Number of People Blind or Visually Impaired by Cataract Worldwide and in World Regions, 1990 to 2010

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See the appendix for the members of the Vision Loss Expert Group of the Global Burden of Disease Study.

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Purpose. To estimate prevalence and number of people visually impaired or blind due to cataract.

Methods. Based on the Global Burden of Diseases Study 2010 and ongoing literature research, we examined how many people were affected by moderate to severe vision impairment (MSVI; presenting visual acuity <6/18, ≥3/60) and blindness (presenting visual acuity <3/60) due to cataract.

Results. In 2010, of overall 32.4 million blind and 191 million vision impaired, 10.8 million people were blind and 35.1 million were visually impaired due to cataract. Cataract caused worldwide 33.4% of all blindness in 2010, and 18.4% of all MSVI. These figures were lower in the high-income regions (<15%) and higher (>40%) in South and Southeast Asia and Oceania. From 1990 to 2010, the number of blind or visually impaired due to cataract decreased by 11.4% and by 20.2%, respectively; the age-standardized global prevalence of cataract-related blindness and MSVI reduced by 46% and 50%, respectively, and the worldwide crude prevalence of cataract-related blindness and MSVI reduced by 32% and 39%, respectively. The percentage of global blindness and MSVI caused by cataract decreased from 38.6% to 33.4%, and from 25.6% to 18.4%, respectively. This decrease took place in almost all world regions, except East Sub-Saharan Africa.

Conclusions. In 2010, one in three blind people was blind due to cataract, and one of six visually impaired people was visually impaired due to cataract. Despite major improvements in terms of reduction of prevalence, cataract remains a major public health problem.

Keywords: cataract, epidemiology, blindness, visual impairment

Although cataract is relatively easily, safely, and cost-efficiently treatable, and in spite of the increasing rates of cataract surgery,[1] cataract is still the leading cause of blindness and visual impairment worldwide, especially in developing countries.[2,3]

Population-based studies and previous meta-analyses performed in different regions worldwide have reported that cataract is responsible for 47.8% to 51% of all global blindness.[2,4–9] However, these studies did not report data on the change during the past 2 decades in terms of prevalence and number of people blind or visually impaired due to cataract.

The purpose of the current study was to determine, in a meta-analysis of all available population-based studies performed worldwide within the past 2 decades, prevalence and number of people affected by blindness and visual impairment due to cataract, to assess changes during the period from 1990 to 2010, and to examine regional differences in the prevalence of cataract-related blindness and visual impairment.

Methods

Medline, Embase, and the WHO (World Health Organization) library information system were used to search for articles published between 1980 and 2012. Search terms included concepts to describe "blindness," "visual impairment," "population," "eye," "survey," and a list of ocular disorders. Of 14,908 relevant manuscripts primarily identified, 243 population-based studies remained after application of rigorous selection criteria and review by an expert panel.[3,10] Criteria for inclusion included (1) random-sample cross-sectional surveys of representative populations of any age of a country or area of a country; studies using hospital or clinic case series, blindness registries, and interview studies with self-reported vision status were not included; (2) definitions of visual impairment or blindness were clearly stated, using thresholds of visual acuity, in the better eye that matched or could be later modeled to match to the following definitions: mild vision impairment (<6/12 to 6/18), moderate vision impairment (<6/18 to 6/60), severe vision impairment (<6/60 to 3/60), or blindness (<3/60); (3) best-corrected and/or presenting visual acuity was recorded; and (4) procedures used for measurement of visual acuity needed to be clearly stated.

As recently described in detail, additional unpublished data sources through personal communication with researchers identified in the literature search were found.[3,10] Additional data sources were identified through personal communications with researchers, including enquiries about additional data from authors of published studies. These data were used only if information about the study population and measurement methods were available. We applied the same inclusion criteria to these data sources as were used in the published articles identified in the systematic review. Additionally, published and unpublished results from rapid assessment survey methodologies that follow consistent protocols, such as the Rapid Assessment of Avoidable Blindness and the Rapid Assessment of Cataract Surgical Services, augmented the population-based data.[11]

Population-based studies that reported prevalence disaggregated by cause (128 studies) provided the basic data to calculate the proportion of blindness and moderate to severe vision impairment (MSVI) that were due to cataract, besides other causes, such as macular degeneration, glaucoma, diabetic retinopathy, trachoma, or uncorrected refractive errors. A full list of data sources used for each cause has been published recently.[10]

For 18 of 21 Global Burden of Disease (GBD) study regions, at least two studies were identified. However there were no studies with cause-specific data identified in two of the GBD study regions (Central Africa, Eastern Europe) and only one study was identified for Central Europe. There was no identified study for 126 of the 191 countries defined by the WHO and United Nations. Blindness was defined as presenting visual acuity less than 3/60 in the better eye, and MSVI was defined as visual acuity in the better eye lower than 6/18 but at least 3/60 at presentation.

We estimated trends in causes of vision impairment, including analysis of uncertainties, by age, sex, and geographical region. For the latter, we used the 21 regions defined in the GBD study.[12] The statistical analysis was performed in three 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, sex, age, and region; and the third step included the application of cause fractions to the prevalence of all-cause presenting vision impairment, which was assessed previously.[10] For the statistical analysis, the DisMod-MR model from the GBD was used to calculate the fraction of vision impairment due to macular degeneration and the other causes mentioned above. It has been described in detail recently.[3,10] Briefly, DisMod-MR is a negative binomial regression model including the following elements: covariates that predict variation in the true proportion of vision impairment from each disease (e.g., year); fixed effects that adjust for definitional differences (e.g., whether the causes of presenting versus best-corrected vision 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 visual impairment due to cataract, we fit one DisMod-MR model using three covariates: an indicator variable describing whether the data were for blindness or for MSVI, 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 two sets of the prediction for cataract: one for best-corrected blindness and one for best-corrected MSVI. For the presentation of the data, we present age-standardized prevalence in the 50 years and older population using the WHO reference population[13] and crude prevalence for all ages. The numbers of people with vision impairment and blindness due to cataract were also calculated, which reflects each region's population size and age structure. Pearson's χ^2 test was used to assess associations. A P value of 0.05 was considered statistically significant.

Results

Of overall 32.4 million people blind and 191 million people vision impaired in 2010,[10] 10.8 million (95% uncertainty interval [UI]: 9.2–12.3) people were blind, and 35.1 million (UI: 29.6–43.1) million were moderately or severely visually impaired due to cataract (Table 1).

From 1990 to 2010, the number of people blind due to cataract decreased from 12.3 million (UI: 10.7–14.2 million) to 10.8 million (9.3–12.3 million), and for MSVI fell from 44.0 million (35.6–52.4 million) to 35.2 million (29.6–43.5 million).[3] This represents an 11.4% decrease in the number of people affected by blindness due to cataract (−1.4 million, UI: −1.3 to −1.9) and a 20.2% decrease in the number of people moderately or severely visually impaired (−8.9 million, UI: 6.0–8.9) over a 20-year period (Tables 1, 2). If only people with an age of 50 years or older were included, the number of people blind due to cataract decreased from 11.1 million (UI: 9.7–12.8) in 1990 to 9.8 million (UI: 8.4–11.1) in 2010, and the number of people with cataract-related MSVI decreased from 38.7 million (UI: 31.4–45.4) in 1990 to 31.3 million (UI: 26.4–38.4) in 2010.

In 1990, cataract was the predominant cause of blindness worldwide and in all world regions. In 2010, cataract remained the predominant cause of blindness worldwide and in 16 world regions, and was the second most common cause of blindness, after macular degeneration, in five regions (high-income Asia Pacific, Australasia, Western Europe, Southern Latin America, and high-income North America). In 2010, cataract was responsible for 33.4% (UI: 29.6–36.49) of global blindness, and 18.4% (UI: 15.8–20.9) of global MSVI (Table 1). The lowest percentages of blindness caused by cataract were recorded in high-income North America (12.7% [8.3–18.7]), high-income Asia Pacific, (13.1% [8.3–20.8]), Western Europe (13.8% [11.2–17.9]), and Australasia (14.5% [8.5–22.4]). The highest percentages were recorded in Oceania (40.6% [31.5–

Table 1. Number of People (Mean, 95% UI) Blind (Presenting Visual Acuity <3/60) or MSVI (Presenting Visual Acuity <6/18, ≥3/60) Due to Cataract in Different World Regions in 2010

World Region	Blindness/ MSVI	Total Population 2010	Number of People Affected in 2010			Percentage of Blindness/MSVI by Cataract in 2010
			Mean Value	Lower Value	Upper Value	
World	Blind	6,890,000,000	10,817,300	9,294,610	12,305,540	33.4 (29.6–36.4)
Asia Pacific, high income	Blind	169,000,000	46,290	26,376	91,341	13.1 (8.3–20.8)
Asia, Central	Blind	68,800,000	32,664	22,885	50,041	24.2 (18.6–29.7)
Asia, East	Blind	1,190,000,000	1,475,722	999,568	2,038,195	28.2 (19.3–37.3)
Asia, South	Blind	1,120,000,000	4,419,037	3,299,108	5,408,084	41.7 (33.0–51.6)
Asia, Southeast	Blind	460,000,000	1,453,634	1,043,589	1,772,977	42.0 (34.8–47.9)
Australasia	Blind	20,500,000	5,581	3,243	15,186	14.5 (8.5–22.4)
Caribbean	Blind	34,300,000	59,530	42,476	84,509	30.2 (23.8–37.1)
Europe, Central	Blind	122,000,000	70,673	48,875	159,563	21.6 (17.0–26.7)
Europe, Eastern	Blind	222,000,000	121,247	59,787	236,715	20.6 (13.1–30.5)
Europe, Western	Blind	381,000,000	131,526	94,423	209,980	13.8 (11.2–17.9)
Latin America, Andean	Blind	38,600,000	61,021	39,575	85,006	31.0 (23.3–38.7)
Latin America, Central	Blind	166,000,000	239,966	173,449	336,751	26.4 (20.9–32.3)
Latin America, Southern	Blind	48,900,000	40,675	26,621	69,086	18.0 (12.0–25.8)
Latin America, Tropical	Blind	154,000,000	190,491	101,848	406,117	23.9 (16.2–32.5)
North Africa/Middle East	Blind	301,000,000	728,223	501,750	977,177	23.4 (18.7–28.6)
North America, high income	Blind	281,000,000	60,223	30,414	100,252	12.7 (8.3–18.7)
Oceania	Blind	5,814,186	13,202	7,107	21,392	40.6 (31.5–48.6)
Sub-Saharan Africa, Central	Blind	53,400,000	97,755	55,476	193,169	34.8 (25.3–42.5)
Sub-Saharan Africa, East	Blind	208,000,000	766,161	554,007	989,127	36.7 (31.9–41.5)
Sub-Saharan Africa, South	Blind	52,600,000	93,329	47,414	132,805	31.2 (24.6–39.0)
Sub-Saharan Africa, West	Blind	201,000,000	712,281	491,235	910,725	33.8 (28.1–39.3)
World	MSVI	6,890,000,000	35,152,780	29,620,110	43,462,120	18.4 (15.8–20.9)
Asia Pacific, high income	MSVI	169,000,000	295,528	146,659	1,115,721	15.2 (8.2–22.1)
Asia, Central	MSVI	68,800,000	219,873	134,773	417,284	18.7 (13.9–23.5)
Asia, East	MSVI	1,190,000,000	4,470,178	2,647,028	6,811,842	13.4 (8.0–19.7)
Asia, South	MSVI	1,120,000,000	15,300,000	10,700,000	20,300,000	21.4 (16.1–24.2)
Asia, Southeast	MSVI	460,000,000	4,181,188	3,141,780	6,495,660	22.7 (17.9–27.4)
Australasia	MSVI	20,500,000	62,691	25,749	166,525	13.7 (8.4–20.8)
Caribbean	MSVI	34,300,000	195,394	113,003	277,805	15.9 (11.4–21.3)
Europe, Central	MSVI	122,000,000	600,202	309,211	1,181,098	18.1 (13.2–23.4)
Europe, Eastern	MSVI	222,000,000	1,078,622	460,202	1,950,506	18.4 (11.8–26.2)
Europe, Western	MSVI	381,000,000	1,034,671	679,359	1,960,703	13.8 (10.3–18.3)
Latin America, Andean	MSVI	38,600,000	205,832	124,519	306,902	14.8 (10.2–20.1)
Latin America, Central	MSVI	166,000,000	707,342	466,411	1,040,016	13.9 (9.9–18.8)
Latin America, Southern	MSVI	48,900,000	275,910	162,458	523,779	17.3 (10.7–23.2)
Latin America, Tropical	MSVI	154,000,000	674,298	375,002	1,170,746	13.9 (8.5–20.7)
North Africa/Middle East	MSVI	301,000,000	2,452,359	1,738,012	3,404,856	18.0 (13.3–22.6)
North America, high income	MSVI	281,000,000	404,127	247,756	852,132	13.0 (7.8–19.5)
Oceania	MSVI	5,814,186	44,988	22,648	66,921	18.2 (12.1–25.4)
Sub-Saharan Africa, Central	MSVI	53,400,000	263,062	150,529	473,206	18.8 (12.8–24.3)
Sub-Saharan Africa, East	MSVI	208,000,000	1,397,081	1,070,839	1,876,168	19.6 (15.8–23.6)
Sub-Saharan Africa, South	MSVI	52,600,000	168,047	104,040	301,302	17.8 (12.3–23.9)
Sub-Saharan Africa, West	MSVI	201,000,000	1,124,199	766,578	1,707,504	15.6 (11.4–20.5)

48.6]), South Asia (41.7% [33.0–51.6]), and Southeast Asia (42.0% [34.8–47.9]) (Table 1). The lowest percentages of MSVI caused by cataracts were recorded in East Asia (13.4% [8.0–19.7]), Australasia (13.7% [8.4–20.8]), Western Europe (13.8% [10.3–18.3]), Central Latin America (13.9% [9.9–18.8]), and Tropical Latin America (13.9% [8.5–20.7]). The highest percentages were recorded in South Asia and Southeast Asia (21.4% [16.1–24.2] and 22.7% [17.9–27.4], respectively) (Table 1).

Compared with 1990, the percentage of global blindness and of global MSVI caused by cataract decreased from 38.6% (35.2–42.0) to 33.4% (29.6–36.4), and from 25.6% (22.7–28.4) to 18.4% (15.8–20.9), respectively (Tables 1, 2).

The age-standardized global prevalence of cataract-related blindness and MSVI was reduced by 46% and 50%, respectively, and the worldwide crude prevalence of cataract-related blindness and MSVI was reduced by 32% and 39%, respectively (Table 3).

A decrease of percentage of global blindness and of global MSVI caused by cataract from 1990 to 2010 took place in almost world regions, except in East Sub-Saharan Africa (35.4% [31.7–39.8] in 1990 vs. 36.7% [31.9–41.5] in 2010) (Tables 1, 2).

The decline in age-standardized prevalence of blindness or MVSI due to cataract was greatest in East Asia, Tropical Latin America, and Western Europe, in all of which prevalence fell

Table 2. Number of People (Mean, 95% UI) Blind (Presenting Visual Acuity <3/60) or MSVI (Presenting Visual Acuity <6/18, ≥3/60) Due to Cataract in Different World Regions in 1990

Region	Blindness/ MSVI	Number of People Affected in 1990			Difference in the Number of People Affected 2010 − 1990			Percentage of Blindness/MSVI by Cataract in 1990
		Mean	Lower Value	Upper Value	Mean	Lower Value	Upper Value	
World	Blind	12,274,800	10,674,200	14,214,600	−1,457,500	−1,379,590	−1,909,060	38.6 (35.2–42.0)
Asia Pacific, high income	Blind	52,804	32,462	94,422	−6,514	−6,086	−3,081	18.8 (13.3–25.6)
Asia, Central	Blind	58,477	41,636	80,744	−25,813	−18,751	−30,703	29.0 (24.3–33.6)
Asia, East	Blind	2,233,323	1,712,881	2,897,472	−757,601	−713,313	−859,277	37.2 (29.7–45.4)
Asia, South	Blind	4,574,939	3,678,602	5,845,147	−155,902	−379,494	−437,063	47.7 (39.5–59.4)
Asia, Southeast	Blind	1,597,042	1,103,499	1,922,475	−143,408	−59,910	−149,498	47.2 (42.0–51.7)
Australasia	Blind	6,856	4,361	17,746	−1,275	−1,118	−2,560	19.7 (15.2–26.0)
Caribbean	Blind	67,653	47,722	90,719	−8,123	−5,246	−6,210	32.9 (28.3–38.0)
Europe, Central	Blind	111,153	81,715	218,530	−40,480	−32,840	−58,967	26.9 (23.1–31.5)
Europe, Eastern	Blind	241,370	121,148	421,822	−120,123	−61,361	−185,107	25.3 (18.7–32.5)
Europe, Western	Blind	225,831	166,844	331,139	−94,305	−72,421	−121,159	19.2 (16.2–22.7)
Latin America, Andean	Blind	71,720	46,048	96,168	−10,699	−6,473	−11,162	37.5 (30.5–44.2)
Latin America, Central	Blind	278,967	207,039	367,863	−39,001	−33,590	−31,112	32.9 (27.6–38.6)
Latin America, Southern	Blind	56,800	38,417	89,446	−16,125	−11,796	−20,360	24.3 (18.5–31.2)
Latin America, Tropical	Blind	242,717	135,737	436,280	−52,226	−33,889	−30,163	32.7 (23.9–42.5)
North Africa/Middle East	Blind	874,488	613,520	1,122,952	−146,265	−111,770	−145,775	29.2 (25.5–33.4)
North America, high income	Blind	78,425	51,406	120,897	−18,202	−20,992	−20,645	17.4 (12.5–22.8)
Oceania	Blind	11,984	6,472	18,832	1,218	635	2,560	43.3 (35.2–49.9)
Sub-Saharan Africa, Central	Blind	114,558	67,346	212,804	−16,803	−11,870	−19,635	41.0 (33.3–47.5)
Sub-Saharan Africa, East	Blind	579,591	424,347	713,488	186,570	129,660	275,639	35.4 (31.7–39.8)
Sub-Saharan Africa, Southern	Blind	104,792	54,449	139,045	−11,463	−7,035	−6,240	34.0 (29.0–39.8)
Sub-Saharan Africa, West	Blind	696,809	497,485	860,176	15,472	−6,250	50,549	37.1 (32.1–41.9)
World	MSVI	44,074,800	35,631,900	52,353,400	−8,922,020	−6,011,790	−8,891,280	25.6 (22.7–28.4)
Asia Pacific, high income	MSVI	365,843	241,283	1,102,044	−70,315	−94,624	13,677	22.8 (18.1–29.4)
Asia, Central	MSVI	388,666	247,319	609,844	−168,793	−112,546	−192,560	26.6 (22.1–31.2)
Asia, East	MSVI	7,742,213	4,521,841	10,300,000	−3,272,035	−1,874,813	−3,488,158	24.1 (18.9–29.4)
Asia, South	MSVI	15,900,000	10,900,000	21,400,000	−600,000	−200,000	−1,100,000	26.7 (21.4–29.5)
Asia, Southeast	MSVI	4,830,046	3,392,385	6,569,304	−648,858	−250,605	−73,644	30.1 (25.4–35.2)
Australasia	MSVI	88,178	42,875	191,962	−25,487	−17,126	−25,437	21.9 (17.2–27.6)
Caribbean	MSVI	260,283	143,650	347,465	−64,889	−30,647	−69,660	22.8 (18.4–27.4)
Europe, Central	MSVI	1,017,502	548,048	1,624,181	−417,300	−238,837	−443,083	26.6 (21.9–31.7)
Europe, Eastern	MSVI	2,113,966	1,046,245	3,001,578	−1,035,344	−586,043	−1,051,072	26.4 (20.4–32.1)
Europe, Western	MSVI	2,057,764	1,341,364	3,292,341	−1,023,093	−662,005	−1,331,638	24.1 (19.9–28.8)
Latin America, Andean	MSVI	276,505	156,848	395,235	−70,673	−32,329	−88,333	22.9 (17.8–28.6)
Latin America, Central	MSVI	933,177	610,362	1,211,152	−225,835	−143,951	−171,136	21.6 (17.3–26.0)
Latin America, Southern	MSVI	416,687	256,179	750,298	−140,777	−93,721	−226,519	26.5 (21.1–32.6)
Latin America, Tropical	MSVI	939,919	518,927	1,304,160	−265,621	−143,925	−133,414	22.0 (16.0–28.3)
North Africa / Middle East	MSVI	2,957,300	1,969,658	3,948,769	−504,941	−231,646	−543,913	25.1 (20.8–29.4)
North America, high income	MSVI	626,752	468,261	1,043,381	−222,625	−220,505	−191,249	21.1 (16.6–26.1)
Oceania	MSVI	47,458	24,719	67,446	−2,470	−2,071	−525	25.2 (20.1–31.5)
Sub-Saharan Africa, Central	MSVI	335,137	199,393	576,512	−72,075	−48,864	−103,306	27.1 (22.2–32.4)
Sub-Saharan Africa, East	MSVI	1,165,820	875,019	1,522,309	231,261	195,820	353,859	22.7 (19.3–26.6)
Sub-Saharan Africa, Southern	MSVI	201,821	145,667	309,584	−33,774	−41,627	−8,282	24.2 (19.3–29.6)
Sub-Saharan Africa, West	MSVI	1,402,193	975,822	1,879,899	−277,994	−209,244	−172,395	24.3 (20.0–28.2)

by more than half. The region with the least decline was East Sub-Saharan Africa (Table 3).

A reduction in crude and age-standardized prevalence of more than 50% was observed in two regions for cataract blindness (Central Asia and Central Sub-Saharan Africa) and in five regions for cataract-related MSVI (East and Central Asia, Western Europe, Western and Central Africa) (Table 3).

Worldwide age-standardized prevalence for all ages in 2010 was higher in women than men for cataract blindness (0.19% [95% UI: 0.17–0.22] vs. 0.13% [95% UI: 0.11–0.16], respectively) ($P < 0.001$) and cataract-related MSVI (0.62% [95% UI: 0.52–0.77] vs. 0.45% [95% UI: 0.36–0.56], respectively) ($P < 0.001$).

Worldwide, cataract caused 35.5% (95% UI: 31.0–39.1) of blindness in women, compared with 30.1% (95% UI: 25.2–33.7) in men, and 20.2% (95% UI: 17.2–23.0) of MSVI in women versus 15.9% (95% UI: 12.8–18.6) in men.

Discussion

Results of our study show that despite the reduction in absolute numbers, crude and age-standardized prevalences, cataract remains the leading cause of blindness worldwide and in 16 world regions. In 2010, one of three blind people was blind due to cataract, and one of six visually impaired people were visually impaired due to cataract.

Table 3. Crude and Age-Standardized Prevalences (Mean, 95% UI) Due to Cataract in Different World Regions in 1990 and 2010

		Crude Prevalence, All Ages, %							Age-Standardized Prevalence in 50+, %						
		1990			2010				1990			2010			
Region	Level	Mean	Lower	Upper	Mean	Lower	Upper	Change	Mean	Lower	Upper	Mean	Lower	Upper	Change
Asia Pacific, high income	Blind	0.03	0.03	0.03	0.03	0.01	0.1	−18	0.1	0.1	0.2	0.0	0.0	0.1	−59
Asia, Central	Blind	0.1	0.1	0.1	0.04	0.03	0.1	−52	0.6	0.4	0.8	0.2	0.2	0.4	−58
Asia, East	Blind	0.2	0.1	0.2	0.1	0.1	0.1	−44	1.2	0.9	1.5	0.5	0.3	0.6	−62
Asia, South	Blind	0.4	0.3	0.5	0.3	0.2	0.3	−33	3.7	3.0	4.7	2.0	1.5	2.4	−46
Asia, Southeast	Blind	0.3	0.2	0.4	0.2	0.2	0.3	−31	3.0	2.1	3.6	1.5	1.1	1.8	−51
Australasia	Blind	0.03	0.02	0.1	0.02	0.01	0.1	−37	0.1	0.1	0.3	0.1	0.03	0.1	−55
Caribbean	Blind	0.2	0.1	0.3	0.1	0.1	0.2	−28	1.1	0.8	1.5	0.6	0.4	0.8	−46
Europe, Central	Blind	0.1	0.1	0.2	0.1	0.04	0.1	−35	0.3	0.2	0.6	0.1	0.1	0.3	−55
Europe, Eastern	Blind	0.1	0.1	0.2	0.1	0.03	0.1	−46	0.4	0.2	0.6	0.2	0.1	0.3	−58
Europe, Western	Blind	0.1	0.04	0.1	0.03	0.02	0.1	−47	0.1	0.1	0.2	0.1	0.04	0.1	−60
Latin America, Andean	Blind	0.2	0.1	0.2	0.1	0.1	0.2	−39	1.6	1.1	2.2	0.7	0.4	1.0	−58
Latin America, Central	Blind	0.2	0.1	0.2	0.1	0.1	0.1	−38	1.4	1.1	1.9	0.6	0.4	0.8	−58
Latin America, Southern	Blind	0.1	0.1	0.2	0.1	0.04	0.1	−42	0.5	0.4	0.8	0.2	0.1	0.4	−58
Latin America, Tropical	Blind	0.2	0.1	0.3	0.1	0.1	0.2	−40	1.3	0.7	2.3	0.5	0.2	1.0	−64
North Africa/Middle East	Blind	0.3	0.2	0.4	0.2	0.1	0.2	−44	2.8	2.0	3.6	1.2	0.8	1.6	−58
North America, high income	Blind	0.03	0.02	0.0	0.02	0.01	0.0	−37	0.1	0.1	0.1	0.0	0.02	0.1	−49
Oceania	Blind	0.2	0.1	0.3	0.1	0.1	0.2	−29	2.6	1.5	4.0	1.6	0.9	2.5	−41
Sub-Saharan Africa, Central	Blind	0.2	0.1	0.4	0.1	0.1	0.2	−52	2.6	1.6	4.6	1.3	0.7	2.6	−49
Sub-Saharan Africa, East	Blind	0.3	0.2	0.3	0.2	0.2	0.3	−22	3.3	2.5	4.0	2.4	1.8	3.1	−27
Sub-Saharan Africa, Southern	Blind	0.2	0.1	0.3	0.1	0.1	0.2	−33	2.2	1.2	2.9	1.1	0.5	1.5	−51
Sub-Saharan Africa, West	Blind	0.3	0.2	0.4	0.2	0.1	0.3	−39	3.9	2.9	4.8	2.4	1.7	3.0	−39
World	Blind	0.2	0.2	0.3	0.2	0.1	0.2	−32	1.3	1.1	1.5	0.7	0.6	0.8	−46
Asia Pacific, high income	MSVI	0.2	0.1	0.7	0.2	0.1	0.6	−24	0.8	0.5	2.3	0.3	0.2	1.2	−59
Asia, Central	MSVI	0.6	0.4	0.9	0.3	0.2	0.5	−51	3.6	2.3	5.6	1.6	0.9	2.9	−57
Asia, East	MSVI	0.6	0.4	0.9	0.3	0.2	0.5	−51	3.8	2.3	5.0	1.3	0.8	2.0	−66
Asia, South	MSVI	1.4	1.0	1.9	1.0	0.7	1.3	−33	11.0	7.7	14.3	6.3	4.5	8.2	−43
Asia, Southeast	MSVI	1.1	0.7	1.4	0.7	0.5	1.1	−35	8.2	5.9	11.0	4.0	3.0	6.1	−51
Australasia	MSVI	0.4	0.2	0.9	0.2	0.1	0.6	−45	1.4	0.7	3.2	0.6	0.2	1.6	−58
Caribbean	MSVI	0.8	0.4	1.0	0.5	0.3	0.7	−38	4.2	2.3	5.6	2.0	1.2	2.8	−53
Europe, Central	MSVI	0.8	0.4	1.3	0.5	0.3	1.0	−40	2.9	1.6	4.5	1.2	0.6	2.4	−56
Europe, Eastern	MSVI	1.0	0.5	1.3	0.5	0.2	0.9	−46	3.1	1.5	4.4	1.4	0.6	2.5	−56
Europe, Western	MSVI	0.5	0.4	0.9	0.2	0.2	0.5	−54	1.4	0.9	2.2	0.5	0.3	0.9	−65
Latin America, Andean	MSVI	0.7	0.4	1.0	0.4	0.2	0.6	−46	5.9	3.4	8.0	2.3	1.4	3.3	−62
Latin America, Central	MSVI	0.6	0.4	0.7	0.3	0.2	0.5	−46	4.6	3.0	5.9	1.7	1.1	2.6	−62
Latin America, Southern	MSVI	0.9	0.5	1.5	0.5	0.3	0.9	−47	3.7	2.3	6.5	1.5	0.9	2.9	−59
Latin America, Tropical	MSVI	0.6	0.3	0.8	0.3	0.2	0.6	−45	4.6	2.6	6.2	1.6	0.9	2.8	−65
North Africa/Middle East	MSVI	1.0	0.7	1.3	0.5	0.4	0.8	−44	8.5	5.9	11.0	3.8	2.7	5.2	−55
North America, high income	MSVI	0.2	0.2	0.4	0.1	0.1	0.2	−47	0.7	0.5	1.1	0.3	0.2	0.6	−56
Oceania	MSVI	0.8	0.4	1.2	0.5	0.3	0.7	−39	9.0	4.9	12.1	4.8	2.5	6.7	−46
Sub-Saharan Africa, Central	MSVI	0.6	0.4	1.1	0.3	0.2	0.5	−56	6.7	4.1	11.0	3.3	1.8	5.8	−51
Sub-Saharan Africa, East	MSVI	0.6	0.4	0.7	0.4	0.3	0.5	−30	6.0	4.6	7.6	4.1	3.2	5.4	−31
Sub-Saharan Africa, Southern	MSVI	0.4	0.3	0.6	0.2	0.1	0.4	−38	3.9	2.8	5.8	1.8	1.1	3.2	−53
Sub-Saharan Africa, West	MSVI	0.7	0.5	0.9	0.3	0.2	0.5	−52	7.2	5.3	9.3	3.5	2.4	5.1	−51
World	MSVI	0.8	0.7	1.0	0.5	0.4	0.6	−39	4.4	3.6	5.2	2.2	1.9	2.7	−50

In 2010, the age-standardized prevalence of blindness and MSVI caused by cataract in people aged 50 years and older were reduced by half from 1.3% to 0.7% and from 4.4% to 2.2%, respectively, compared with 1990. In a similar manner, the age-standardized prevalence of trachoma and uncorrected refractive error showed the greatest declines worldwide between 1990 and 2010. For glaucoma, macular degeneration, and diabetic retinopathy, prevalence declined less (for blindness), or increased slightly (for MSVI).[3]

It has been recently shown that the worldwide age-standardized prevalence for blindness and for MSVI declined substantially from 1990 to 2010, and of this overall decline in vision impairment, approximately half was a result of decline in vision impairment caused by cataract.[3] This decline may also indicate a shift in the relative importance of the various diseases as causes for blindness and visual impairment, with a decline for causes of avoidable blindness, which are relatively easily, safely, and cost-efficiently treatable diseases,[14] and diseases such as glaucoma, macular degeneration, and diabetic retinopathy, the management of which needs efforts and takes considerably more time with a markedly lower rate of success. This decline may also reflect the effect of the Vision 2020 the Right to Sight initiative of WHO and the International Agency for the Prevention of Blindness.[15] This global partnership for the elimination of avoidable blindness that involves a collaboration of international nongovernmental organizations, professional associations, and eye-care institutions has laid great emphasis on increasing the numbers of people receiving cataract surgery, particularly in low- and middle-income countries. During the period under consideration, the total number of cataract surgeries more than tripled in the world and the cataract surgical rate (i.e., the number of surgeries per million population per year) increased in all regions, especially in Asia,[16] with improvement of surgical techniques, and a lower rate of complications.[17,18] However, despite the decline in prevalence of blindness and MSVI, cataract remains the first cause of blindness in 2010 followed by uncorrected refractive error and macular degeneration, and the second cause of MSVI after uncorrected refractive error.[3] This may be the result of rapid aging of populations, with a growth rate of ophthalmologists lower than the growth rate of the population older than 60 years,[17] in addition to the barriers to uptake of cataract surgery that still exist in most countries. In fact, our data show that globally, the age-standardized prevalence declined more dramatically than the crude prevalence for both blindness (–46% vs. –32%) and MSVI (–50% vs. –39%), which reflects the effect of the demographic transition. The surgical services are struggling to cope with the aging of the population; this is particularly marked in the Asia Pacific, high-income region, where the crude prevalence of cataract blindness declined by 18% only while the age-standardized prevalence dropped by 59%. Conversely, in Western Sub-Saharan Africa, crude and age-standardized prevalences declined both by 39%.

Other barriers include surgical cost, lack of family support, and failure to understand the need for surgery and other social, infrastructural, and geographic factors, such as disparity in the distribution of ophthalmologists leading to unsatisfactory coverage across some regions and difficulties in accessing eye-care centers with patients having to travel too far and not having anyone to accompany them.[17,19–23] Quality of cataract surgery also remains a concern, with poor outcomes reaching 40% in some places.[24] In fact, many ophthalmologists do not perform surgery or may be inadequately trained.[17,25,26] Cataract, therefore, continues to be a challenge to tackle with the need to plan a comprehensive strategy addressing issues related to availability, affordability, accessibility, and acceptability of eye-care services, and improving outcome of cataract surgery in low- and middle-income countries.[27] In addition, reduction of cataract-related blindness and visual impairment will have a positive impact on long-term survival. In fact, recent studies show that correcting related visual impairment by cataract surgery was associated with improvements in quality of life and a lower mortality risk compared with that of older persons whose moderate to severe levels of visual impairment persisted, independent of other known mortality risk factors.[28–30]

Globally, women as compared with men had a larger percentage of blindness and MSVI caused by cataract. Worldwide, 35.5% of blindness among women was caused by cataract versus 30.1% of blindness among men; for MSVI, the figures were 20.2% vs. 15.9%, respectively. A recent meta-analysis revealed that sex inequity in use of cataract surgical services persists in the low- and middle-income countries, and that men were 1.71 times (95% confidence interval [CI]: 1.48–1.97) more likely to have cataract surgery than women.[31] It is estimated in that study that blindness and severe visual impairment from cataract could be reduced by approximately 11% in the low- and middle-income countries if women were to receive cataract surgery at the same rate as men.[31] Similarly, a previous study found that the cataract surgical coverage rate was 1.2 to 1.7 times higher for males than for females and that the odds ratio of having surgery, compared with males, was 0.67 (95% CI: 0.60–0.74). Estimates in that study suggest that the prevalence of cataract blindness in developing countries would be reduced by a median of 12.5% if women received surgery at the same rates as men.[32] In contrast, a survey from Latin American countries in which cataract surgical cover was assessed; sex does not appear to be a significant factor in receiving cataract surgery.[33] Additional focus is needed to bring cataract surgical services to women mainly in low- and middle-income countries.

Literature reviews published by WHO and the WHO Prevention of Blindness and Deafness program have previously been used to make worldwide estimates of numbers of people blind or with vision impairment. The latest of these studies included literature published in the period from 2000 to 2010.[2] That analysis was limited to three age groups, with no breakdown by sex, or estimates for the six WHO epidemiological subregions within a more limited time frame. In contrast, the present study achieved a greater degree of granularity in its analysis, analyzed in 5-year age brackets, allowed the disaggregation by sex, time series estimates for the period 1990 to 2010, and a geographic breakdown for 190 countries in the 21 geographic regions identified by the GBD. These factors led to more detailed estimations of prevalence of vision impairment of all causes including cataracts.

Our study had some limitations. First, as also pointed out in our previous study on the global prevalence of vision loss,[3,10] 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 were available. 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 in the study matched the modeled age pattern of vision impaired in the country in which the study was carried out.[10] Third, classification of cataract may not be uniform and may vary from one study to another. Fourth, in most surveys, protocol dictated that population-based studies will report one cause as the principal cause for an individual examined in that particular study, so as to arrive at the causal prevalence. When there were multiple disorders contributing equally to visual loss, only the "most readily curable" or the "most easily preventable" was recorded.[34] This approach has the potential to underestimate the impact of diabetic retinopathy, glaucoma, or other diseases when the patient presents with cataract,

while underestimating the burden of cataract when patients also have an uncorrected refractive error.[35] Finally, some studies had a relatively small sample size. Therefore, the CIs 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, analysis of trends in the causes of vision impairment, incorporation of nonlinear age trends and accounting for data that were not reported by age, and systematic quantitative analysis and reporting of uncertainty. The large network of ophthalmologic researchers involved in identification and evaluation of data sources ensured to access 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), 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, despite major improvements in terms of reduction of prevalence, cataract remains a major public health problem. Additional efforts in terms of advocacy, availability, affordability, and accessibility to high-volume and high-quality cataract surgery mainly in developing countries are mandatory to achieve the global target set by WHO target, which is a 25% reduction in the prevalence of avoidable visual impairment.

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Appendix

A list of the Vision Loss Expert Group members appears at http://www.anglia.ac.uk/ruskin/en/home/microsites/veru/other_research_areas/global_burden_of_diseases.html.