

Prevalence and causes of vision loss in sub-Saharan Africa: 1990–2010

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ABSTRACT

Aim To estimate the magnitude, temporal trends and subregional variation in the prevalence of blindness, and moderate/severe vision impairment (MSVI) in sub-Saharan Africa.

Methods A systematic review was conducted of published and unpublished population-based surveys as part of the Global Burden of Disease, Risk Factors and Injuries Study 2010. The prevalence of blindness and vision impairment by country and subregion was estimated.

Results In sub-Saharan Africa, 52 studies satisfied the inclusion criteria. The estimated age-standardised prevalence of blindness decreased by 32% from 1.9% (95% CI 1.5% to 2.2%) in 1990 to 1.3% (95% CI 1.1% to 1.5%) in 2010 and MSVI by 25% from 5.3% (95% CI 0.2% to 0.3%) to 4.0% (95% CI 0.2% to 0.3%) over that time. However, there was a 16% increase in the absolute numbers with blindness and a 28% increase in those with MSVI. The major causes of blindness in 2010 were; cataract 35%, other/unidentified causes 33.1%, refractive error 13.2%, macular degeneration 6.3%, trachoma 5.2%, glaucoma 4.4% and diabetic retinopathy 2.8%. In 2010, age-standardised prevalence of MSVI in Africa was 3.8% (95% CI 3.1% to 4.7%) for men and 4.2% (95% CI 3.6% to 5.3%) for women with subregional variations from 4.1% (95% CI 3.3% to 5.4%) in West Africa to 2.0% (95% CI 1.5% to 3.3%) in southern Africa for men; and 4.7% (95% CI 3.9% to 6.0%) in West Africa to 2.3% (95% CI 1.7% to 3.8%) in southern Africa for women.

Conclusions The age-standardised prevalence of blindness and MSVI decreased substantially from 1990 to 2010, although there was a moderate increase in the absolute numbers with blindness or MSVI. Significant subregional and gender disparities exist.

INTRODUCTION

Sub-Saharan Africa (SSA) is characterised by the highest population growth rate in the world, poverty and poor health status.^{1,2} The average life expectancy from birth is a mere 54 years.³ The SSA region bears a disproportionate burden of non-communicable diseases (NCDs) and infectious (communicable) diseases in comparison with the rest of the world.⁴ It is estimated that NCDs, due to their influence on morbidity and mortality, will overtake communicable diseases as the major public health challenge by the year 2030.⁵ Blindness and

its resulting disability are among the serious consequences of NCDs in Africa.⁶

In 2010, WHO estimated that 39 million people were blind (<3/60) and 285 million had moderate to severe vision loss (moderate/severe vision impairment (MSVI) <6/18 to ≥3/60) globally.⁷ SSA is characterised by an inordinate amount of the global distribution of blindness largely due to the high prevalence of neglected (infectious) tropical diseases such as trachoma and onchocerciasis, with vision impairment ranking as one of the leading and significantly preventable causes of disability. Despite representing 12% of the world's population, Africa contributes to 15% of the visually impaired globally.^{8,9}

Global efforts such as the VISION 2020: Right to Sight Campaign of the WHO and the International Agency for the Prevention of Blindness in aiming to eliminate avoidable blindness in Africa, have sought to use epidemiological data on African eye disease prevalence to draw attention to the key causes of blindness and visual impairment in Africa. However population-based studies on blindness and vision impairment have been limited in African countries, prompting the WHO in 2004 to call for more prevalence studies in the region.¹⁰ Since then, a number of Rapid Assessment of Avoidable Blindness (RAAB) studies have been conducted and they have generated valuable data for projections and planning. However, studies of blindness and vision impairment that have presented data for Africa and other regions have lacked details of the changes in vision impairment prevalence over time as well as regional trends in the prevalence of vision impairment by cause.^{8,10–12}

The recent Global Burden of Disease, Injuries and Risk Factors 2010 (GBD) Study provided the basis for a comprehensive review of blindness and vision impairment studies globally and quantified significant variations in different regions,¹³ reinforcing the need to review and generate comprehensive regional data to guide policy and interventions in eye health. This paper presents the results of a systematic review of published and unpublished blindness and vision impairment studies in SSA, performed between 1980 and 2012 and provides temporal trends and regional variations which have not been previously presented.

METHODOLOGY

Detailed information regarding the GBD Vision Loss Project has been reported previously.^{13,14} In



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brief, a systematic review of all medical literature published from 1 January 1980 to 31 January 2012 that reported the incidence, prevalence and causes of blindness and/or MSVI were considered for inclusion. Only population-based cross-sectional studies that are representative of the general population were considered for data extraction. The definition of blindness used is presenting visual acuity of <3/60 and the definition of MSVI is <6/18 to ≥3/60. Unpublished data and data from studies following the protocol of RAAB were also included. Despite the studies spanning a significant period, strict adherence to the inclusion criteria and the involvement of ophthalmic epidemiologists with knowledge of the specific countries and studies conducted in these countries, ensured that all studies included in the analysis were of a similar quality. A complete list of the studies is available online.¹⁵

We estimated the contribution of six causes of vision impairment and blindness: cataract, glaucoma, macular degeneration, diabetic retinopathy, trachoma and uncorrected refractive error (estimated as the difference between presenting and best-corrected vision impairment, including aphakia). We also estimated the fraction of visual impairment that had other known or unknown causes. For the statistical analysis, we used 5-year age-range estimates and applied DisMod-MR, an age-integrating Bayesian multilevel regression tool, for the calculation of cause fractions for major causes of vision impairment to calculate the fraction of vision impairment due to causes mentioned above.^{16 17} For presentation, we age-standardised prevalences using the WHO reference population.

More detailed description of the methodology and statistical analysis can be found in the GBD High Income Countries paper.¹⁷

The 95% CIs are presented for summary estimates.

RESULTS

A total of 52 studies for SSA countries (table 1) met the inclusion criteria; 1 from central Africa, 19 from East Africa, 6 from southern Africa and 26 from West Africa were included in the analysis.

The estimated age-standardised prevalence of blindness was 1.9% (1.5% to 2.2%) in 1990 and decreased to 1.3% (1.1% to 1.5%) in 2010 while MSVI decreased from 5.3% (4.3% to 6.5%) in 1990 to 4.0% (3.4% to 5.0%) in 2010, a 32% and 25% reduction in blindness and MSVI, respectively. The all-age temporal trend was significant at the 0.05 level. A reduction in age-standardised prevalence among men and women was

Table 1 Countries in the sub-Saharan Africa region

Region	Countries
Central Africa	Angola, Central African Republic, Congo*, Democratic Republic of the Congo, Equatorial Guinea, Gabon
East Africa	Burundi, Comoros, Djibouti, Eritrea, Ethiopia*, Kenya*, Madagascar, Malawi*, Mauritius, Mozambique, Rwanda*, Seychelles, Somalia, Sudan*, Tanzania*, Uganda*, Zambia
Southern Africa	Botswana*, Lesotho, Namibia, South Africa*, Swaziland, Zimbabwe*
West Africa	Benin*, Burkina Faso, Cameroon*, Cape Verde*, Chad, Côte d'Ivoire, Gambia*, Ghana*, Guinea, Guinea-Bissau, Liberia, Mali*, Mauritania*, Niger, Nigeria*, Senegal, Sierra Leone*, São Tome and Príncipe, Togo

*Those for which data were available are marked with an asterisk.

A list of all references used for this analysis can be found in a web appendix at <http://www.anglia.ac.uk/verugbd>.

Table 2 Age-standardised prevalence of blindness and MSVI in 1990 and in 2010

Visual acuity category	Sex	1990 Mean % (95% CI)	2010 Mean % (95% CI)
Blindness	Male	1.8 (1.4 to 2.1)	1.2 (1.0 to 1.4)
	Female	2.0 (1.6 to 2.3)	1.4 (1.1 to 1.6)
	Both	1.9 (1.5 to 2.2)	1.3 (1.1 to 1.5)
MSVI	Male	5.0 (4.0 to 6.1)	3.8 (3.1 to 4.7)
	Female	5.6 (4.5 to 6.8)	4.2 (3.6 to 5.3)
	Both	5.3 (4.3 to 6.5)	4.0 (3.4 to 5.0)

MSVI, moderate/severe vision impairment.

demonstrated between 1990 and 2010 (table 2). There is a wider CI for the prevalence of blindness in 1990 compared with 2010 (table 2), a consequence of the greater availability of studies in 2010, particularly due to the increase in RAAB studies.

The prevalence of blindness and MSVI was higher among women than men in SSA. Subregional gender variations in the age-standardised prevalence of blindness (table 3) ranged from 2.1% (1.6% to 2.5%) in West Africa to 1.2% (0.8% to 2.2%) in central Africa among men; and 2.3% (1.8% to 2.8%) in West Africa to 1.4% (0.9% to 2.5%) in central Africa and southern Africa in women. West Africa also had the highest prevalence for MSVI.

A higher prevalence of blindness and MSVI in the older than 50 years age group (the focus of RAAB studies) was found, with the 1990 prevalence of blindness being 7.3% (5.8% to 8.3%) in men compared with 8.1% (6.5% to 9.2%) in women. The 2010 prevalence for blindness was lower, at 5.0% (4.0% to 5.8%) for men and 5.5% (4.4% to 6.4%) for women. A similar trend was evident for MSVI, with a prevalence of 18.6% (15.1% to 22.4%) for men and 20.5% (16.8% to 24.6%) for women in 1990, and of 14.2% (11.8% to 17.7%) for men and 15.7% (13.4% to 19.4%) for women in 2010.

The country-level estimates of the age-standardised prevalence of blindness for those over 50 years of age was the highest in Mauritania for men (12.1%) and women (13.3%) in 1990 (figure 1), whereas Niger had the highest prevalence for 2010 at 9.3% and 10.2% for men and women, respectively. MSVI prevalence was highest in Chad (24.4% for men and 26.8% for women) and Niger (25.2% for men and 27.7% for women) in 1990, and in Somalia (21.9% for men and 24.2% for women) in 2010 (figure 2).

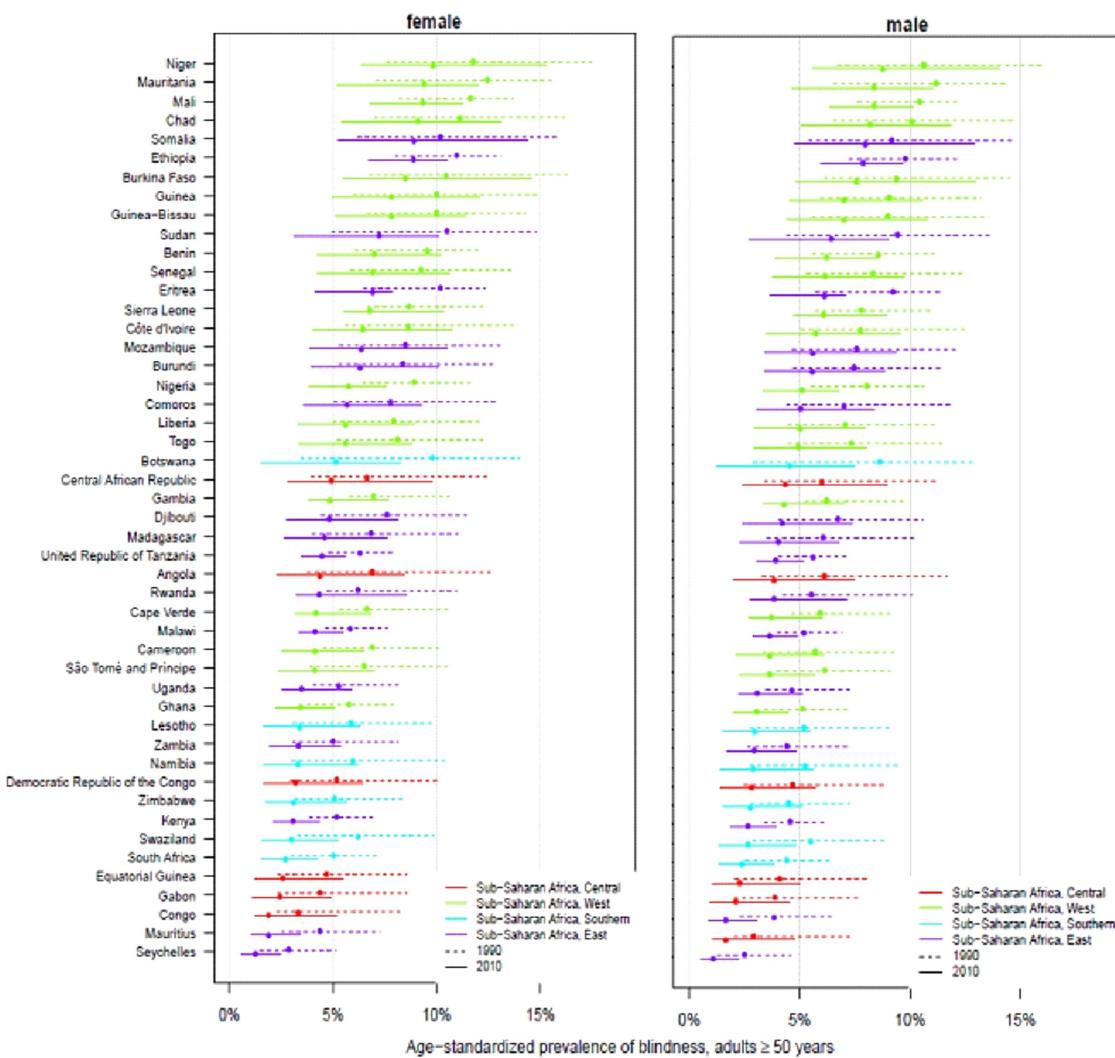
A total of 4.1 million people (1.8 million men and 2.3 million women) from the SSA region contributed to the global blind population in 1990, and 4.8 million (2.1 million men and 2.7 million women) in 2010, contributing, 12.9% and 14.8% of global blindness, respectively (table 4). This represented a 16% increase in blind people in this region between 1990 and 2010. In 1990 there were 13.0 million people (5.7 million men and 7.3 million women) with MSVI and 16.6 million (7.3 million men and 9.3 million women) in 2010; 17.3% and 17.1% of the global burden of MSVI, respectively. This was equivalent to a 28% increase in the number of people with MSVI. However, it should be noted that concurrently the SSA population grew by 66%. In 2010, the West Africa subregion had the highest number of people with blindness and MSVI (2.1 million and 7.2 million, respectively) while central Africa

Global issues

Table 3 Age-standardised prevalence of blindness and vision impairment (and 95% CI) by sex, region and year comparing adults 50 years and older with all ages

Region	Adults 50+				All ages			
	Men		Women		Men		Women	
	Blind	MSVI	Blind	MSVI	Blind	MSVI	Blind	MSVI
1990								
Central Africa	5.1 (3.1 to 9.0)	17.5 (11.5 to 26.4)	5.7 (3.6 to 9.9)	19.6 (12.6 to 29.4)	1.2 (0.8 to 2.2)	4.7 (3.1 to 7.4)	1.4 (0.9 to 2.5)	5.3 (3.4 to 8.4)
East Africa	7.4 (5.6 to 8.7)	18.7 (14.6 to 22.6)	8.3 (6.4 to 9.7)	20.8 (16.8 to 24.8)	1.8 (1.4 to 2.2)	5.0 (3.9 to 6.2)	2.1 (1.6 to 2.4)	5.6 (4.5 to 6.9)
Southern Africa	5.2 (2.7 to 6.7)	11.6 (9.0 to 15.9)	5.8 (3.2 to 7.5)	13.1 (10.0 to 17.8)	1.3 (0.7 to 1.7)	3.0 (2.3 to 4.3)	1.4 (0.8 to 1.8)	3.4 (2.6 to 4.8)
West Africa	8.4 (6.4 to 9.9)	20.5 (15.9 to 25.7)	9.3 (7.3 to 11.1)	22.8 (17.8 to 28.2)	2.1 (1.6 to 2.5)	5.5 (4.2 to 7.2)	2.3 (1.8 to 2.8)	6.2 (4.7 to 7.9)
Africa	7.3 (5.8 to 8.3)	18.6 (15.1 to 22.4)	8.1 (6.5 to 9.2)	20.5 (16.8 to 24.6)	1.8 (1.4 to 2.1)	5.0 (4.0 to 6.1)	2.0 (1.6 to 2.3)	5.6 (4.5 to 6.8)
World	2.8 (2.4 to 3.2)	13.8 (11.6 to 15.6)	3.2 (2.9 to 3.7)	14.8 (12.5 to 16.8)	0.7 (0.6 to 0.8)	3.9 (3.2 to 4.4)	0.8 (0.7 to 1.0)	4.3 (3.5 to 4.9)
2010								
Central Africa	3.0 (1.8 to 5.8)	12.1 (8.0 to 19.5)	3.4 (2.1 to 6.6)	13.6 (9.0 to 22.1)	0.7 (0.4 to 1.4)	3.2 (2.1 to 5.3)	0.8 (0.5 to 1.6)	3.6 (2.4 to 6.0)
East Africa	5.4 (4.1 to 6.5)	14.9 (12.1 to 18.7)	6.0 (4.6 to 7.2)	16.7 (13.7 to 20.4)	1.3 (1.0 to 1.6)	4.0 (3.2 to 5.0)	1.5 (1.1 to 1.8)	4.5 (3.6 to 5.6)
Southern Africa	2.9 (1.5 to 4.1)	7.8 (5.7 to 12.2)	3.2 (1.7 to 4.5)	8.8 (6.7 to 14.2)	0.7 (0.4 to 1.0)	2.0 (1.5 to 3.3)	0.8 (0.4 to 1.1)	2.3 (1.7 to 3.8)
West Africa	5.6 (4.2 to 6.7)	13.5 (10.7 to 17.4)	6.3 (4.8 to 7.5)	17.5 (14.5 to 22.1)	1.4 (1.0 to 1.7)	4.1 (3.3 to 5.4)	1.6 (1.2 to 1.9)	4.7 (3.9 to 6.0)
Africa	5.0 (4.0 to 5.8)	14.2 (11.8 to 17.7)	5.5 (4.4 to 6.4)	15.7 (13.4 to 19.4)	1.2 (1.0 to 1.4)	3.8 (3.1 to 4.7)	1.4 (1.1 to 1.6)	4.2 (3.6 to 5.3)
World	1.7 (1.5 to 1.9)	9.7 (8.8 to 11.5)	2.1 (1.9 to 2.4)	11.0 (10.0 to 13.1)	0.4 (0.4 to 0.5)	2.7 (2.4 to 3.2)	0.5 (0.5 to 0.6)	3.1 (2.8 to 3.7)

MSVI, moderate/severe vision impairment.

**Figure 1** Ladder plot showing the age-standardised prevalence of blindness and change in women (A) and men (B) aged 50+ years for 1990 and 2010. These are modelled estimates using prevalence figures applied to the individual populations of countries.

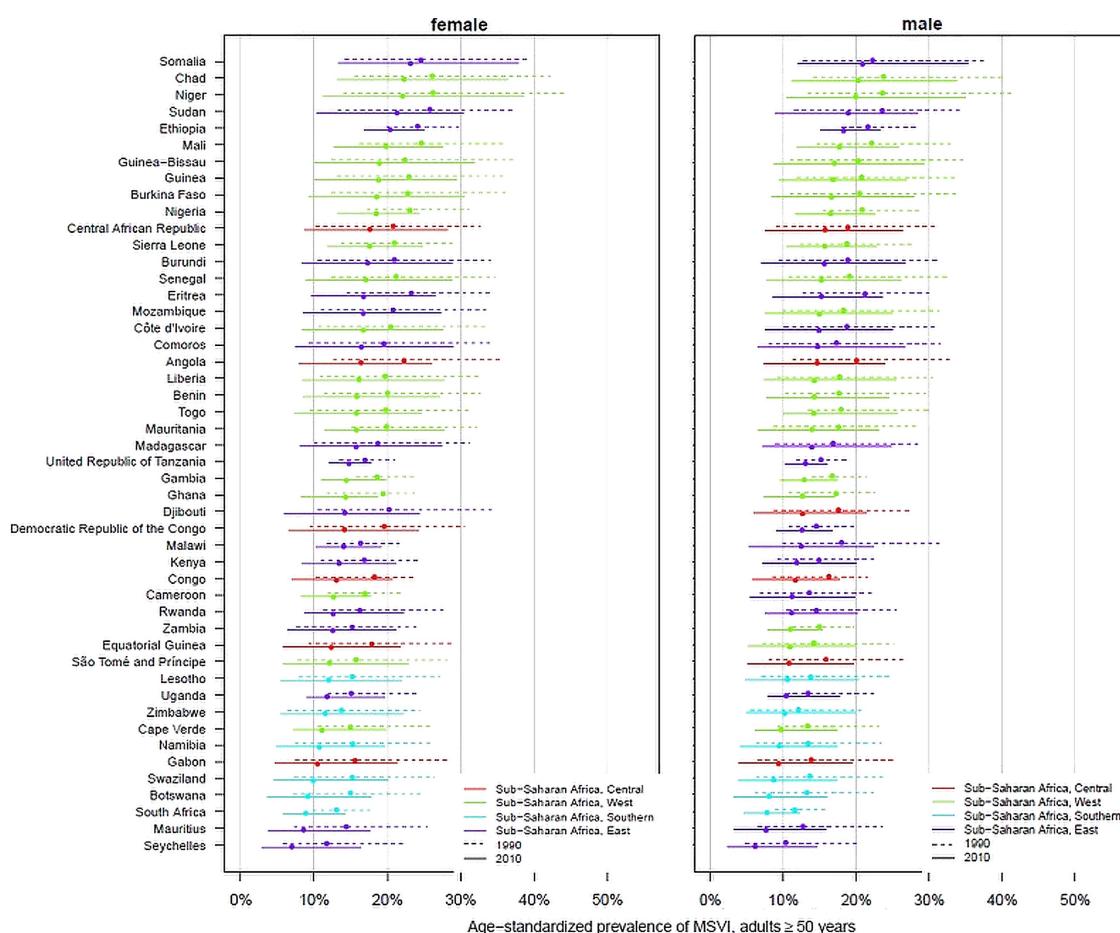


Figure 2 Ladder plot showing the age-standardised prevalence of moderate/severe vision impairment (MSVI) and change in women (A) and men (B) aged 50+ years for 1990 and 2010. These are modelled estimates using prevalence figures applied to the individual populations of countries.

showed the lowest numbers, with 0.28 million blind and 1.4 million MSVI. Similar subregional trends were observed in 1990 (table 4).

In 1990, cataract was the main cause of blindness (36.5% (35.7% to 37.5%)) followed by other or unidentified causes as

the second main cause of blindness (32.0% (31.3% to 33.0%)). This was followed by uncorrected refractive error (12.9% (9.5% to 15.1%)), trachoma (8.9% (8.7% to 9.4%)), macular degeneration (3.8% (3.0% to 4.7%)), glaucoma (3.1% (3.1% to 3.3%)) and diabetic retinopathy (2.2% (2.2% to 2.5%)) (table 5). In

Table 4 Absolute numbers affected by blindness and moderate/severe vision impairment (MSVI) in sub-Saharan Africa

Region	Men		Total population ('000s)	Women		Total population ('000s)
	Blind ('000s)	MSVI ('000s)		Blind ('000s)	MSVI ('000s)	
1990						
Central Africa	116 (69 to 215)	527 (331 to 893)	26 348	163 (102 to 301)	712 (444 to 1196)	27 020
East Africa	714 (522 to 852)	2274 (1729 to 2861)	103 149	922 (693 to 1109)	2871 (2200 to 3588)	104 973
Southern Africa	123 (62 to 163)	344 (258 to 499)	25 975	186 (101 to 243)	490 (367 to 696)	26 588
West Africa	830 (615 to 1014)	2591 (1902 to 3457)	100 636	1048 (796 to 1271)	3189 (2403 to 4217)	100 195
Africa	1783 (1401 to 2040)	5733 (4528 to 7150)	256 108	2320 (1826 to 2668)	7269 (5766 to 9082)	258 776
World	12,781 (11 063 to 14,752)	75,347 (61 168 to 87 018)	2 671 106	19 054 (16 824 to 22 121)	96 967 (79 886 to 111 527)	2 632 068
2010						
Central Africa	119 (70 to 235)	604 (388 to 1056)	47 564	162 (99 to 324)	795 (517 to 1398)	48 134
East Africa	907 (679 to 1124)	3124 (2495 to 4008)	176 321	1182 (896 to 1445)	3988 (3162 to 5084)	177 653
Southern Africa	114 (59 to 161)	374 (271 to 632)	34 817	184 (97 to 265)	569 (435 to 935)	35 534
West Africa	930 (695 to 1133)	3221 (2511 to 4284)	168 792	1175 (899 to 1434)	3972 (3233 to 5198)	166 473
Africa	2068 (1638 to 2446)	7316 (5964 to 9299)	427 494	2705 (2176 to 3188)	9329 (7885 to 11 852)	427 794
World	12 848 (11 418 to 14 626)	82 740 (74 444 to 99 069)	3 475 478	19 610 (17 719 to 22 165)	108 883 (99 159 to 130 141)	3 415 322

Table 5 Proportion of blindness, and moderate/severe vision impairment (MSVI) by cause in 1990 and 2010 for all ages

Region	Cataract Blind (%)	Cataract MSVI (%)	Refractive error Blind (%)	Refractive error MSVI (%)	Macular degeneration Blind (%)	Macular degeneration MSVI (%)	Glaucoma Blind (%)	Glaucoma MSVI (%)	Diabetic retinopathy Blind (%)	Diabetic retinopathy MSVI (%)	Trachoma Blind (%)	Trachoma MSVI (%)	Other causes/ unidentified Blind (%)	Other causes/ unidentified MSVI (%)
1990														
Central Africa	41.0 (33.3 to 47.5)	27.1 (22.2 to 32.4)	13.3 (7.8 to 17.2)	44.5 (35.5 to 51.3)	4.8 (3.5 to 7.1)	1.9 (1.3 to 2.9)	3.3 (2.4 to 4.6)	1.0 (0.71 to 1.5)	2.5 (1.8 to 3.6)	1.7 (1.2 to 2.5)	0.94 (0.52 to 1.6)	0.46 (0.20 to 0.85)	34.2 (28.4 to 41.2)	23.4 (19.6 to 28.6)
East Africa	35.4 (31.7 to 39.8)	22.7 (19.3 to 26.6)	12.9 (7.7 to 17.1)	44.0 (35.4 to 50.6)	4.1 (3.4 to 5.1)	2.5 (1.9 to 3.2)	2.9 (2.4 to 3.6)	0.95 (0.76 to 1.2)	2.0 (1.6 to 2.5)	1.3 (1.0 to 1.7)	13.5 (11.7 to 15.1)	8.0 (6.5 to 9.6)	29.2 (26.4 to 32.5)	20.6 (17.3 to 24.6)
Southern Africa	34.0 (29.0 to 39.8)	24.2 (19.3 to 29.6)	13.2 (7.8 to 17.3)	45.9 (36.7 to 52.6)	6.9 (5.5 to 8.9)	2.8 (2.0 to 4.2)	5.4 (4.2 to 7.3)	1.5 (1.1 to 2.3)	2.9 (2.0 to 4.1)	1.7 (1.3 to 2.6)	1.6 (1.1 to 2.6)	0.85 (0.40 to 1.6)	36.1 (30.1 to 42.4)	22.9 (18.4 to 28.6)
West Africa	37.1 (32.1 to 41.9)	24.3 (20.0 to 28.2)	12.9 (7.6 to 17.0)	43.8 (35.0 to 50.4)	4.1 (3.4 to 5.4)	1.4 (1.1 to 1.9)	2.9 (2.4 to 3.8)	0.93 (0.71 to 1.3)	2.4 (1.9 to 3.1)	1.6 (1.3 to 2.3)	7.3 (6.6 to 8.6)	4.3 (3.7 to 5.3)	33.4 (28.9 to 38.4)	23.7 (19.7 to 29.1)
Africa	36.5 (35.7 to 37.5)	23.9 (23.3 to 24.3)	12.9 (9.5 to 15.1)	44.1 (40.0 to 45.5)	3.8 (3.0 to 4.7)	1.6 (1.3 to 2.1)	3.1 (3.1 to 3.3)	1.0 (1.0 to 1.1)	2.2 (2.2 to 2.5)	1.5 (1.5 to 1.7)	8.9 (8.7 to 9.4)	5.2 (5.0 to 5.6)	32.0 (31.3 to 33.0)	22.4 (21.5 to 24.1)
World	38.6 (35.2 to 42.0)	25.6 (22.7 to 28.4)	19.9 (14.9 to 24.9)	51.1 (45.6 to 56.0)	4.9 (4.4 to 5.8)	1.9 (1.6 to 2.4)	4.4 (4.0 to 5.1)	1.2 (1.1 to 1.5)	2.1 (1.9 to 2.5)	1.3 (1.2 to 1.6)	2.8 (2.3 to 3.1)	1.3 (0.97 to 1.5)	27.4 (24.9 to 30.0)	17.6 (15.4 to 20.3)
2010														
Central Africa	34.8 (25.3 to 42.5)	18.8 (12.8 to 24.3)	13.6 (8.0 to 17.5)	45.9 (36.8 to 52.4)	6.9 (4.7 to 11.0)	3.6 (2.1 to 6.2)	5.2 (3.4 to 8.8)	1.9 (1.2 to 3.3)	3.0 (2.0 to 5.2)	2.3 (1.6 to 4.0)	0.44 (0.24 to 0.82)	0.25 (0.10 to 0.53)	36.0 (28.4 to 44.0)	27.3 (21.4 to 35.4)
East Africa	36.7 (31.9 to 41.5)	19.6 (15.8 to 23.6)	13.1 (7.8 to 17.2)	44.8 (36.0 to 51.0)	5.8 (4.6 to 7.7)	4.0 (3.0 to 5.5)	4.0 (3.1 to 5.4)	1.5 (1.1 to 2.2)	2.4 (1.9 to 3.4)	1.8 (1.4 to 2.6)	8.1 (6.8 to 9.5)	5.3 (4.2 to 6.9)	29.9 (25.6 to 34.5)	23.1 (19.0 to 28.0)
Southern Africa	31.2 (24.6 to 39.0)	17.8 (12.3 to 23.9)	13.5 (8.0 to 17.7)	46.7 (37.4 to 53.2)	9.7 (6.7 to 14.1)	4.8 (2.8 to 7.7)	7.3 (5.2 to 10.4)	2.6 (1.8 to 4.0)	3.4 (2.1 to 5.8)	2.5 (1.6 to 4.6)	0.69 (0.45 to 1.1)	0.47 (0.24 to 0.96)	34.0 (27.1 to 42.2)	25.2 (19.7 to 32.4)
West Africa	33.8 (28.1 to 39.3)	15.6 (11.4 to 20.5)	13.2 (7.8 to 17.3)	44.8 (35.8 to 51.2)	6.2 (4.8 to 8.4)	2.9 (2.0 to 4.3)	4.4 (3.4 to 5.9)	1.8 (1.3 to 2.7)	3.1 (2.4 to 4.9)	2.7 (1.9 to 4.5)	3.6 (3.2 to 4.6)	2.5 (2.1 to 3.5)	35.6 (30.1 to 41.6)	29.6 (23.9 to 35.3)
Africa	35.0 (33.0 to 35.8)	17.7 (16.6 to 18.8)	13.2 (9.9 to 15.4)	45.0 (40.8 to 47.7)	6.3 (6.0 to 6.7)	2.8 (2.3 to 4.1)	4.4 (4.1 to 5.0)	1.7 (1.6 to 2.0)	2.8 (2.6 to 3.5)	2.3 (2.1 to 2.9)	5.2 (4.9 to 5.8)	3.4 (3.1 to 3.8)	33.1 (31.6 to 34.2)	26.4 (24.3 to 28.4)
World	33.4 (29.6 to 36.4)	18.4 (15.8 to 20.9)	20.9 (15.2 to 25.9)	52.9 (47.2 to 57.3)	6.6 (6.0 to 7.9)	3.1 (2.7 to 4.0)	6.6 (5.9 to 7.9)	2.2 (2.0 to 2.8)	2.6 (2.2 to 3.4)	1.9 (1.6 to 2.7)	1.4 (1.2 to 1.7)	0.71 (0.56 to 0.91)	28.6 (26.1 to 31.5)	20.8 (18.4 to 23.8)

2010, macular degeneration was the only exception to the trend observed in 1990. The prevalence of macular degeneration was higher than that of trachoma. Uncorrected refractive error was the main cause of MSVI in 1990 followed by cataract, other or unidentified causes, trachoma, macular degeneration, glaucoma and diabetic retinopathy (table 5). In 2010, uncorrected refractive error remained the major cause while other or unidentified causes were the second most common cause.

DISCUSSION

The age-standardised prevalence of blindness decreased substantially from 1.9% in 1990 to 1.3% in 2010, although the total number of people of all ages with blindness in Africa increased by 16%, from 4.1 million in 1990 to 4.7 million in 2010. In addition, the prevalence of MSVI decreased by 27%, although the number with MSVI increased from 13.0 million in 1990 to 16.6 million in 2010. The increase in absolute numbers is a reflection of the 66% population growth and increasing ageing of the population.¹³ We found a higher prevalence of blindness in Africa compared with that reported by Lewallen *et al*¹⁸ in 2001, who reported a prevalence of 1%. While Pascolini and Mariotti⁸ reported that Africa contributes 15% of the world's blindness and 9.2% of the world's visual impairment in 2010, we found a relatively similar blindness contribution (14.8%), but our estimated contribution for MSVI was almost double (17.1%) than that reported by Pascolini and Mariotti.⁸ The consideration of data from RAAB studies and unpublished additional sources accessed in our systematic review may have contributed to this difference.

The subregional variations in blindness and vision impairment provide valuable data to guide planning and funding efforts. West Africa consistently has a higher prevalence of both and this highlights the need for a greater intervention in this subregion. This is probably a consequence of poorer eye health services in the former Francophone African countries and the high prevalence of blindness and vision impairment in Nigeria as reported by Rabiu *et al*.¹⁹ Many of the Francophone African countries are located in parts of Africa that have been referred to as the 'corridor of neglect' (Dr Hannah Faal, personal communication). Interventions from governments, civil society and private-citizen philanthropies in blindness prevention efforts in Africa, and greater co-ordination at subregional level may mitigate this.

Others have highlighted the gender disparities in Africa.¹⁸ We found a similar trend in blindness and vision impairment. Although the disparity has remained the same for 1990 and 2010 (0.2%) for blindness, in terms of vision impairment, there was an increase from 0.6% in 1990 to 0.8% in 2010, indicating a worsening of the disparity and the need for targeted action to reach women in eye health programmes.

The reduction in the relative contribution of trachoma to blindness and vision impairment from 1990 to 2010 is probably reflective of the socioeconomic development that is taking place in many places in Africa that is making water and sanitation more accessible. The concurrent increase in prevalence of macular degeneration over the period of review could be attributed to an increase in life expectancy in all regions of the world.²⁰

Cataract is still the leading cause of blindness in this region which most probably reflects the challenges in the provision of cataract surgery, an intervention that is known to be cost-effective with quality improved through simple prospective monitoring.²¹ However, posterior segment diseases like diabetic retinopathy and macular degeneration are gaining increased importance as causes of blindness and vision impairment. Although the prevalence of these conditions is low, the cost of

intervention is higher and treatment options are more complex. This is going to place an increased burden on blindness prevention efforts in Africa. The lower prevalence of glaucoma compared with conditions such as macular degeneration is inconsistent with some studies, notably the recent national survey in Nigeria.¹⁹ This could be a consequence of field surveys with limited diagnostic capacity but is particularly true in the case of rapid assessments and is evident by the high prevalence of unidentified causes.⁸ The lack of refractive services in SSA is magnified by the fact that nearly half of the MSVI prevalence is due to uncorrected refractive error, highlighting the critical need for human resource and service delivery interventions.

A notable data gap in the published literature is in the measurement of the burden of blindness and vision impairment due to onchocerciasis. Onchocerciasis is mainly prevalent in SSA, where 99% of the infected population lives.²² Additionally, it should be noted that although interventions such as vector control, implemented by the Onchocerciasis Control Programme in West Africa from the mid-1970s to 2002, and supplemented with ivermectin since 1988, have contributed greatly to decrease the incidence of ocular pathology associated with this infection, cases persist due to the fact that ivermectin does not reverse prevalent blindness,²³ and transmission has not been totally interrupted.

The data collected in the present study were limited by the shortage of national studies as well as total lack of studies in some countries. Of particular concern was the lack of data collected in central Africa, where only one study was available indicating that this subregion should be prioritised for further research. There has been an increased focus on RAAB studies in Africa which specifically examine those aged 50 years and older. These studies are not conducted at a national level and may therefore overestimate the prevalence of cataract for example, especially when the areas under investigation differ significantly from other areas in the country.

CONCLUSION

In 2010, 16.6 million people had MSVI and 4.8 million people were blind in Africa, and there has been an increase in the absolute numbers affected since 1990. However, there has been a significant reduction in prevalence of blindness and vision impairment from 1990 to 2010. This is a significant improvement given a 66% increase in the overall population in Africa in the same time period. Women bear a greater burden of this blindness and vision impairment. The prevalence of vision impairment, including blindness and MSVI, was highest in West Africa and lowest in southern and central Africa.

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Collaborators Collaboration Group Information: 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

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Prevalence and causes of vision loss in sub-Saharan Africa: 1990–2010

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