, early AMD, and late AMD were 8.7% [95% credible interval (CrI), 4.3–17.4], 8.0% (95% CrI, 4.0–15.5), and 0.4% (95% CrI, 0.2–0.8). Early AMD was more common in individuals of European ancestry (11.2%) than in Asians (6.8%), whereas prevalence of late AMD did not differ significantly. AMD of any type was less common in individuals of African ancestry. The number of individuals with AMD was estimated to be 196 million (95% CrI, 140–261) in 2020 and 288 million (95% CrI, 205–399) in 2040. The worldwide number of persons blind (presenting visual acuity < 3/60) or with moderate to severe vision impairment (MSVI; presenting visual acuity < 6/18 to 3/60 inclusive) due to macular disease in 2010 was 2.1 million [95% uncertainty interval (UI), 1.9–2.7] individuals out of 32.4 million individuals blind and 6.0 million (95% UI, 5.2–8.1) persons out of 191 million people with MSVI. Age-standardized prevalence of macular diseases as cause of blindness in adults aged 50+ years worldwide decreased from 0.2% (95% UI, 0.2–0.2) in 1990 to 0.1% (95% UI, 0.1–0.2) in 2010; as cause for MSVI, it remained mostly unchanged (1990: 0.4%; 95% UI, 0.3–0.5; 2010: 0.4%; 95% UI, 0.4–0.6), with no significant sex difference. In 2015, AMD was the fourth most common cause of blindness globally (in approximately 5.8% of blind individuals) and third most common cause for MSVI (3.9%). These data show the globally increasing importance of AMD.

Key Words: age-related macular degeneration, macular disease, macular degeneration, myopic maculopathy, Global Burden of Disease Study

(*Asia-Pac J Ophthalmol* 2017;6:493–497)

Due to longer life expectancy and general ageing of populations, maculopathies and in particular age-related macular degeneration (AMD) have markedly increased in their importance as causes of irreversible visual impairment and blindness within the past 2 decades.[1–48] As a progressive chronic disease of the central retina, AMD leads to visual loss mostly in its medium-advanced and late stages due to a loss of retinal pigment epithelium cells and closure of the choriocapillaris in eyes with geographic atrophy and/or due to a scar formation in the macular region in association with a choroidal neovascularization in the foveal region. These changes result in a central relative or absolute scotoma, though the peripheral visual field is usually not affected.[49] Since landmark clinical trials demonstrated the therapeutic benefit of intravitreally applied antibodies against vascular endothelial growth factor (VEGF) in 2006, repeated intravitreal injections of ranibizumab, bevacizumab, aflibercept, and conbercept significantly improved vision in patients treated as compared with untreated patients of control groups.[50–52] Correspondingly, recent population-based data have suggested that legal AMD-related blindness has been reduced by 50% in some countries since the introduction of VEGF antagonists.[53,54]

Population-based investigations have revealed that age-related macular degeneration as the most common form of maculopathy is a major cause of vision loss in elderly people and that it shows a steep increase in its prevalence beyond an age of 75 years.[3,8,13,23,25,42] The meta-analysis conducted by Wong and colleagues[42] suggested that AMD, as the most common cause of blindness in developed countries, was responsible for 8.7% of all global blindness. The present study was undertaken to summarize and update the findings obtained in previous studies.

MATERIALS AND METHODS

For the meta-analyses that formed the main basis of this report, and also for the search performed for this report itself, articles reporting on the prevalence of AMD were looked for using the electronic databases of PubMed, Web of Science, and Embase. Search words applied were macular degeneration, age-related maculopathy or macular degeneration, and prevalence or epidemiology or cross-sectional studies or cohort studies. That search strategy was also employed in the previous landmark study performed by Wong and associates on the same topic in 2014.[42] In addition, the results of the Global Vision Database were used as another pillar of this report.[35,36,47,55–65] The Global Vision Database of the Vision Loss Expert Group is based on articles published between 1980 and 2015 as described in detail previously.[35,36] As also reported previously, trends in the causes of vision impairment were estimated. This included uncertainties, stratified by age, sex, and geographical region. One differentiated among 21 regions globally as defined by the Global Burden of Disease Study.[35]

RESULTS

The number of individuals affected by AMD was estimated in the landmark study by Wong and colleagues.[42] That meta-analysis

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Received for publication June 25, 2017; accepted August 7, 2017.
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The authors have no other funding or conflicts of interest to declare.
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ISSN: 2162-0989
DOI: 10.22608/APO.2017251

revealed that, within an age range of 45–85 years, early- and late-stage AMD together had a prevalence of 8.69% [95% credible interval (CrI), 4.26–17.40] with a prevalence of early-stage of AMD of 8.01% (95% CrI, 3.95–15.49) and a prevalence of late-stage AMD of 0.37% (0.18–0.77). Early-stage AMD occurred more frequently in individuals of European ancestry (11.2%) than in Asian individuals (6.8%), and correspondingly, any AMD was more common in populations of European ancestry (12.3%) than of Asian ancestry (7.4%). Early AMD, late AMD (12.3% versus 7.5%), or any AMD were markedly less common in populations of African ancestry than in populations of European ancestry. Men and women did not differ significantly in the prevalence of any type of AMD.

If the late stage of AMD was stratified into geographic atrophy and neovascular AMD, geographic atrophy was more common among Europeans (1.11%; 95% CrI, 0.53–2.08) than among Africans (0.14%; 95% CrI, 0.04–0.45), Asians (0.21%; 95% CrI, 0.04–0.87), and Hispanics (0.16%; 95% CrI, 0.05–0.46), whereas neovascular AMD did not differ between various ethnic groups. The association of a higher prevalence of AMD with older age was not linear but showed a more pronounced increase beyond the age of 75 years in all ethnicities examined. It held true in particular for the late stage of AMD, especially in individuals of European descent. This suggested a nonlinear relationship of the prevalence of AMD with age.

The meta-analysis by Wong and colleagues[42] estimated that the projected number of individuals with AMD would be 196 million (95% CrI, 140–261) in the year 2020 and 288 million (95% CrI, 205–399) in the year 2040. Per geographical region, the number of patients afflicted by AMD in the year 2040 was expected to be highest in Asia (113 million; 95% CrI, 60–203), followed by Europe (69 million; 95% CrI, 40–109), Africa (39 million; 95% CrI, 12–93), Latin America and the Caribbean (39 million; 95% CrI, 15–82), North America (25 million; 95% CrI, 15–38), and finally Oceania (2 million; 95% CrI, 1–5).

The number of persons being blind or visually impaired due to AMD was estimated in the meta-analysis performed by the Vision Loss Expert Group for the year 2010.[35,36] Macular diseases, namely AMD, were the cause of blindness (defined as presenting visual acuity worse than 3/60) for 2.1 million [95% uncertainty interval (UI), 1.9–2.7] individuals out of 32.4 million blind individuals worldwide, and AMD was the cause for moderate to severe vision impairment (MSVI; defined as presenting visual acuity worse than 6/18 to 3/60 inclusive) in 6.0 million (95% UI, 5.2–8.1) persons out of 191 million people with moderate to severe visual impairment.[62] The increase in the number of persons being blind due to macular diseases from 1990 to 2010 was 36% (or 0.6 million), and the increase in the number of visually impaired persons was 81% (or 2.7 million). Because the global population increased by 30% during the period from 1990 to 2010, the increase in the number of people affected by AMD was mainly due to the increase in population and, additionally, due to ageing of the population. Correspondingly, the world population aged 50+ years increased by 60%; the number of people aged 50+ years and blind due to macular diseases increased by 31% from 1.6 million in 1990 to 2.1 million in 2010, and the number of individuals with MSVI caused by macular diseases increased by 62% from 3.3 million in 1990 to 6.0 million in 2010.[62]

In 2010, macular diseases, namely AMD, were the cause of blindness in 6.6% of all blind individuals and were the cause for MSVI in 3.1% of all visually impaired persons.[62] The proportion of blindness caused by macular diseases including AMD showed a geographic variation. It was lowest in South Asia (<3%) and highest in high-income Asia-Pacific countries (19.5%), followed by southern Latin America (19.5%), Australasia (17.7%), high-income North America (16.4%), and Western Europe (16.1%). In a parallel manner, Australasia (8.0%) showed the highest proportion of MSVI caused by macular diseases, followed by Central Europe (7.4%), southern Latin America (7.2%), high-income Asia-Pacific countries (6.0%), high-income North America (5.5%), and finally South and Southeast Asia (<2%) and the Caribbean (<2%). This ranking followed the tendency that world regions with older populations, such as the high-income regions and southern Latin America, as compared with world regions with younger populations showed a higher percentage of blindness and MSVI caused by macular diseases, namely AMD.[62]

In the year 2010 as compared with the year 1990, the percentage of blindness and of MSVI related to macular diseases, namely AMD, as compared with all causes of blindness and MSVI increased globally from 4.9% to 6.6% and from 1.9% to 3.1%, respectively. With the exception of Western Europe and high-income North America with constant figures, most other world regions experienced an increase in the proportion of global blindness and MSVI caused by macular diseases, namely AMD, in the period from 1990 to 2010.[62]

Age-standardized figures of prevalence of macular diseases, namely AMD, as a cause of blindness in adults aged 50+ years worldwide showed a reduction from 0.2% (95% UI, 0.2–0.2) in 1990 to 0.1% (95% UI, 0.1–0.2) in 2010, whereas the corresponding age-adjusted figures for MSVI remained mostly unchanged in the period [1990: 0.4% (95% UI, 0.3–0.5); 2010: 0.4% (95% UI, 0.4–0.6)]. Differentiating between men and women showed that macular diseases (namely AMD) caused 7.3% (95% UI, 6.4–8.9%) of blindness among women and 5.5% (95% UI, 4.8–6.8%) of blindness among men.

A recent meta-analysis performed by the Vision Loss Expert Group revealed that in the year 2015 AMD was the fourth most common cause of blindness (defined as presenting visual acuity less than 3/60 in the better eye) globally (causing blindness in approximately 5.8% of blind individuals) after cataract, undercorrection of refractive errors, and glaucoma (unpublished data). The estimated figures for 2020 suggested a similar ranking. In the ranked list of causes of MSVI (defined as visual acuity in the better eye lower than 6/18 but at least 3/60 at presentation), AMD ranked third (3.9%) after undercorrected refractive error and cataract, and it was followed by glaucoma (unpublished data).

DISCUSSION

The analysis of the existing literature and recent meta-analyses of the prevalence of AMD revealed that, within an age range of 45–85 years, the global prevalence of any type of AMD was approximately 8.7%, with the prevalence of early AMD being 8.0% and the prevalence of late AMD being 0.4%. Early AMD was more common in individuals of European ancestry than in Asians or in Africans, whereas the prevalence of the late stage of AMD did not differ significantly between Europeans and Asians. In individuals of African ancestry, the prevalence of any AMD was lowest. A marked increase in the prevalence of late AMD was noted for the age group of 75+ years, in particular in individuals

of European descent. Globally, the number of individuals affected by AMD was forecasted to increase to 196 million in 2020 and to 288 million in the year 2040.[42] In 2010, AMD (besides other macular diseases) was the cause of blindness or MSVI in 2.1 million individuals out of 32.4 million blind individuals worldwide and 6.0 million persons out of 191 million people with MSVI. Age-standardized prevalence of macular diseases, namely AMD, as a cause of blindness in adults aged 50+ years worldwide decreased from 0.2% in 1990 to 0.1% in 2010, and as a cause for MSVI, it remained mostly unchanged at a value of 0.4%, with no significant difference between men and women. In 2015, AMD was the fourth most common cause of blindness globally (causing blindness in approximately 5.8% of blind individuals) after cataract, undercorrection of refractive errors, and glaucoma. It was the third most common cause for MSVI (3.9%) after undercorrected refractive error and cataract.

The ethnic difference in the prevalence of AMD as summarized in the present study is in agreement with previous studies, such as the Baltimore Eye Study or another multiethnic population-based study in the USA, which showed a significantly lower prevalence of any type of AMD in individuals of African ancestry than in people of European ancestry.[16,26] In the Baltimore Eye Study, persons of European ancestry were more likely to have early and late AMD than those of African ancestry.[11] Two meta-analyses conducted in populations of European and Asian ancestry suggested that among persons aged 40–79 years, the age-specific prevalence of late AMD was similar in Asians (0.56%) and Europeans (0.59%), whereas early AMD was less common among Asians (6.8%) than in Europeans (8.8%).[25,31]

Sex was not markedly associated with the prevalence of AMD or with the frequency of AMD as a cause for vision impairment or blindness. In some previous studies, female sex was considered a weak risk factor for late AMD.[63,64] The finding of the present study summarizing previous meta-analyses agrees with the results of previous investigations on individuals of European ancestry, who did not show a significant sex difference in the prevalence of neovascular age-related macular degeneration or geographic atrophy.[65] It is also in agreement with other studies on Asians.[14,21,22]

The global overall increase in the number of people affected by blindness due to AMD, despite the reduction in its age-adjusted prevalence, was due to the worldwide demographic transition with increasing population size, substantial increase in the average age in most regions, and falling death rates.[66] As the drop in the age-standardized prevalence of macular degeneration–related blindness by 50 relative percent took place mostly in the high-income regions, one may infer that it was due to the clinical introduction of intravitreally applied anti-VEGF drugs.[50–53] Corresponding to the decrease in the age-standardized prevalence of macular degeneration–related blindness, the high-income regions of North America and Western Europe showed a stable percentage of blindness caused by macular degeneration in the period from 1990 to 2010, whereas most other regions experienced an increase. The reduction in the age-standardized prevalence of macular degeneration–related blindness (and the stable figures for visual impairment) was markedly less profound than the global decrease in the age-standardized prevalences of blindness due to cataract, undercorrected refractive error, and trachoma.[35,62]

The increasing number of patients with late AMD, in particular neovascular AMD, will markedly increase the necessity of sufficient financial funds to treat this stage of the disease as is currently performed by intravitreal application of anti-VEGF. Future developments will show whether a more common use of inexpensive bevacizumab in an off-label fashion and/or the expiration of patent rights for ranibizumab and other approved drugs in several years will have an effect on the general availability of this hitherto only proven treatment for neovascular AMD. In that context, it may also be of interest that the steepest rise in the number of patients with late AMD will be in Asia due to the foreseeable demographic development. The future increase in the prevalence of AMD may be most marked in regions that actually have a relatively young population and where ageing of the population has just started, in contrast to regions that already now have a relatively old population. One may also consider that the impact of anti-VEGF therapy in these areas in Asia where polypoidal choroidal vasculopathy is a predominant subtype is less certain.

From 1990 onwards, the percentage of individuals blind or visually impaired due to AMD in comparison with the total number of blind or visually impaired people has continuously increased, reflecting the success in reducing the amount of blindness and vision impairment due to cataract and refractive error. Preliminary data as assessed by the Vision Loss Expert Group revealed that in the year 2015 AMD was globally the fourth most common cause of blindness and the third most common cause of MSVI. This shows the future importance of AMD for public health. If one anticipates that treatment modalities may also become available for the nonexudative forms of AMD, for which currently no treatments exist, the treatment costs for AMD may further increase in future. Several therapies directed against geographic atrophy as one form of late AMD are currently under development, and their potential impact on the incidence of blindness due to geographic atrophy of the macula will need to be evaluated in future studies.

Limitations of our study should be mentioned. First, most primary studies did not differentiate reliably between polypoidal choroidal vasculopathy and exudative age-related macular degeneration, which upon ophthalmoscopy can have a similar appearance. This might have led to an overestimation of the prevalence of late AMD in the Asian subgroup in the present study, as polypoidal choroidal vasculopathy is more common in Asians than in Europeans.[44,45,67] Second, by the same token, some studies did not clearly differentiate between AMD and myopic maculopathy as causes for blindness or vision impairment. Again, this might have led to an overestimation of AMD as a cause for blindness or vision impairment. Third, a major limitation was that many country-years remained without data or only had subnational data. Only a few national studies reporting vision impairment for all ages and all causes including AMD were available. Fourth, another limitation was that the number of patients with late AMD was relatively small in the primary studies, so that the statistical power of the statistical analysis was limited. Fifth, some population-based studies reported only the major cause of blindness or vision impairment so that in an individual with cataract and AMD, only cataract might have been noted as the cause of vision impairment. Additionally, in eyes with dense cataract, lens opacification might have prevented a clear examination of the fundus and the detection of concomitant AMD. This may have resulted in an underestimation of the prevalence of AMD.

In conclusion, these data show the increasing global importance of AMD as a visually disabling disease, which may be more common in individuals of European descent than in Asians or in

people of African ancestry. In particular, the prevalence of late AMD showed a nonlinear increase after the age of 75 years, in particular in people of European descent. The percentage of AMD in total blindness and MSVI was higher in high-income regions with relatively older populations. In view of the globally ageing population, it is expected that the prevalence of AMD as a blinding disease will increase, in particular in regions with a still relatively young population. The stable prevalence of macular degeneration–related blindness and MSVI in some high-income regions despite increasing ageing might have been due to the therapeutic success of intravitreal medication.

REFERENCES

1. Gibson JM, Rosenthal AR, Lavery J. A study of the prevalence of eye disease in the elderly in an English community. *Trans Ophthalmol Soc UK.* 1985;104:196–203.
2. Rouhiainen H, Terasvirta M. Kuopio eye survey (KEYS). *Acta Ophthalmol (Copenh).* 1990;68:554–558.
3. Klein R, Klein BE, Linton KL. Prevalence of age-related maculopathy. The Beaver Dam Eye Study. *Ophthalmology*. 1992;99:933–943.
4. Das BN, Thompson JR, Patel R, et al. The prevalence of eye disease in Leicester: a comparison of adults of Asian and European descent. *J R Soc Med.* 1994;87:219–222.
5. Vinding T. Age-related macular degeneration. An epidemiological study of 1000 elderly individuals. With reference to prevalence, funduscopic findings, visual impairment and risk factors. *Acta Ophthalmol Scand Suppl*. 1995;217:1–32.
6. Vingerling JR, Dielemans I, Hofman A, et al. The prevalence of age-related maculopathy in the Rotterdam Study. *Ophthalmology.* 1995;102:205–210.
7. Ramrattan RS, Wolfs RC, Panda-Jonas S, et al. Prevalence and causes of visual field loss in the elderly and associations with impairment in daily functioning: the Rotterdam Study. *Arch Ophthalmol.* 2001;119:1788–1794.
8. Mitchell P, Smith W, Attebo K, et al. Prevalence of age-related maculopathy in Australia. The Blue Mountains Eye Study. *Ophthalmology*. 1995;102: 1450–1460.
9. Mitchell P, Hayes P, Wang JJ. Visual impairment in nursing home residents: the Blue Mountains Eye Study. *Med J Aust.* 1997;166:73–76.
10. Klein R, Klein BE, Cruickshanks KJ. The prevalence of age-related maculopathy by geographic region and ethnicity. *Prog Retin Eye Res.* 1999; 18:371–389.
11. Friedman DS, Katz J, Bressler NM, et al. Racial differences in the prevalence of age-related macular degeneration: the Baltimore Eye Survey. *Ophthalmology.* 1999;106:1049–1055.
12. Van der Pols JC, Bates CJ, McGraw PV, et al. Visual acuity measurements in a national sample of British elderly people. *Br J Ophthalmol.* 2000;84: 165–170.
13. Klaver CC, Assink JJ, van Leeuwen R, et al. Incidence and progression rates of age-related maculopathy: the Rotterdam Study. *Invest Ophthalmol Vis Sci.* 2001;42:2237–2241.
14. Oshima Y, Ishibashi T, Murata T, et al. Prevalence of age related maculopathy in a representative Japanese population: the Hisayama Study. *Br J Ophthalmol.* 2001;85:1153–1157.
15. Bressler NM. Age-related macular degeneration is the leading cause of blindness. *JAMA.* 2004;291:1900–1901.
16. Klein R, Klein BE, Knudtson MD, et al. Prevalence of age-related macular degeneration in 4 racial/ethnic groups in the multi-ethnic study of atherosclerosis. *Ophthalmology.* 2006;113:373–380.
17. Augood CA, Vingerling JR, de Jong PT, et al. Prevalence of age-related maculopathy in older Europeans: the European Eye Study (EUREYE). *Arch Ophthalmol.* 2006;124:529–535.
18. Iwase A, Araie M, Tomidokoro A, et al. Prevalence and causes of low vision and blindness in a Japanese adult population: the Tajimi Study. *Ophthalmology.* 2006;113:1354–1362.
19. Xu L, Wang Y, Li Y, et al. Causes of blindness and visual impairment in an urban and rural area in Beijing: the Beijing Eye Study. *Ophthalmology.* 2006;113:1141.e1–e3.
20. Maruko I, Iida T, Saito M, et al. Clinical characteristics of exudative age-related macular degeneration in Japanese patients. *Am J Ophthalmol.* 2007; 144:15–22.
21. Kawasaki R, Wang JJ, Aung T, et al. Prevalence of age-related macular degeneration in a Malay population: the Singapore Malay Eye Study. *Ophthalmology.* 2008;115:1735–1741.
22. Chen SJ, Cheng CY, Peng KL, et al. Prevalence and associated risk factors of age-related macular degeneration in an elderly Chinese population in Taiwan: the Shihpai Eye Study. *Invest Ophthalmol Vis Sci.* 2008;49:3126–3133.
23. Wong TY, Chakravarthy U, Klein R, et al. The natural history and prognosis of neovascular age-related macular degeneration: a systematic review of the literature and meta-analysis. *Ophthalmology.* 2008;115:116–126.
24. Klein BE, Klein R. Forecasting age-related macular degeneration through 2050. *JAMA.* 2009;301:2152–2153.
25. Kawasaki R, Yasuda M, Song SJ, et al. The prevalence of age-related macular degeneration in Asians: a systematic review and meta-analysis. *Ophthalmology.* 2010;117:921–927.
26. Klein R, Chou CF, Klein BE, et al. Prevalence of age-related macular degeneration in the US population. *Arch Ophthalmol.* 2011;129:75–80.
27. Jenchitr W, Ruamviboonsuk P, Sanmee A, et al. Prevalence of age-related macular degeneration in Thailand. *Ophthalmic Epidemiol.* 2011;18:48–52.
28. Yang K, Liang YB, Gao LQ, et al. Prevalence of age-related macular degeneration in a rural Chinese population: the Handan Eye Study. *Ophthalmology.* 2011;118:1395–1401.
29. Nangia V, Jonas JB, Kulkarni M, et al. Prevalence of age-related macular degeneration in rural central India: the Central India Eye and Medical Study. *Retina.* 2011;31:1179–1185.
30. Wu L, Sun X, Zhou X, et al. Causes and 3-year-incidence of blindness in Jing-An District, Shanghai, China 2001-2009. *BMC Ophthalmol.* 2011;11:10.
31. Rudnicka AR, Jarrar Z, Wormald R, et al. Age and gender variations in age-related macular degeneration prevalence in populations of European ancestry: a meta-analysis. *Ophthalmology.* 2012;119:571–580.
32. He M, Abdou A, Naidoo KS, et al. Prevalence and correction of near vision impairment at seven sites in China, India, Nepal, Niger, South Africa, and the United States. *Am J Ophthalmol.* 2012;154:107–116.e1.
33. Cheung CM, Tai ES, Kawasaki R, et al. Prevalence of and risk factors for age-related macular degeneration in a multiethnic Asian cohort. *Arch Ophthalmol.* 2012;130:480–486.
34. Lim LS, Mitchell P, Seddon JM, et al. Age-related macular degeneration. *Lancet.* 2012;379:1728–1738.
35. Bourne R, Stevens GA, White RA, et al. Causes of vision loss worldwide: 1990-2010: a systematic analysis. *Lancet Global Health.* 2013;1:339–349.
36. Stevens G, White R, Flaxman SR, et al. Global prevalence of visual impairment and blindness: magnitude and temporal trends, 1990-2010. *Ophthalmology.* 2013;120:2377–2384.
37. Cheung GCM, Li X, Cheng CY, et al. Prevalence and risk factors for age-related macular degeneration in Indians: a comparative study in Singapore and India. *Am J Ophthalmol.* 2013;155:764–773.e3.
38. Klein R, Klein BE. The prevalence of age-related eye diseases and visual impairment in aging: current estimates. *Invest Ophthalmol Vis Sci.* 2013;54: ORSF5–ORSF13.
39. Cheung CM, Li X, Cheng CY, et al. Prevalence, racial variations, and risk factors of age-related macular degeneration in Singaporean Chinese, Indians,

and Malays. *Ophthalmology.* 2014;121:1598–1603.
40. Bourne RRA, Flaxman SR, Braithwaite T, et al. Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: a systematic review and meta-analysis. *Lancet Glob Health.* 2017;5:e888–e897.
41. Klein R, Myers CE, Buitendijk GH, et al. Lipids, lipid genes, and incident age-related macular degeneration: the Three Continent Age-Related Macular Degeneration Consortium. *Am J Ophthalmol.* 2014;158:513–524.e3.
42. Wong WL, Su X, Li X, et al. Global prevalence and burden of age-related macular degeneration: a meta-analysis and disease burden projection for 2020 and 2040. *Lancet Global Health.* 2014;2:e106–e116.
43. Rudnicka AR, Kapetanakis VV, Jarrar Z, et al. Incidence of late-stage age-related macular degeneration in American whites: systematic review and meta-analysis. *Am J Ophthalmol.* 2015;160:85–93.e3.
44. Wong CW, Wong TY, Cheung CM. Polypoidal choroidal vasculopathy in Asians. *J Clin Med.* 2015;4:782–821.
45. Wong CW, Yanagi Y, Lee WK, et al. Age-related macular degeneration and polypoidal choroidal vasculopathy in Asians. *Prog Retin Eye Res.* 2016;53: 107–139.
46. Taylor HR. The global issue of vision loss and what we can do about it: José Rizal Medal 2015. *Asia Pac J Ophthalmol (Phila).* 2016;5:95–96.
47. Global Vision Database. Available at: http://www.globalvisiondata.org. Accessed June 21, 2017.
48. RAAB Repository. Available at: http://www.raabdata.info. Accessed June 21, 2017.
49. Wong EN, Chew AL, Morgan WH, et al. The use of microperimetry to detect functional progression in non-neovascular age-related macular degeneration: a systematic review. *Asia Pac J Ophthalmol (Phila).* 2017;6:70–79.
50. Rosenfeld PJ, Brown DM, Heier JS, et al. Ranibizumab for neovascular age-related macular degeneration. *N Engl J Med.* 2006;355:1419–1431.
51. Rush RB, Rush SW. Ranibizumab versus bevacizumab for neovascular age-related macular degeneration with an incomplete posterior vitreous detachment. *Asia Pac J Ophthalmol (Phila).* 2016;5:171–175.
52. Koh A, Lanzetta P, Lee WK, et al. Recommended guidelines for use of intravitreal aflibercept with a treat-and-extend regimen for the management of neovascular age-related macular degeneration in the Asia-Pacific region: report from a consensus panel. *Asia Pac J Ophthalmol (Phila).* 2017;6:296–302.
53. Bressler NM, Doan QV, Varma R, et al. Estimated cases of legal blindness and visual impairment avoided using ranibizumab for choroidal neovascularization: non-Hispanic white population in the United States with age-related macular degeneration. *Arch Ophthalmol.* 2011;129:709–717.
54. Bloch SB, Larsen M, Munch IC. Incidence of legal blindness from age-related macular degeneration in Denmark: year 2000 to 2010. *Am J Ophthalmol.* 2012;153:209–213.
55. Wong TY, Zheng Y, Jonas JB, et al. Prevalence and causes of vision loss in East Asia: 1990-2010. *Br J Ophthalmol.* 2014;98:599–604.
56. Naidoo K, Gichuhi S, Basáñez MG, et al. Prevalence and causes of vision loss in Sub-Saharan Africa: 1990-2010. *Br J Ophthalmol.* 2014;98:612–618.
57. Jonas JB, George R, Asokan R, et al. Prevalence and causes of vision loss in Central and South Asia: 1990-2010. *Br J Ophthalmol.* 2014;98:592–598.
58. Leasher JL, Lansingh V, Flaxman SR, et al. Prevalence and causes of vision loss in Latin America and the Caribbean: 1990-2010. *Br J Ophthalmol.* 2014;98:619–628.
59. Khairallah M, Kahloun R, Flaxman SR, et al. Prevalence and causes of vision loss in North Africa and the Middle East: 1990-2010. *Br J Ophthalmol.* 2014; 98:605–611.
60. Bourne RR, Jonas JB, Flaxman SR, et al. Prevalence and causes of vision loss in high-income countries and in Eastern and Central Europe: 1990-2010. *Br J Ophthalmol.* 2014;98:629–638.
61. Keeffe J, Taylor HR, Pesudovs K, et al. Prevalence and causes of vision loss in Southeast Asia and Oceania: 1990-2010. *Br J Ophthalmol.* 2014; 98:586–591.
62. Jonas JB, Bourne RR, White RA, et al. Visual impairment and blindness due to macular diseases globally: a systematic review and meta-analysis. *Am J Ophthalmol.* 2014;158:808–815.
63. Chakravarthy U, Wong TY, Fletcher A, et al. Clinical risk factors for age-related macular degeneration: a systematic review and meta-analysis. *BMC Ophthalmol.* 2010;10:31.
64. Evans JR. Risk factors for age-related macular degeneration. *Prog Retin Eye Res.* 2001;20:227–253.
65. Smith W, Assink J, Klein R, et al. Risk factors for age-related macular degeneration: pooled findings from three continents. *Ophthalmology.* 2001; 108:697–704.
66. Murray CJ, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet.* 2012;380:2197–223.
67. Maruko I, Iida T, Saito M, et al. Clinical characteristics of exudative age-related macular degeneration in Japanese patients. *Am J Ophthalmol.* 2007; 144:15–22.