Visual impairment and blindness due to macular diseases globally: a systematic review and meta-analysis

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Visual Impairment and Blindness Due to Macular Diseases Globally: A Systematic Review and Meta-Analysis

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• PURPOSE: To estimate the number of people visually impaired or blind due to macular diseases except those caused by diabetic maculopathy.

• DESIGN: Meta-analysis.

• METHODS: Based on the Global Burden of Disease Study 2010 and ongoing literature research, we examined how many people were affected by vision impairment (presenting visual acuity <6/18, ≥3/60) and blindness (presenting visual acuity <3/60) due to macular diseases, with diabetic maculopathy excluded.

• RESULTS: In 2010, of 32.4 million blind people and 191 million vision-impaired people, 2.1 million (95% uncertainty interval [UI]: 1.9, 2.7) people were blind, and 6.0 million (95% UI: 5.2, 8.1) million were visually impaired due to macular diseases. In 2010, macular diseases caused 6.6% (95% UI: 6.0, 7.9) of all blindness and 3.1% (95% UI: 2.7, 4.0) of all vision impairment, worldwide. These figures were lower in regions with young populations than in high-income regions. Between 1990 and 2010, the number of people who were blind or visually impaired due to macular diseases increased by 36%, or 0.6 million people (95% UI: 0.5, 0.8) and by 81%, or 2.7 million (95% UI: 2.6, 3.9) people, respectively, whereas the global population increased by 30%. Age-standardized global prevalence of macula-related blindness and vision impairment in adults 50 years of age and older decreased from 0.2% (95% UI: 0.2, 0.2) in 1990 to 0.1% (95% UI: 0.1, 0.2) in 2010 and remained unchanged from 0.4% (95% UI: 0.3, 0.5) to 0.4% (95% UI: 0.4, 0.6), respectively.

• CONCLUSIONS: In 2010, 2.1 million people were blind and 6.0 million people were visually impaired due to macular diseases, except those caused by diabetic maculopathy. Of every 15 blind people, 1 was blind due to macular disease, and of every 32 visually impaired people, 1 was visually impaired due to macular disease. (Am J Ophthalmol 2014;158:808–815. © 2014 by Elsevier Inc. All rights reserved.)

MACULAR DISEASES, IN PARTICULAR, AGE-related macular degeneration, have profoundly increased in importance in public health, because of generally aging populations, and in clinics, because of the development of new treatments. In particular, large randomized controlled trials have shown the efficacy of intravitreal antivascular endothelial growth factor drugs against exudative age-related macular degeneration and myopic maculopathy.[1–3] Population-based studies performed in all regions worldwide and meta-analyses of these studies have revealed that macular diseases, in particular age-related macular degeneration, are a major cause of vision loss in elderly people, with a steep increase in prevalence beyond the age of 75 years.[4–9] It has been estimated that age-related macular degeneration alone is responsible for 8.7% of all global blindness and that it is the most common cause of blindness in developed countries,[4–9] particularly in elderly people older than 60 years of age. However, previous studies had some limitations. For example, these estimations were based on meta-analyses that did not include studies from all regions of the world, did not comprise all available population-based studies, did not assess changes during the past 2 decades, and did not report the number of people blind or visually impaired due to macular diseases. For public health purposes, however, the number of patients functionally affected is more important than the number of patients with any stage of the disease because the burden of a disease as compared to the presence of a disease is of particular importance for the individual patient and for the society in general.

As part of the Global Burden of Disease Study, we conducted this meta-analysis of all available population-based

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studies performed worldwide within the past 2 decades and assessed the number of people affected by blindness and moderate to severe visual impairment due to macular diseases except macular changes due to diabetic retinopathy. We evaluated changes in that figure during the period from 1990 to 2010, examined regional differences in the prevalence of blindness and moderate and severe vision impairment related to macular diseases, and finally compared the number of people blind and visually impaired due to macular diseases with the number of people blind and visually impaired due to other diseases.

METHODS

WE SYSTEMATICALLY REVIEWED ARTICLES PUBLISHED between January 1980 and January 2012, we primarily identified 14 908 relevant manuscripts out of which 243 articles of high-quality, population-based studies remained after application of rigorous selection criteria and review by an expert panel.[10,11] The study was approved by the ethics committee II of the Medical Faculty Mannheim of the University of Heidelberg. We used MEDLINE, Embase and the World Health Organization library information system. We found additional unpublished data sources through personal communication with researchers identified in the literature search. The method applied in our study has been described in detail recently.[10,11] Of the 243 high-quality population-based studies, 128 studies reported prevalence of blindness and moderate and severe visual impairment disaggregated by cause. These formed the database for calculating the proportion of blindness and moderate and severe visual impairment that was due to macular diseases. Macular diseases were defined as any disorder of the macula or posterior pole, except macular changes due to diabetic retinopathy. It included such disorders as age-related macular degeneration, myopic maculopathy and macular holes. A full list of data sources used for macular diseases and other causes of blindness and moderate and severe visual impairment has been presented recently.[9] At least 2 studies were identified for 18 of 21 Global Burden of Disease Study regions, but there were no studies with cause-specific data identified in 2 of the regions (central Africa and east Europe), and only 1 study was identified for central Europe. No study reporting prevalence separated by cause was identified for 126 of 191 countries. Blindness was defined as presenting visual acuity less than 3/60 in the better eye, and moderate to severe visual impairmentwas defined as visual acuity in the better eye lower than 6/18 but at least 3/60 at presentation.

As also described in detail previously, we estimated trends in causes of vision impairment, including analysis of uncertainties by age, gender and geographic region in 21 regions as defined by the Global Burden of Disease Study.[10–12] The statistical analysis was performed in 3 steps. The first step included the data identification and access; the second step consisted of the estimation of fractions for each cause, stratified by the severity of vision impairment, gender, age, and region; and the third step included the application of cause fractions to the prevalence of all-cause presenting vision impairment, which has been assessed previously.[10] For the statistical analysis, the DisMod-MR model from the Global Burden of Disease was used to calculate the fraction of moderate to severe visual impairment due to macular diseases. It has been described in detail recently.[9,10] Briefly, DisMod-MR is a negative binomial regression model that includes the following elements: covariates that predict variation in the true proportion of moderate to severe visual impairment caused by each disease (eg, year); fixed effects that adjust for definitional differences (eg, whether the causes of presenting vs best-corrected moderate to severe visual impairment were reported); a hierarchical model structure that fits random intercepts in individual countries derived from the data observed in the country, in its region and in other regions, based on the availability and consistency of country- and region-specific data; age-specific fixed-effects allowing for a nonlinear age pattern; and a fixed effect for data on males. For the assessment of the fractions of blindness and moderate to severe visual impairment due to macular diseases, we fit one DisMod-MR model using 3 covariates: an indicator variable describing whether the data were for blindness or for vision impairment; an indicator variable describing whether the data were based on presenting visual acuity or best-corrected visual acuity measurements; and a country-level covariate reflecting health-systems access. We made 2 sets of the prediction for macular diseases, 1 for best-corrected blindness and 1 for best-corrected vision impairment. For the presentation of the data, we age-standardized prevalences using the World Health Organization reference population.[13] We also calculated the numbers of people with moderate to severe visual impairment and blindness due to macular diseases, which reflected each region's population size and age structure.

RESULTS

OF 32.4 MILLION PEOPLE WHO WERE BLIND AND 191 MILLION people who were vision impaired in 2010,[9] 2.1 million (95% uncertainty interval (UI): 1.9, 2.7) people were blind, and 6.0 million (95% UI: 5.2, 8.1) million were visually impaired due to macular diseases, worldwide (Table 1).

Between 1990 and 2010, the number of people blind due to macular diseases increased by 0.6 million people, or 36%, and the number of visually impaired people by 2.7 million people, or 81%. During the same period the global population increased by 30% (Table 1, Table 2). For people 50 years of age or older, the number of those blind due to

TABLE 1. Number of People (Mean, 95% Uncertainty Interval) Blind (Presenting Visual Acuity <3/60) or Visually Impaired (Presenting Visual Acuity <6/18, ≥3/60) Due to Macular Diseases (Except Those of Diabetic Maculopathy) and the Age-Standardized Prevalences (Mean, 95% Uncertainty Interval) in Various World Regions in 2010

World Region	Blindness/ Moderate to Severe Vision Impairment	Total Population 2010	Number of People Affected in 2010			Age-Standardized Prevalence in People Aged 50+ Years in 2010			Proportion of Blindness/Visual Impairment by Macular Diseases in 2010
			Mean Value	Lower Value	Upper Value	Mean Value	Lower Value	Upper Value	
World	Blind	6 890 000 000	2 135 900	1 874 080	2 652 650	0.10%	0.10%	0.20%	6.6 (6.0, 7.9)
Asia Pacific, high income	Blind	169 000 000	68 808	34 615	133 321	0.10%	0.00%	0.10%	19.5 (12.3, 28.8)
Asia, central	Blind	68 800 000	17 946	12 037	29 639	0.10%	0.10%	0.20%	13.3 (9.4, 18.1)
Asia, east	Blind	1 190 000 000	363 866	227 258	611 335	0.10%	0.10%	0.20%	6.9 (4.5, 11.0)
Asia, south	Blind	1 120 000 000	270 230	172 783	451 290	0.10%	0.10%	0.30%	2.6 (1.7, 4.2)
Asia, southeast	Blind	460 000 000	205 091	148 128	301 749	0.20%	0.20%	0.40%	5.9 (4.7, 8.3)
Australasia	Blind	20 500 000	6 798	3668	18 919	0.10%	0.00%	0.20%	17.7 (11.1, 26.3)
Caribbean	Blind	34 300 000	12 052	7889	18 191	0.10%	0.10%	0.20%	6.1 (4.3, 8.9)
Europe, central	Blind	122 000 000	50 473	34 339	104 998	0.10%	0.10%	0.20%	15.4 (10.9, 20.8)
Europe, east	Blind	222 000 000	97 783	44 030	183 929	0.10%	0.10%	0.20%	16.6 (10.1, 25.1)
Europe, west	Blind	381 000 000	153 855	104 094	248 279	0.10%	0.00%	0.10%	16.1 (12.5, 20.1)
Latin America, Andean	Blind	38 600 000	12 170	6818	20 579	0.10%	0.10%	0.30%	6.2 (4.1, 9.2)
Latin America, central	Blind	166 000 000	61 650	40 193	96 914	0.20%	0.10%	0.30%	6.8 (4.9, 9.9)
Latin America, south	Blind	48 900 000	44 020	29 376	71 964	0.20%	0.20%	0.40%	19.5 (13.2, 26.8)
Latin America, tropical	Blind	154 000 000	72 557	39 743	147 788	0.20%	0.10%	0.40%	9.1 (5.7, 13.3)
North Africa/Middle East	Blind	301 000 000	320 335	216 494	468 902	0.60%	0.40%	0.90%	10.3 (7.8, 13.6)
North America, High Income	Blind	281 000 000	77 690	44 574	131 585	0.00%	0.00%	0.10%	16.4 (10.8, 23.4)
Oceania	Blind	5 814 186	1505	819	2766	0.20%	0.10%	0.40%	4.6 (3.1, 7.6)
Sub-Saharan Africa, central	Blind	53 400 000	19 499	9712	42 318	0.30%	0.20%	0.70%	6.9 (4.7, 11.0)
Sub-Saharan Africa, east	Blind	208 000 000	120 884	83 741	170 573	0.50%	0.30%	0.70%	5.8 (4.6, 7.7)
Sub-Saharan Africa, south	Blind	52 600 000	29 100	14 092	45 385	0.40%	0.20%	0.60%	9.7 (6.7, 14.1)
Sub-Saharan Africa, west	Blind	201 000 000	131 012	91 407	183 939	0.60%	0.40%	0.80%	6.2 (4.8, 8.4)
World	MSVI	6 890 000 000	5 994 300	5 174 390	8 123 310	0.40%	0.40%	0.60%	3.1 (2.7, 4.0)
Asia Pacific, high income	MSVI	169 000 000	116 405	63 028	436 778	0.10%	0.10%	0.40%	6.0 (3.8, 9.8)
Asia, central	MSVI	68 800 000	58 672	35 531	125 122	0.50%	0.30%	1.00%	5.0 (3.5, 7.5)
Asia, east	MSVI	1 190 000 000	1 744 733	1 038 766	2 775 881	0.60%	0.30%	0.90%	5.2 (3.3, 8.0)
Asia, south	MSVI	1 120 000 000	705 446	447 089	1 266 346	0.30%	0.20%	0.60%	0.98 (0.65, 1.6)
Asia, southeast	MSVI	460 000 000	334 853	213 902	675 460	0.40%	0.20%	0.80%	1.8 (1.3, 2.7)
Australasia	MSVI	20 500 000	36 571	15 682	97 066	0.30%	0.10%	0.90%	8.0 (5.1, 12.6)
Caribbean	MSVI	34 300 000	14 716	8 741	25 315	0.20%	0.10%	0.30%	1.2 (0.90, 1.9)
Europe, central	MSVI	122 000 000	246 285	129 283	518 097	0.50%	0.30%	1.10%	7.4 (5.2, 11.0)
Europe, east	MSVI	222 000 000	398 568	175 847	820 277	0.50%	0.20%	1.00%	6.8 (4.0, 10.9)
Europe, west	MSVI	381 000 000	402 828	272 912	734 163	0.20%	0.10%	0.30%	5.4 (4.1, 7.5)
Latin America, Andean	MSVI	38 600 000	42 917	25 322	73 210	0.50%	0.30%	0.90%	3.1 (2.0, 5.1)
Latin America, central	MSVI	166 000 000	161 750	100 899	258 897	0.40%	0.30%	0.70%	3.2 (2.2, 5.0)
Latin America, south	MSVI	48 900 000	114 983	68 485	245 231	0.60%	0.40%	1.40%	7.2 (4.5, 11.5)
Latin America, tropical	MSVI	154 000 000	291 453	162 394	500 368	0.70%	0.40%	1.30%	6.0 (3.7, 9.2)
North Africa/Middle East	MSVI	301 000 000	558 470	385 992	890 307	1.00%	0.70%	1.60%	4.1 (3.0, 6.2)
North America, high income	MSVI	281 000 000	169 367	111 781	349 536	0.10%	0.10%	0.20%	5.5 (3.5, 8.0)
Oceania	MSVI	5 814 186	6642	3085	11 974	0.90%	0.40%	1.60%	2.7 (1.7, 4.8)
Sub-Saharan Africa, central	MSVI	53 400 000	49 922	25 693	116 494	0.80%	0.40%	1.70%	3.6 (2.1, 6.2)
Sub-Saharan Africa, east	MSVI	208 000 000	283 239	194 996	420 362	1.00%	0.70%	1.50%	4.0 (3.0, 5.5)
Sub-Saharan Africa, south	MSVI	52 600 000	45 002	25 208	91 961	0.60%	0.30%	1.10%	4.8 (2.8, 7.7)
Sub-Saharan Africa, west	MSVI	201 000 000	208 749	150 669	341 386	0.80%	0.60%	1.30%	2.9 (2.0, 4.3)

MSVI = moderate to severe vision impairment.

macular diseases increased by 31%, from 1.6 million in 1990 to 2.1 million in 2010. The number of people with moderate to severe visual impairment related to macular diseases increased by 62%, from 3.3 million in 1990 to 6.0 million in 2010. In the same period, the world population older than 50 years of age increased by 60%.

Worldwide, macular diseases caused 6.6% of all blindness in 2010 and 3.1% of all moderate to severe visual impairment (Table 1). The proportion of blindness caused by macular diseases varied from less than 3% in south Asia to 16.1% in west Europe and from 16.4% in high-income North America to 17.7% in Australasia, 19.5% in south Latin America and 19.5% in high-income Asia Pacific (Table 1). In a similar manner, the proportion of moderate to severe visual impairment caused by macular diseases varied from less than 2% in south and southeast Asia and in the Caribbean to 5.5% in high-income North America, 6.0% in high-income Asia Pacific, 7.4% in central Europe, 7.2% south Latin America, and 8.0% in Australasia (Table 1). Generally, world regions with older populations, such as the high-income regions and south Latin Americas, compared to regions with younger populations and showed a higher proportion of blindness and moderate to severe visual impairment caused by macular diseases.

Compared with 1990, the proportion of global blindness and of global moderate to severe visual impairment caused by macular diseases increased from 4.9% to 6.6% and from 1.9% to 3.1%, respectively (Table 1, Table 2). Regions with older populations, such as the high-income regions as compared to regions with younger populations, had a higher proportion of global blindness and moderate to severe visual impairment caused by macular diseases when modeled for 1990 and 2010. The increase in the proportion of global blindness and moderate to severe visual impairment caused by macular diseases from 1990 to 2010 took place in most world regions except for west Europe and high-income North America, where the contribution hardly changed (Table 1, Table 2).

The age-standardized prevalence of blindness related to macular diseases worldwide was 0.1% in adults aged 50 years or older in 2010, and the age-standardized prevalence of moderate to severe vision impairment worldwide was 0.4% (Table 1). Compared with 1990, the age-standardized prevalence of blindness was reduced from 0.2% (95% UI: 0.2, 0.2) to 0.1%, and the prevalence of moderate to severe visual impairment was mostly unchanged (1990: 0.4%; 95% UI: 0.3, 0.5) (Table 1, Table 2). With respect to gender, macular diseases caused 7.3% (6.4%–8.9%) of blindness among women vs 5.5% (4.8%–6.8%) of blindness among men.

DISCUSSION

IN 2010, OF 32.4 MILLION BLIND AND 191 MILLION VISION impaired people, 2.1 million people were blind, and 6.0 million were visually impaired due to macular diseases, excepting those of diabetic maculopathy. The age-standardized prevalence of blindness related to macular diseases worldwide in adults aged 50 years or older in 2010 was 0.1 %, and the prevalence of moderate to severe visual impairment was 0.2%. These figures complement the findings obtained in a recent meta-analysis by Wong and colleagues of the prevalence of early and late age-related macular degeneration.[9] Based on the pooled data from 39 previously published studies of 130 000 people aged 30 to 97 years, Wong and coworkers calculated a prevalence (mapped to the age range of 45 to 85) for early, late and any age-related macular degeneration of any stage to be 8.0%, 0.4% and 8.7%, respectively. Because major vision loss is usually observed only in the late stage of age-related macular degeneration, the prevalence of 0.4% of late age-related macular degeneration is broadly similar to the summed prevalence of blindness and moderate to severe visual impairment of 0.3% in our study.

Comparing 1990 with 2010, our study showed that the number of people affected by blindness and moderate to severe visual impairment related to macular diseases increased by 0.6 million, or 36%, and by 2.7 million, or 81%, respectively. The age-standardized prevalence of blindness related to macular diseases, however, was reduced by half, from 0.2% to 0.1%, while the prevalence of moderate to severe visual impairment remained unchanged (Table 1, Table 2). The global overall increase in the number of people affected by blindness due to macular diseases, despite the reduction in the prevalence, was the result of the worldwide demographic transition, with increasing population size, substantial increase in the average age in most regions, and falling death rates.[12] Because the drop in the age-standardized prevalence of blindness related to macular diseases by 50 relative percentage points took place mostly in the high-income regions, one may infer that it may have been due partially to the clinical introduction of intravitreally applied antivascular endothelial growth factor drugs.[1–3] Corresponding with the decrease in the age-standardized prevalence of blindness related to macular diseases, the high-income regions of North America and west Europe showed a stable proportion of blindness caused by macular diseases in the period from 1990 to 2010, whereas most other regions experienced increases. The reduction in the age-standardized prevalence of blindness related to macular disease (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 or trachoma.[11] It is interesting that the age-standardized prevalence of glaucoma and diabetic retinopathy declined only slightly (for blindness) or even increased slightly (for vision impairment).[11]

In the study by Wong and colleagues, early age-related macular degeneration showed a higher prevalence in Europeans than in Asians (11.2% vs 6.8%), and both early and late age-related macular degeneration were more prevalent in Europeans than in Africans (early: 11.2% vs 7.1%; late: 0.5% vs 0.3%).[9] Asians and Africans did not differ significantly in the prevalence of age-related macular degeneration. In the Baltimore Eye Study, persons of European ancestry were more likely to have early and late age-related macular degeneration than those of African ancestry.[14]

TABLE 2. Number of People (Mean, 95% Uncertainty Interval) Blind (Presenting Visual Acuity <3/60) or Visually Impaired (MSVI) (Presenting Visual Acuity <6/18, ≥3/60) Due to Macular Diseases (Except those of Diabetic Maculopathy) and the Age-Standardized Prevalences (Mean, 95% Uncertainty Interval) in Various World Regions in 1990

		Number of People Affected in 1990			Mean Difference in the Number of People Affected 2010–1990			Age-Standardized Prevalence in People Aged 50+ Years in 1990			
Region		Mean	Lower Value	Upper Value	Mean	Lower Value	Upper Value	Mean	Lower Value	Upper Value	Proportion of Blindness/Visual Impairment by Macular Diseases in 1990
World	Blind	1 568 800	1 362 100	1 892 100	567 100	511 980	760 550	0.20%	0.20%	0.20%	4.9 (4.4, 5.8)
Asia Pacific, high income	Blind	41 881	24 655	79 063	26 927	9960	54 258	0.10%	0.10%	0.20%	14.9 (10.3, 21.3)
Asia, central	Blind	23 367	16 276	34 457	−5421	−4239	−4818	0.20%	0.20%	0.40%	11.6 (8.8, 15.3)
Asia, east	Blind	301 671	184 170	494 124	62 195	43 088	117 211	0.20%	0.10%	0.30%	5.0 (3.2, 7.9)
Asia, south	Blind	134 289	97 192	183 936	135 941	75 591	267 354	0.10%	0.10%	0.20%	1.4 (1.0, 1.9)
Asia, southeast	Blind	125 835	85 007	165 079	79 256	63 121	136 670	0.30%	0.20%	0.40%	3.7 (2.9, 5.0)
Australasia	Blind	5836	3828	14 189	962	−160	4730	0.10%	0.10%	0.20%	16.8 (12.9, 22.2)
Caribbean	Blind	9319	6078	13 522	2733	1811	4669	0.20%	0.10%	0.20%	4.5 (3.4, 6.0)
Europe, central	Blind	50 232	35 204	107 356	241	−865	−2358	0.20%	0.10%	0.30%	12.2 (9.3, 15.6)
Europe, east	Blind	124 924	68 406	217 874	−27 141	−24 376	−33 945	0.20%	0.10%	0.30%	13.1 (9.1, 19.2)
Europe, west	Blind	189 652	138 762	289 270	−35 797	−34 668	−40 991	0.10%	0.10%	0.20%	16.1 (13.4, 19.6)
Latin America, Andean	Blind	7092	4375	10 862	5078	2443	9717	0.20%	0.10%	0.30%	3.7 (2.6, 5.5)
Latin America, central	Blind	38 817	26 806	56 360	22 833	13 387	40 554	0.20%	0.20%	0.30%	4.6 (3.5, 6.2)
Latin America, south	Blind	34 101	22 049	56 700	9919	7327	15 264	0.30%	0.20%	0.60%	14.6 (10.6, 19.6)
Latin America, tropical	Blind	37 026	18 701	75 476	35 531	21 042	72 312	0.20%	0.10%	0.50%	5.0 (3.1, 8.0)
North Africa/Middle East	Blind	191 239	129 163	274 038	129 096	87 331	194 864	0.80%	0.50%	1.10%	6.4 (5.2, 8.0)
North America, high income	Blind	73 840	47 458	114 618	3850	−2884	16 967	0.10%	0.00%	0.10%	16.4 (12.2, 21.4)
Oceania	Blind	915	490	1588	590	329	1178	0.30%	0.20%	0.50%	3.3 (2.3, 4.7)
Sub-Saharan Africa, central	Blind	13 322	7603	28 197	6177	2109	14 121	0.40%	0.20%	0.80%	4.8 (3.5, 7.1)
Sub-Saharan Africa, east	Blind	67 610	50 046	90 732	53 274	33 695	79 841	0.50%	0.40%	0.70%	4.1 (3.4, 5.1)
Sub-Saharan Africa, south	Blind	21 367	11 634	29 601	7733	2458	15 784	0.60%	0.30%	0.80%	6.9 (5.5, 8.9)
Sub-Saharan Africa, west	Blind	77 357	53 822	101 363	53 655	37 585	82 576	0.60%	0.40%	0.70%	4.1 (3.4, 5.4)
World	MSVI	3 307 200	2 623 500	4 181 700	2 687 100	2 550 890	3 941 610	0.40%	0.30%	0.50%	1.9 (1.6, 2.4)
Asia Pacific, high income	MSVI	55 762	33 200	194 839	60 643	29 828	241 939	0.10%	0.10%	0.40%	3.5 (2.4, 5.1)
Asia, central	MSVI	48 771	28 521	84 173	9901	7010	40 949	0.50%	0.30%	0.90%	3.3 (2.4, 4.6)
Asia, east	MSVI	989 498	523 428	1 612 265	755 235	515 338	1 163 616	0.60%	0.30%	0.90%	3.1 (1.9, 5.2)
Asia, south	MSVI	266 190	175 671	381 442	439 256	271 418	884 904	0.20%	0.20%	0.40%	0.45 (0.32, 0.61)
Asia,southeast	MSVI	149 545	99 613	229 494	185 308	114 289	445 966	0.30%	0.20%	0.50%	0.93 (0.72, 1.3)
Australasia	MSVI	26 728	12 582	64 894	9843	3100	32 172	0.40%	0.20%	1.10%	6.6 (4.6, 9.5)
Caribbean	MSVI	8475	4712	12 443	6241	4029	12 872	0.10%	0.10%	0.20%	0.74 (0.57, 1.0)
Europe, central	MSVI	179 174	89 974	310 812	67 111	39 309	207 285	0.50%	0.30%	0.90%	4.7 (3.4, 6.5)
Europe, east	MSVI	344 165	166 872	624 992	54 403	8975	195 285	0.50%	0.30%	1.00%	4.3 (2.7, 6.9)
Europe, west	MSVI	352 395	228 028	590 886	50 433	44 884	143 277	0.20%	0.20%	0.40%	4.1 (3.3, 5.2)
Latin America, Andean	MSVI	17 367	9074	27 863	25 550	16 248	45 347	0.40%	0.20%	0.70%	1.4 (0.99, 2.2)

Continued on next page

TABLE 2. Number of People (Mean, 95% Uncertainty Interval) Blind (Presenting Visual Acuity <3/60) or Visually Impaired (MSVI) (Presenting Visual Acuity <6/18, ≥3/60) Due to Macular Diseases (Except those of Diabetic Maculopathy) and the Age-Standardized Prevalences (Mean, 95% Uncertainty Interval) in Various World Regions in 1990 (*Continued*)

Region		Number of People Affected in 1990			Mean Difference in the Number of People Affected 2010–1990			Age-Standardized Prevalence in People Aged 50+ Years in 1990			Proportion of Blindness/Visual Impairment by Macular Diseases in 1990
		Mean	Lower Value	Upper Value	Mean	Lower Value	Upper Value	Mean	Lower Value	Upper Value	
Latin America, central	MSVI	74 996	43 646	114 570	86 754	57 253	144 327	0.40%	0.20%	0.60%	1.7 (1.2, 2.5)
Latin America, south	MSVI	66 571	39 350	126 099	48 412	29 135	119 132	0.60%	0.40%	1.20%	4.2 (2.9, 6.2)
Latin America, tropical	MSVI	119 970	61 511	199 545	171 483	100 883	300 823	0.70%	0.30%	1.10%	2.8 (1.7, 4.6)
North Africa/Middle East	MSVI	216 316	144 735	300 316	342 154	241 257	589 991	0.80%	0.50%	1.10%	1.8 (1.4, 2.6)
North America, high income	MSVI	132 277	93 698	231 801	37 090	18 083	117 735	0.10%	0.10%	0.20%	4.5 (3.2, 6.1)
Oceania	MSVI	2639	1363	3956	4003	1722	8018	0.70%	0.40%	1.00%	1.4 (0.99, 2.1)
Sub-Saharan Africa, central	MSVI	23 775	13 449	44 080	26 147	12 244	72 414	0.60%	0.30%	1.10%	1.9 (1.3, 2.9)
Sub-Saharan Africa, east	MSVI	128 963	95 061	184 627	154 276	99 935	235 735	0.90%	0.60%	1.20%	2.5 (1.9, 3.2)
Sub-Saharan Africa, south	MSVI	23 681	15 132	39 889	21 321	10 076	52 072	0.60%	0.40%	0.90%	2.8 (2.0, 4.2)
Sub-Saharan Africa, west	MSVI	81 348	56 217	116 564	127 401	94 452	224 822	0.50%	0.40%	0.80%	1.4 (1.1, 1.9)

MSVI = moderate to severe vision impairment.

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 age-related macular degeneration was similar in Asians (0.56%) and Europeans (0.59%), whereas early age-related macular degeneration was less common in Asians (6.8%) than in Europeans (8.8%).[8,15] In our study of the prevalence of blindness and moderate to severe visual impairment due to macular diseases, the differences among the world regions were less clear. One of the reasons for the discrepancy between the previous studies and our investigation may be that the previous studies addressed the prevalence of the disease, whereas our investigation was focused on the prevalence of blindness and moderate to severe visual impairment caused by the disease group. Another reason for the discrepancy may be that our study addressed any macular disease (except that of diabetic maculopathy), whereas the previous investigations were focused on age-related macular degeneration as the most prevalent disorder among the macular diseases. Because myopic macular degeneration is a relatively common cause for vision loss in Asians,[16–18] the potentially relatively low prevalence of age-related macular degeneration as the cause for vision loss in Asians may have been compensated for by the relatively high prevalence of myopic maculopathy as the cause for vision loss in Asians. It is interesting that the highest figures for the prevalence of macular diseases as the cause of vision loss were found for the African regions in our study. A potential reason may be wide uncertainty intervals in the estimates of studies from sub-Saharan countries because of the scarcity of data of fundus-related eye diseases in surveys from this region.

A recent study showed that globally, in 1990 and in 2010, the leading causes of blindness were cataract and undercorrected refractive error, with marked differences among the world's regions.[11] In 2010, the proportion of blindness caused by cataract ranged from less than 15% in the high-income regions to more than 40% in South and Southeast Asia and Oceania.[11] Macular diseases ranked at the third position, with profound differences in the 2 leading causes. Worldwide, only 6.6% of all blindness was caused by macular diseases (Table 1). In a parallel manner, the leading causes of moderate to severe visual impairment were undercorrected refractive error followed by cataract and, with a major gap, macular diseases in the third ranking position. As it was with blindness, the proportion of moderate to severe visual impairment caused by cataract was smallest in high-income regions (13.0%–13.8%), and it was largest in south and southeast Asia (both >20%).[11] The proportion of moderate to severe visual impairment caused by macular diseases was small in comparison, causing 1.0%–8.0% of moderate to severe visual impairment (in south Asia and Australasia, respectively) (worldwide: 3.1%) (Table 1). Although macular diseases were the third most common cause of blindness and moderate to severe visual impairment worldwide,

one must take into account that only about 1 of 15 blind people and 1 of 32 visually impaired people had macular diseases as the principal cause.

Globally and in all regions, women had a larger proportion of blindness and moderate to severe visual impairment caused by macular diseases than did men. A similar finding was observed for the proportion of blindness and moderate to severe visual impairment caused by cataract.[10,11] Globally, 35.5% of blindness among women was caused by cataract vs 30.1% of blindness among men; for vision impairment, the figures were 20.2% vs 15.9%, respectively.[10,11] Likewise, macular diseases caused 7.3% of all blindness in women vs 5.5% of all blindness in men. These gender disparities were less marked for other causes of vision impairment. It is interesting that Wong and colleagues did not find major gender differences in the prevalence of early or late age-related macular degeneration.[9] In many areas, the life expectancy of women is substantially longer than that of men, leading to there being many more old and very old women. Many of the data sets we used did not allow the fine age adjustment by gender that is required to tease out this interaction.

The design of our study had potential limitations. First, as also pointed out in our previous study of the global prevalence of vision loss,[10,11] a major limitation was that many country-years remained without data or had only subnational data. Second, some data sources did not report prevalence by age. To use these data, we imputed age-specific cause fractions, assuming that the age pattern of vision-impaired subjects in the study matched the modeled age pattern of vision-impaired people in the country where the study was carried out.[10] Third, the group of macular diseases included any macular disease (except macular changes due to diabetic retinopathy) that was associated with reduced vision; therefore, our study could not differentiate among age-related macular degeneration, myopic maculopathy and other macular disorders. In view of the marked increase in the prevalence of myopia, particularly in east Asia, future studies may differentiate among the various types of macular diseases as causes of visual loss. Fourth, cataract and undercorrection of refractive error have been overestimated because of the current coding rule: when an individual showed 2 causes of vision loss, the most curable or preventable cause had to be recorded as the main cause. Fifth, some studies had relatively small sample sizes, therefore the confidence intervals of the cause-specific prevalence estimate were relatively large. Our methods, however, took into account sample size, so that studies with small sample sizes influenced the estimates less than studies with large sample sizes.

The strengths of our study included the amount of population-based data accessed and used; the analysis of trends in the causes of vision impairment; the incorporation of nonlinear age trends and the accounting for data that were not reported by age; and the systematic quantitative analysis and reporting of uncertainty. The large network of ophthalmologic researchers involved in identification and evaluation of data sources ensured access to unpublished materials (unpublished data from 48 population-based studies, 4 from government reports and 44 from Rapid Assessment of Cataract Surgical Services and Rapid Assessment of Avoidable Blindness surveys were assessed), which allowed us to obtain additional unpublished data from study investigators who had published only summary data, to evaluate all major studies of vision impairment, and to include only studies that met inclusion criteria governing population representativeness and clarity of visual acuity procedures and definitions.

In conclusion, in 2010, 2.1 million people were blind and 6.0 million people were visually impaired due to macular diseases (except those of diabetic maculopathy), with an increase of 0.6 million (36%) and 2.7 million (81%) in the number of blind and visually impaired, respectively, from 1990 to 2010. The proportion of macular diseases related to total blindness and moderate to severe visual impairment was higher in high-income regions with relatively older populations. The stable prevalence of blindness related to macular diseases and moderate to severe visual impairment in some high-income regions, despite increasing ageing, may be due to the therapeutic success of intravitreal medication. Of 15 blind people, 1 was blind due to macular diseases, and 1 of 32 visually impaired people was visually impaired due to macular diseases.

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World War I and its Collateral Damage to the Eye Journals

During the severe paper shortage of the First World War there was strong political and economic pressure in both the United States and Britain to combine the journals. Each medical specialty formed a single "national" journal for that specialty, in order to save paper. The British did it in ophthalmology with the resultant establishment of the *British Journal Of Ophthalmology*.

Edward Jackson tried a similar strategy in the US. He organized the Ophthalmic Publishing Company representing the ownership of the *Ophthalmic Year Book*, *Ophthalmic Literature* (both AOS publications), *Ophthalmic Records*, *Annals Of Ophthalmology*, *Annals De Oftalmologia*, and *Ophthalmology* (the latter apparently unrelated to today's *Ophthalmology*). However, Arnold Knapp, who succeeded his father as editor of the *Archives Of Ophthalmology*, resisted the pressure put on him to join the group. He believed he must perpetuate the name of the journal his father founded. Later, of course, he moved it under the AMA where it's retained its name for another 75 years until Howard Bauchner changed it to *JAMA Ophthalmology*.

During the Second World War, I participated along with other kids in going from door-to-door collecting old newspapers and magazines for the war effort. Librarians are familiar with the poor quality paper that was used for publications during that time. Apparently the situation was even worse during the First World War. (With electronic publishing this shouldn't be a problem in future wars.)

Submitted by Dan Albert MD from the Cogan Ophthalmic History Society