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Prevalence and causes of vision loss in Latin America and the Caribbean: 1990–2010

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ABSTRACT

Objective To present regional estimates of the magnitude and temporal trends in the prevalence and causes of blindness and moderate/severe visual impairment (MSVI) in Latin America and the Caribbean (LAC).

Methods A systematic review of cross-sectional population-representative data from published literature and unpublished studies was accessed and extracted to model the estimated prevalence of vision loss by region, country and globally, and the attributable cause fraction by region.

Results In the LAC combined region, estimated all-age both-gender age-standardised prevalence of blindness halved from 0.8% (0.6 to 1.1) in 1990 to 0.4% (0.4 to 0.6) in 2010 and MSVI decreased from 4.3% (3.1 to 5.3) to 2.7% (2.2 to 3.4). In the Caribbean, estimated all-age both-gender age-standardised prevalence of blindness decreased from 0.6% (0.4 to 0.8) in 1990 to 0.5% (0.4 to 0.6) in 2010 and MSVI decreased from 3.3% (1.3 to 4.1) in 1990 to 2.9% (1.8 to 3.8). In the LAC regions combined, there was an estimated 2.3 million blind and 14.1 million with MSVI in 2010. In 2010, cataract continues to contribute the largest proportion of blindness, except in Southern Latin America where macular degeneration is most common. In 2010, uncorrected refractive error was the most common cause of MSVI.

Conclusions While models suggest a decrease in age-standardised prevalence estimates, better data are needed to evaluate the disparities in the region. The increasing numbers of older people, coupled with the increase in vision loss associated with older age, will require further intervention to continue to reduce prevalence rates and to prevent a rise in absolute numbers of blind.

INTRODUCTION

Concern about the global burden of blindness and visual impairment led to the WHO global initiative VISION 2020: The Right to Sight,[1] and World Health Assembly Resolutions.[2 3] Regionally, the Pan American Health Organization[4] developed Strategies[5 6] and Resolutions,[7 8] and mobilised both governmental and non-governmental organisations to develop blindness prevention programmes nationally and regionally through the International Agency for the Prevention of Blindness and partners.[9]

Previous global prevalence meta-analytical estimates of blindness and visual impairment for Latin America and the Caribbean (LAC) used a variety of meta-analytical methodologies.[10 11] In 2002, for every million population in LAC, 5000 were estimated to be blind and 20 000 visually impaired. At

Table 1 Global burden of disease, injury and risk factor study defined country regions in Latin America and the Caribbean

Caribbean		Latin America, Andean	Latin America, Central	Latin America, Southern	Latin America, Tropical
Antigua and Barbuda	Haiti	Bolivia	Colombia	Argentina*	Brazil*
Bahamas	Jamaica	Ecuador*	Costa Rica	Chile*	Paraguay*
Barbados*	Puerto Rico	Peru*	El Salvador	Uruguay	
Belize	Saint Lucia		Guatemala*		
Cuba*	Saint Vincent & Grenadines		Honduras		
Dominica	Suriname		Mexico*		
Dominican Republic*	Trinidad and Tobago		Nicaragua		
Grenada			Panama		
Guyana			Venezuela*		

These subregional country designations differ from other regional or geographical designations such as the Pan American Health Organization, the Pan American Association of Ophthalmology or the World Council of Optometry. Other countries not listed here were not included in the analysis.
*Countries with included studies in the analysis.

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Table 2 Age-standardised prevalence of visual impairment by gender, region and year

Region	Adults ≥50 years						All ages					
	Men		Women		Both genders		Men		Women		Both genders	
	Blind (%)	Moderate and severe visual impairment (%)	Blind (%)	Moderate and severe visual impairment (%)	Blind (%)	Moderate and severe visual impairment (%)	Blind (%)	Moderate and severe visual impairment (%)	Blind (%)	Moderate and severe visual impairment (%)	Blind (%)	Moderate and severe visual impairment (%)
1990												
Caribbean	2.6 (1.9 to 3.6)	13.4 (7.7 to 18.4)	3.5 (2.6 to 4.9)	15.3 (9.0 to 20.9)	3.1 (2.2 to 3.9)	15.6 (9.1 to 18.9)	0.6 (0.5 to 0.9)	3.6 (2.1 to 5.1)	0.9 (0.6 to 1.3)	4.1 (2.4 to 5.8)	0.6 (0.4 to 0.8)	3.3 (1.9 to 4.1)
Latin America, Andean	3.2 (2.1 to 4.4)	17.2 (11.1 to 23.2)	4.3 (3.0 to 6.0)	19.4 (12.9 to 25.7)	3.9 (2.6 to 5.0)	19.9 (12.9 to 24.5)	0.8 (0.5 to 1.1)	4.6 (2.9 to 6.2)	1.1 (0.7 to 1.5)	5.2 (3.4 to 7.1)	1.0 (0.6 to 1.2)	5.4 (3.4 to 6.8)
Latin America, Central	3.2 (2.5 to 4.2)	14.6 (10.5 to 19.1)	4.3 (3.4 to 5.6)	16.6 (12.1 to 21.7)	3.9 (3.0 to 4.9)	16.8 (12.3 to 21.0)	0.8 (0.6 to 1.0)	3.9 (2.8 to 5.1)	1.1 (0.8 to 1.4)	4.4 (3.2 to 5.9)	0.9 (0.7 to 1.2)	4.5 (3.3 to 5.6)
Latin America, Southern	1.8 (1.2 to 2.5)	11.1 (7.7 to 19.1)	2.5 (1.6 to 3.5)	12.8 (9.0 to 21.4)	2.1 (1.5 to 2.9)	12.6 (8.5 to 20.2)	0.4 (0.3 to 0.6)	2.9 (2.0 to 5.2)	0.6 (0.4 to 0.8)	3.4 (2.3 to 5.7)	0.5 (0.4 to 0.7)	3.3 (2.2 to 5.4)
Latin America, Tropical	3.2 (2.0 to 6.0)	14.5 (10.5 to 19.7)	4.3 (2.6 to 8.2)	16.6 (12.2 to 22.2)	3.5 (2.2 to 6.9)	16.7 (10.6 to 21.3)	0.8 (0.5 to 1.5)	3.8 (2.8 to 5.3)	1.1 (0.6 to 2.0)	4.4 (3.2 to 6.0)	0.9 (0.5 to 1.6)	4.4 (2.8 to 5.7)
Combined Super-region Latin America and Caribbean (LAC)	2.8 (2.1 to 3.7)	15.1 (10.8 to 18.2)	3.8 (2.9 to 4.9)	17.0 (12.4 to 20.4)	3.3 (2.6 to 4.4)	16.1 (11.7 to 19.5)	0.7 (0.5 to 0.9)	4.0 (2.8 to 4.9)	0.9 (0.7 to 1.2)	4.6 (3.2 to 5.6)	0.8 (0.6 to 1.1)	4.3 (4.1 to 5.3)
World	2.9 (2.4 to 3.3)	13.7 (10.8 to 15.5)	3.3 (2.9 to 3.9)	14.6 (11.8 to 16.6)	3.0 (2.7 to 3.4)	14.3 (12.1 to 16.2)	0.7 (0.6 to 0.8)	3.8 (3.0 to 4.4)	0.9 (0.7 to 1.0)	4.2 (3.4 to 4.9)	0.8 (0.7 to 0.9)	4.1 (3.4 to 4.7)
2010												
Caribbean	1.6 (1.1 to 2.2)	9.8 (6.2 to 13.2)	2.2 (1.6 to 3.0)	11.3 (7.2 to 15.1)	1.9 (1.4 to 2.4)	11.0 (7.1 to 13.9)	0.4 (0.3 to 0.6)	2.6 (1.6 to 3.6)	0.5 (0.4 to 0.8)	3.0 (1.9 to 4.2)	0.5 (0.4 to 0.6)	2.9 (1.8 to 3.8)
Latin America, Andean	1.7 (1.1 to 2.2)	11.7 (8.1 to 15.3)	2.4 (1.6 to 3.1)	13.4 (9.4 to 17.2)	2.1 (1.4 to 2.6)	13.0 (9.4 to 16.6)	0.4 (0.3 to 0.5)	3.1 (2.1 to 4.1)	0.6 (0.4 to 0.8)	3.5 (2.5 to 4.6)	0.5 (0.3 to 0.6)	3.4 (2.4 to 4.4)
Latin America, Central	1.8 (1.4 to 2.4)	9.8 (7.6 to 12.6)	2.4 (2.0 to 3.1)	11.4 (8.7 to 14.7)	2.1 (1.7 to 2.7)	10.7 (8.5 to 13.6)	0.4 (0.3 to 0.6)	2.6 (2.0 to 3.3)	0.6 (0.5 to 0.8)	3.0 (2.3 to 3.9)	0.5 (0.4 to 0.7)	2.8 (2.2 to 3.6)
Latin America, Southern	1.1 (0.7 to 1.5)	7.7 (5.8 to 12.8)	1.5 (1.0 to 2.0)	8.8 (6.7 to 14.9)	1.2 (0.9 to 1.7)	8.3 (6.3 to 14.2)	0.3 (0.2 to 0.4)	2.0 (1.5 to 3.3)	0.4 (0.2 to 0.5)	2.3 (1.7 to 3.9)	0.3 (0.2 to 0.4)	2.2 (1.6 to 3.8)
Latin America, Tropical	1.7 (1.0 to 3.3)	9.4 (6.8 to 12.9)	2.3 (1.3 to 4.5)	10.8 (7.8 to 14.9)	1.8 (1.1 to 3.5)	10.2 (6.9 to 14.2)	0.4 (0.2 to 0.8)	2.4 (1.8 to 3.4)	0.6 (0.3 to 1.1)	2.8 (2.1 to 3.9)	0.4 (0.3 to 0.8)	2.7 (1.8 to 3.7)
Combined Super-region LAC	1.5 (1.2 to 2.1)	9.6 (8.0 to 12.0)	2.1 (1.7 to 2.8)	11.0 (9.0 to 13.8)	1.8 (1.5 to 2.5)	10.4 (8.6 to 12.9)	0.4 (0.3 to 0.5)	2.5 (2.1 to 3.2)	0.5 (0.4 to 0.7)	2.9 (2.4 to 3.6)	0.4 (0.4 to 0.6)	2.7 (2.2 to 3.4)
World	1.8 (1.6 to 2.0)	10.1 (9.0 to 11.6)	2.2 (1.9 to 2.5)	11.5 (10.3 to 13.1)	1.9 (1.7 to 2.2)	10.4 (9.5 to 12.3)	0.4 (0.4 to 0.5)	2.8 (2.5 to 3.2)	0.6 (0.5 to 0.6)	3.2 (2.9 to 3.8)	0.5 (0.4 to 0.6)	2.9 (2.6 to 3.5)

95% uncertainty interval is shown in parentheses. The world figures are presented for comparison.

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Table 3 Population with visual impairment by gender, region and year

Region	Males			Females			Both genders		
	Blind ('000s)	Moderate and severe visually impaired ('000s)	Total population ('000s)	Blind ('000s)	Moderate and severe visually impaired ('000s)	Total population ('000s)	Blind ('000s)	Moderate and severe visually impaired ('000s)	Total population ('000s)
1990									
Caribbean	81 (59 to 115)	464 (264 to 658)	17 084	125 (92 to 178)	580 (334 to 813)	17 228	205 (150 to 261)	1143 (639 to 1422)	34 312
Latin America, Andean	72 (47 to 101)	485 (300 to 673)	19 337	115 (79 to 160)	616 (395 to 845)	19 267	191 (127 to 249)	1208 (748 to 1552)	38 604
Latin America, Central	318 (244 to 422)	1724 (1226 to 2318)	82 597	522 (410 to 681)	2276 (1651 to 3065)	83 350	847 (657 to 1072)	4322 (3109 to 5550)	165 947
Latin America, Southern	84 (55 to 118)	601 (409 to 1072)	24 039	165 (107 to 233)	900 (627 to 1521)	24 900	234 (169 to 332)	1570 (1055 to 2570)	48 939
Latin America, Tropical	312 (188 to 601)	1724 (1216 to 2407)	76 473	503 (301 to 974)	2241 (1618 to 3118)	77 421	741 (449 to 1398)	4266 (2642 to 5537)	153 894
Combined Super-region Latin American and Caribbean (LAC)	838 (635 to 1128)	5398 (3746 to 6650)	219 530	1382 (1063 to 1829)	7118 (4995 to 8671)	222 166	2220 (1703 to 2967)	12 519 (8745 to 15 346)	441 696
World	13 034 (11 046 to 15 249)	74 444 (57 706 to 87 147)	2 671 106	19 619 (17 001 to 23 130)	95 659 (75 908 to 110 217)	2 632 068	31 816 (28 143 to 36 745)	172 212 (141 749 to 198 125)	5 303 174
2010									
Caribbean	77 (55 to 109)	508 (318 to 706)	20 771	128 (92 to 175)	670 (429 to 918)	20 991	197 (149 to 257)	1227 (766 to 1593)	41 762
Latin America, Andean	75 (48 to 99)	588 (400 to 783)	26 767	123 (82 to 162)	765 (531 to 1000)	26 704	197 (136 to 255)	1395 (991 to 1821	53 471
Latin America, Central	344 (277 to 458)	2135 (1653 to 2833)	114 001	585 (470 to 753)	2910 (2219 to 3852)	116 843	909 (718 to 1185)	5075 (3994 to 6562)	230 844
Latin America, Southern	79 (53 to 112)	619 (472 to 1031)	29 856	170 (112 to 237)	977 (743 to 1634)	31 039	226 (178 to 336)	1592 (1203 to 2726)	60 895
Latin America, Tropical	331 (186 to 640)	2007 (1442 to 2839)	99 194	586 (335 to 1130)	2831 (2068 to 3935)	102 207	798 (486 to 1537)	4846 (3241 to 6843)	201 401
Combined Super-region LAC	845 (683 to 1204)	5930 (4878 to 7471)	290 589	1485 (1199 to 2046)	8219 (6746 to 10 262)	297 784	2326 (1895 to 3194)	14 126 (11 685 to 17 596)	588 373
World	13 186 (11 553 to 15 224)	85 822 (75 807 to 99 567)	3 475 478	20 297 (17 796 to 23 090)	112 851 (100 859 to 131 603)	3 415 322	32 410 (29 351 to 36524)	191 342 (173 910 to 229 823)	6 890 800

95% uncertainty interval is shown in parentheses.

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Table 4 Proportion of blindness and MSVI by cause, Latin America and Caribbean regions and the world, 1990 and 2010, all ages

Region	Cataracts		Uncorrected refractive error		Macular degeneration		Glaucoma		Diabetic retinopathy		Other causes/ unidentified	
	Blind (%)	Moderate severe visual impaired (%)	Blind (%)	Moderate severe visual impaired (%)	Blind (%)	Moderate severe visual impaired (%)	Blind (%)	Moderate severe visual impaired (%)	Blind (%)	Moderate severe visual impaired (%)	Blind (%)	Moderate severe visual impaired (%)
1990												
Caribbean	32.9 (28.3 to 38.0)	22.8 (18.4 to 27.4)	13.3 (8.0 to 17.4)	43.4 (35.6 to 50.4)	4.5 (3.4 to 6.0)	0.74 (0.57 to 1.0)	9.1 (7.3 to 11.8)	3.0 (2.2 to 4.1)	2.1 (1.7 to 2.8)	1.5 (1.2 to 2.1)	38.0 (33.4 to 42.7)	28.6 (23.8 to 34.0)
Latin America, Andean	37.5 (30.5 to 44.2)	22.9 (17.8 to 28.6)	13.3 (8.0 to 17.4)	43.4 (35.0 to 50.8)	3.7 (2.6 to 5.5)	1.4 (0.99 to 2.2)	6.8 (5.0 to 9.6)	2.1 (1.4 to 3.0)	2.1 (1.5 to 3.1)	1.6 (1.1 to 2.4)	36.6 (30.4 to 43.0)	28.7 (23.4 to 34.8)
Latin America, Central	32.9 (27.6 to 38.6)	21.6 (17.3 to 26.0)	13.2 (8.0 to 17.2)	43.9 (35.6 to 50.8)	4.6 (3.5 to 6.2)	1.7 (1.2 to 2.5)	8.6 (6.7 to 11.7)	2.5 (1.9 to 3.7)	2.2 (1.7 to 2.9)	1.6 (1.2 to 2.2)	38.6 (32.6 to 43.8)	28.7 (24.0 to 34.4)
Latin America, Southern	24.3 (18.5 to 31.2)	26.5 (21.1 to 32.6)	13.6 (8.1 to 17.6)	44.4 (35.6 to 51.5)	14.6 (10.6 to 19.6)	4.2 (2.9 to 6.2)	9.3 (6.6 to 12.6)	2.4 (1.7 to 3.7)	5.4 (3.9 to 8.0)	3.1 (2.3 to 5.0)	32.9 (25.0 to 40.1)	19.3 (14.6 to 24.7)
Latin America, Tropical	32.7 (23.9 to 42.5)	22.0 (16.0 to 28.3)	13.4 (8.0 to 17.3)	44.2 (36.0 to 50.9)	5.0 (3.1 to 8.0)	2.8 (1.7 to 4.6)	9.2 (5.9 to 14.0)	2.7 (1.6 to 4.5)	2.5 (1.6 to 4.1)	1.7 (1.1 to 2.8)	37.2 (29.0 to 46.1)	26.6 (20.5 to 32.8)
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)	27.4 (24.9 to 30.0)	17.6 (15.4 to 20.3)
2010												
Caribbean	30.2 (23.8 to 37.1)	15.9 (11.4 to 21.3)	13.5 (8.1 to 17.8)	44.6 (36.3 to 51.2)	6.1 (4.3 to 8.9)	1.2 (0.90 to 1.9)	11.2 (8.0 to 15.1)	4.3 (3.1 to 6.4)	2.3 (1.7 to 3.4)	2.0 (1.5 to 3.2)	36.8 (30.7 to 42.7)	32.0 (25.7 to 38.4)
Latin America, Andean	31.0 (23.3 to 38.7)	14.8 (10.2 to 20.1)	13.6 (8.2 to 17.7)	44.6 (36.0 to 51.6)	6.2 (4.1 to 9.2)	3.1 (2.0 to 5.1)	11.7 (7.9 to 17.1)	4.5 (2.9 to 7.5)	2.5 (1.6 to 4.2)	2.2 (1.5 to 3.8)	35.1 (26.7 to 43.0)	30.8 (24.0 to 38.2)
Latin America, Central	26.4 (20.9 to 32.3)	13.9 (9.9 to 18.8)	13.5 (8.1 to 17.5)	45.2 (36.2 to 51.6)	6.8 (4.9 to 9.9)	3.2 (2.2 to 5.0)	13.0 (9.6 to 18.2)	4.6 (3.2 to 7.1)	2.5 (1.9 to 3.7)	2.1 (1.6 to 3.5)	37.8 (30.4 to 44.6)	30.9 (24.7 to 37.3)
Latin America, Southern	18.0 (12.0 to 25.8)	17.3 (10.7 to 23.2)	13.7 (8.2 to 17.7)	45.4 (36.5 to 52.0)	19.5 (13.2 to 26.8)	7.2 (4.5 to 11.5)	12.6 (7.9 to 19.3)	4.0 (2.5 to 6.3)	5.5 (3.6 to 9.1)	4.0 (2.6 to 6.8)	30.8 (21.8 to 39.3)	22.1 (15.9 to 28.7)
Latin America, Tropical	23.9 (16.2 to 32.5)	13.9 (8.5 to 20.7)	13.6 (8.1 to 17.5)	45.4 (36.7 to 51.9)	9.1 (5.7 to 13.3)	6.0 (3.7 to 9.2)	15.5 (9.6 to 21.9)	5.2 (3.2 to 8.4)	2.9 (1.9 to 4.6)	2.2 (1.4 to 3.6)	35.1 (26.3 to 43.7)	27.3 (20.3 to 34.0)
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)	28.6 (26.1 to 31.5)	20.8 (18.4 to 23.8)

The world figures are included for comparison.

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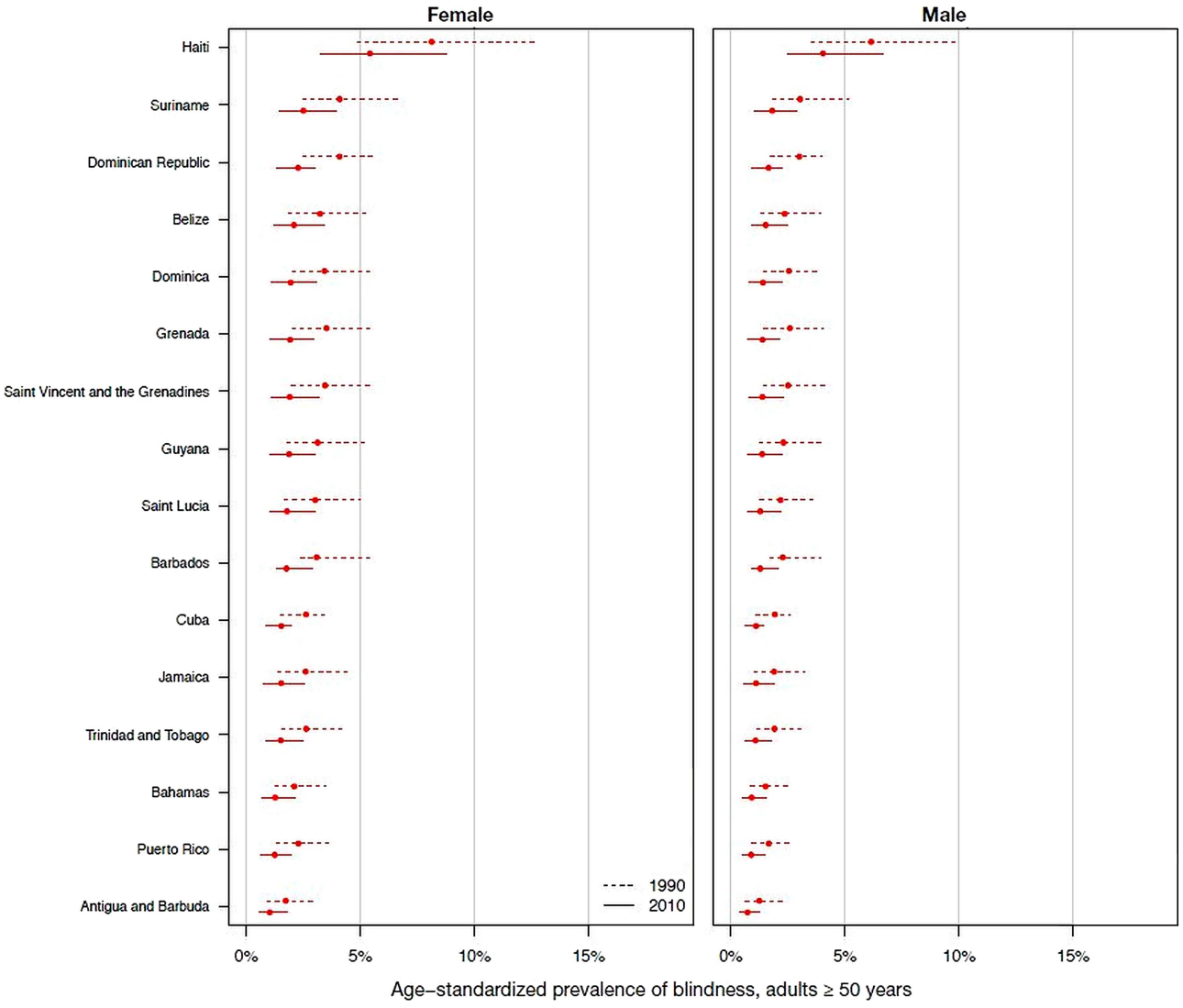

Figure 1 Ladder plot showing the age-standardised prevalence of blindness and change in females (A) and males (B) aged 50+ years for 1990 and 2010 for the Caribbean.

least 66% of blindness was attributable to treatable conditions such as cataract.[12] In 2009, Limburg published a review of Rapid Assessment of Avoidable Blindness studies in nine countries and reported the prevalence of bilateral blindness (VA <3/60 in the better eye with available correction) in those aged 50 years and older ranged from 1.3% in urban Buenos Aires, to 4.0% in two rural districts of Peru. The prevalence of low vision ranged from 5.9% in Buenos Aires to 12.5% in rural Guatemala.[13] Cataract was the main cause of blindness (41–87%), followed by posterior segment disease (7–47%). Avoidable blindness (defined as that which could have been treated or prevented by known, cost-effective means[1–3 9]) ranged from 43% in urban Brazil to 94% in rural Guatemala. Considerable variations in prevalence, the proportion of blindness and visual impairment due to different ophthalmic diseases and cataract surgical rates have been reported in the region.[14–16]

The present publication describes the regional magnitude and temporal trends from 1990 to 2010 in the prevalence of blindness (<3/60) and moderate/severe visual impairment (MSVI <6/18–≥3/60) in LAC as analysed by the Vision Loss Expert Group of the Global Burden of Disease, Risk Factors and Injuries Study 2010 (GBD).[17]

METHODS

We systematically reviewed published literature from 1980 to 2012 on the incidence and prevalence of blindness and visual impairment from nationally representative studies and additional local rapid assessment studies.[18 19] We generated a database of crude, age-standardised and gender-specific estimates on the global prevalence of vision loss. Statistical models were used to estimate the prevalence and causes of vision impairment for every year 1990–2010 in 190 countries and 21 global subregions. The detailed methodology for the systematic review, statistical analyses and global results are published elsewhere.[20–23]

The specific LAC subregions of countries designated by the GBD[19] and those with studies included in this analysis are listed in table 1. These studies[18] covered 12 of 33 countries. Of these studies, only six were nationally representative, three were subnational and the remainder were conducted at a local level. Only the Barbados Eye Study was longitudinal, which assisted in the analysis of temporal trends.

RESULTS

Model-based, age-standardised prevalence estimates are presented for both all-ages and adults 50 years and older. When

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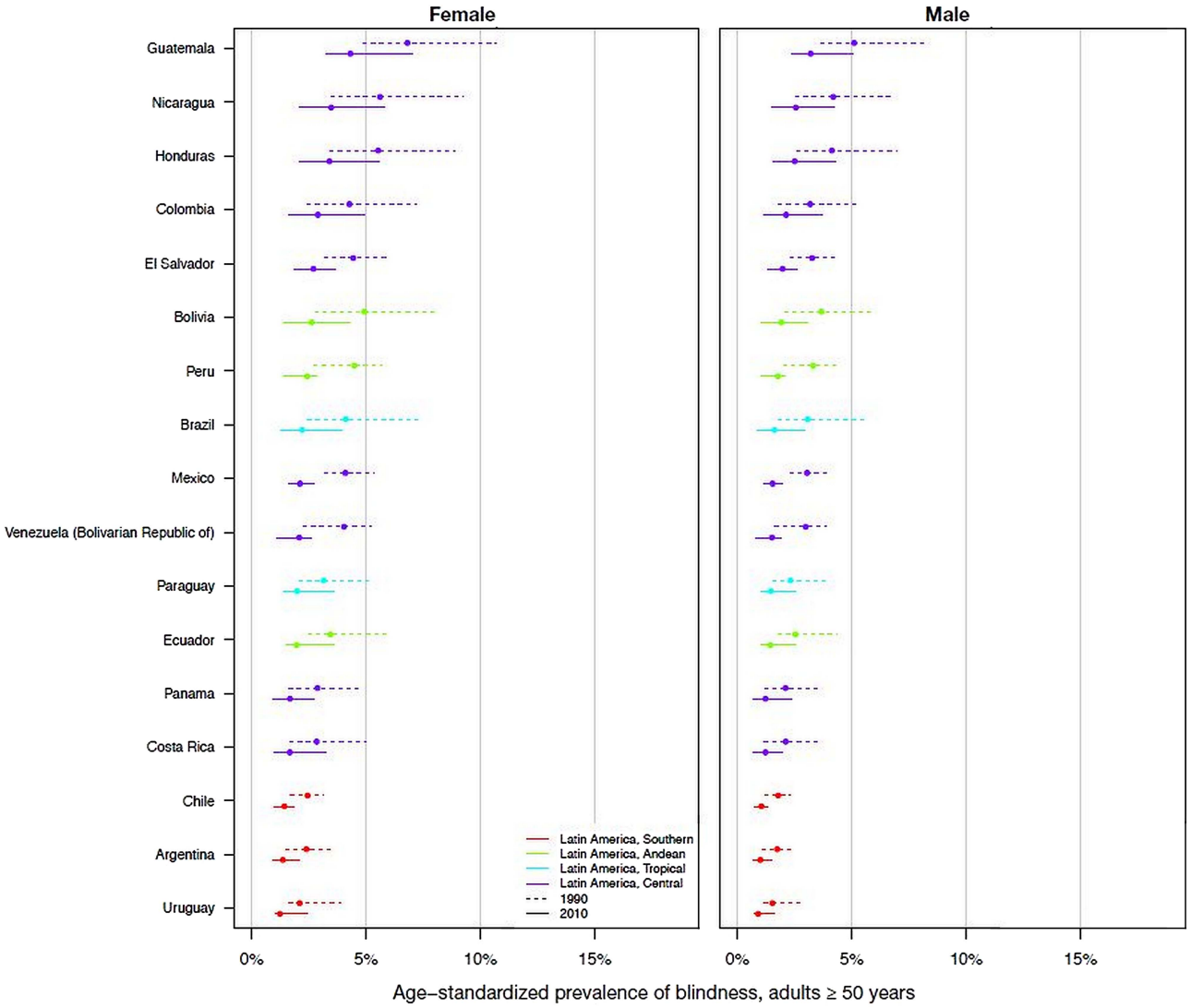

Figure 2 Ladder plot showing the age-standardised prevalence of blindness and change in females (A) and males (B) aged 50+ years for 1990 and 2010 for Latin America.

compared with crude estimates, they remove the effects of aging and epidemiological differences for the inter-country and inter-regional comparisons over time.

In the combined super-region of LAC, overall age-standardised prevalence of blindness halved ($p<0.5$, two-tailed) from 0.8% (0.6 to 1.1) in 1990 to 0.4% (0.4 to 0.6) in 2010 and MSVI decreased by one-third ($p<0.5$, two-tailed) from 4.3% (3.1 to 5.3) in 1990 to 2.7% (2.2 to 3.4).

Blindness levels in the LAC subregions generally are close to the global average for all ages and for men and women aged 50 years and older. However, age-standardised MSVI averages are slightly higher than the world average in the Caribbean and Andean Latin America and slightly lower for Southern Latin America (table 2). All regions and all categories show mean declines from 1990 to 2010; however, the overlapping uncertainty intervals should be noted.

The number of blind persons in the combined LAC super-region was estimated at 2.2 (1.7 to 3.0) million in 1990, rising to 2.3 (1.9 to 3.2) million in 2010 (table 3). Although the prevalence of blindness has decreased, the total number of blind persons has increased or stayed the same between 1990 and 2010, reflecting the 33% increase in total population (table 3). The number of persons with moderate and severe visual impairment in the LAC super-region was estimated at 12.5 (8.7 to 15.3) million in 1990, increasing to 14.1 (11.7 to 17.6) million in 2010 (table 3).

Cataract continues to be the most common cause of blindness in all LAC regions except for Southern Latin America, where macular degeneration has emerged as most common (table 4). The proportion of blindness attributable to cataract has decreased only slightly from 1990 to 2010, whereas the age-standardised prevalence of blindness due to cataract in those aged 50 and older dropped by 42%. The proportion of blindness due to macular degeneration, glaucoma and diabetic retinopathy has increased proportionally. In comparison to the global averages, the LAC regions show less blindness attributable to cataract, uncorrected refractive error, but more blindness attributable to macular degeneration, diabetic retinopathy, glaucoma and other causes.

Uncorrected refractive error shows a proportional rise from 1990 to 2010 in all regions. Models suggest it to be the main cause of MSVI ranging from 44.6% in the Caribbean and Andean Latin America regions to 45.4% in Southern and Tropical Latin America (table 4). In all regions, the second most

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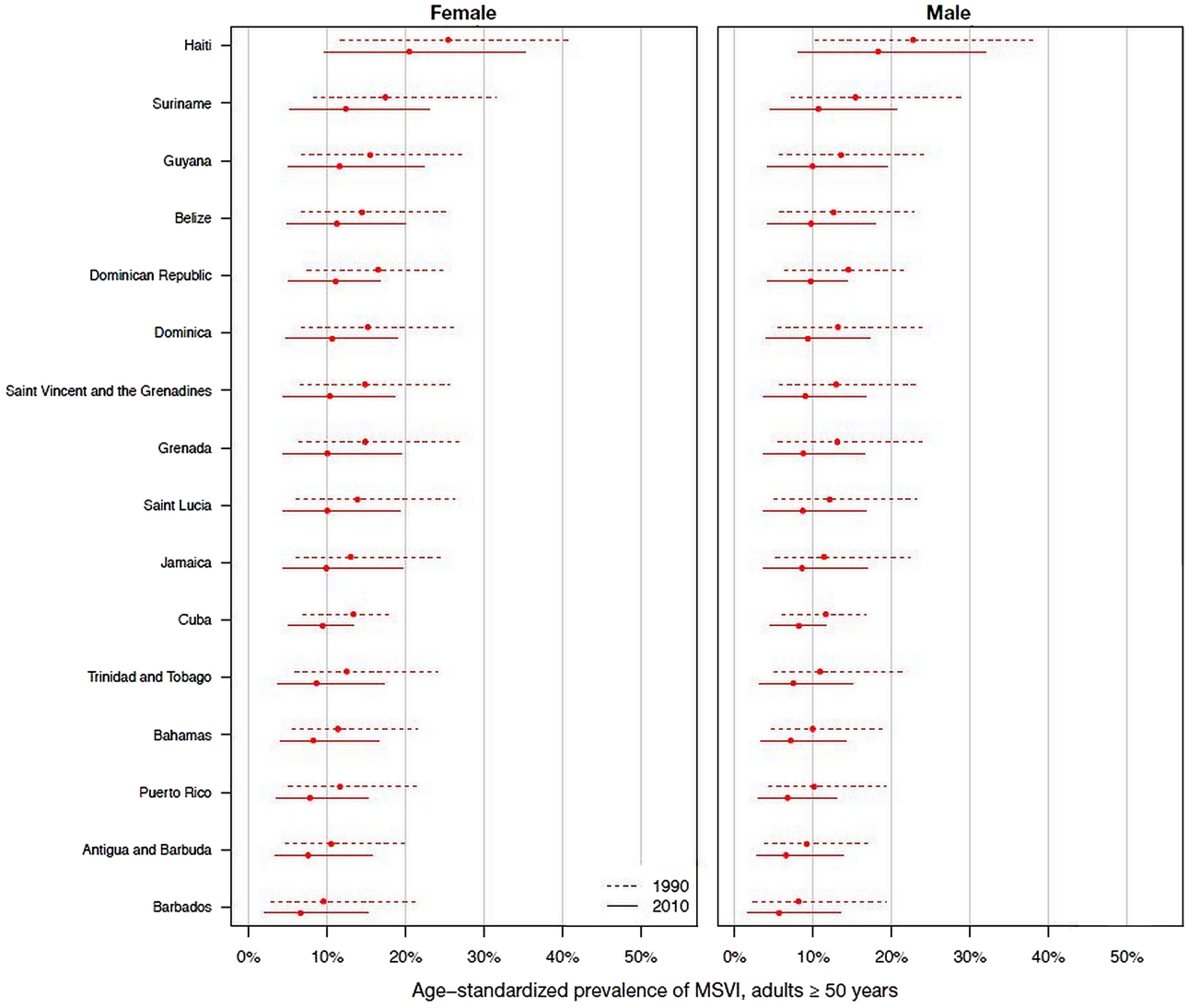

Figure 3 Ladder plot showing the age-standardised prevalence of MSVI and change in females (A) and males (B) aged 50+ years for 1990 and 2010 for the Caribbean.

common cause of MSVI is cataract, which has decreased proportionally since 1990. On the rise are macular degeneration, glaucoma and diabetic retinopathy, as well as other and unidentified causes.

Blindness and MSVI continue to rise with increasing age, with many regions showing double the age-standardised prevalence of blindness and triple the prevalence of MSVI in ages 50 years and older compared with all ages (table 2). A global-level analysis shows that starting at approximately age 50, all prevalence estimates increase.[23] With the increase in absolute numbers of older people,[24 25] the sheer numbers of those blind and visually impaired will continue to impact the region's burden of disease.

Country-level estimates of the age-standardised prevalence of blindness in those over 50 years of age are demonstrated in ranked ladder plots for select countries in the Caribbean (figure 1) and Latin America (figure 2). Across the Latin American and Caribbean regions, the model estimates imply that Haiti at 7.3% (4.3 to 11.4) and Guatemala at 6.1% (4.3 to 9.6) demonstrated the highest age-standardised prevalence of blindness in 1990 for both genders in those aged 50 years and over. In 2010, Haiti continues to be an outlier with the highest estimates of blindness prevalence at 4.8% (2.6 to 7.7) and Guatemala at 3.8% (2.9 to 6.2). In the Caribbean in 2010, Puerto Rico at 1.1% (2.9 to 6.2) was the country with the lowest age-standardised prevalence modelled estimates in both genders in those over 50 years of age. In Latin America, Uruguay was lowest at 1.1% (0.9 to 2.1). Our model shows a threefold to fourfold difference between the highest and lowest prevalence rates.

Country-level estimates of the age-standardised prevalence in those over 50 years of age for MSVI are demonstrated in ranked ladder plots for select countries in the Caribbean (figure 3) and Latin America (figure 4). Again the high estimates for Haiti (21.9% [8.9 to 33.9]) and Guatemala (16.2% [1.9 to 23.1]) are noted. In 2010, the country with the lowest age-standardised modelled prevalence estimates in both genders in those 50 and over in the Caribbean region was Antigua & Barbados (7.4% [3.2 to 15.0]). In Latin America, Argentina (7.5% [5.2 to 14.9]) was lowest. The model again showed a threefold difference in prevalence between the highest and lowest prevalence rates.

For those aged 50 and older, the MSVI age-standardised both-gender prevalence is almost six to seven times higher than the rates of blindness.

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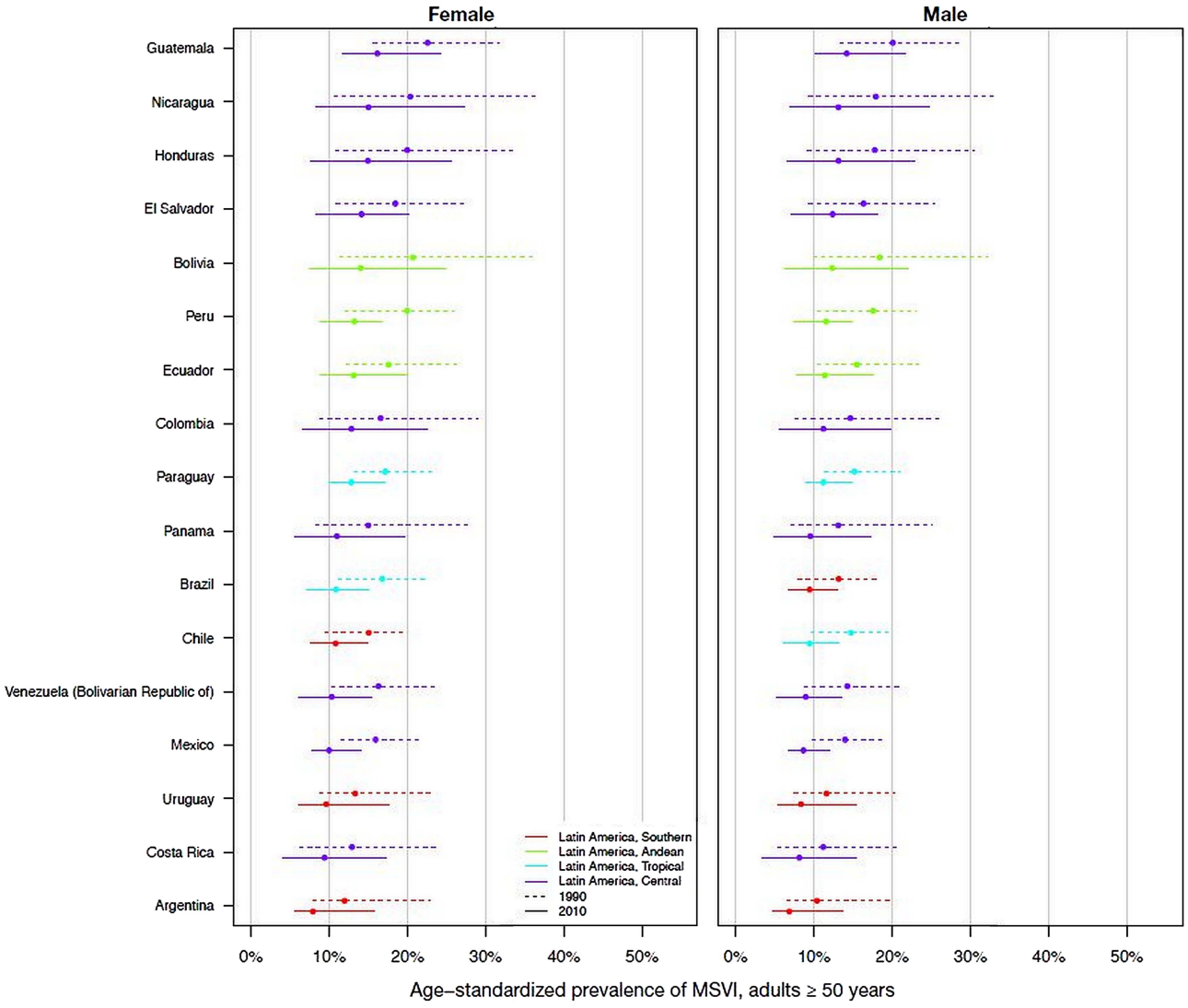

Figure 4 Ladder plot showing the age-standardised prevalence of MSVI and change in females (A) and males (B) aged 50+ years for 1990 and 2010 for Latin America.

DISCUSSION

The LAC regional and country estimates for the age-standardised prevalence of blindness and MSVI have decreased from 1990 to 2010, even though confidence/uncertainty intervals overlap. However, with the increasing size and age of the population, the numbers with vision loss in the region are still substantial. More intense efforts are needed to meet WHO's goal of a 25% reduction in avoidable blindness by 2019.[3]

Our estimates of the absolute numbers of blind and visually impaired are lower than those described by others.[1–16] However, these estimates of the absolute numbers of blind from 1990 to 2010 have not decreased. The striking difference between the all-age and those aged 50 years and older age-standardised prevalence of blindness and visual impairment needs to be considered by policy planners. Due to the rise in the aging population, the absolute number of people with vision loss, particularly older people, continues to be a major public health concern in LAC.

Interpretation of the mean age-standardised prevalence of blindness and MSVI in the Caribbean and Latin American countries in those aged 50 and older shows a decrease in all countries from 1990 to 2010, but the overlapping uncertainty intervals should be noted. Additionally, differences between countries warrant further assessment and better data.

Gender disparities in blindness and visual impairment should be considered in each country. World figures suggest that blindness and MSVI are higher in females than males, although this might be less true in LAC where uncertainty intervals overlap.[26]

The strength of these estimates is supported by the rigorous scientific methodology and strict selection criteria that retrospectively reviewed data to determine a consistent measure of temporal trends for the past 20-year time period. While there are always differences in estimations that have used different meta-analytical techniques, these results generally do not fall outside the intervals of uncertainty of other estimations reported at the global level.

The study limitations focus primarily on the dearth of peer-reviewed, nationally representative, epidemiologically sound, cross-sectional prevalence and incidence surveys to inform these and future estimates of vision impairment as per the selection criteria set forth by the GBD protocol. Most of the surveys were conducted after the year 2000, which limits the precision of the trends analysis. Local rapid assessment surveys may overestimate

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cataract blindness as the principal cause of impairment and may not be generalisable to the national level.[27 28] In accordance with the WHO global action plan to prevent blindness during the period 2014–2019,[3] the undertaking of nationally representative cross-sectional studies generates important evidence for planning eye care services. Conducting reliable and representative studies on blindness and visual impairment may be costly, but the value of disclosing the inequities and barriers to reach universal eye care coverage must be considered.

The proportion of blindness and MSVI attributable to the five most common causes and other causes is also an important consideration for LAC policy and intervention evaluation and planning. The shift in the proportion of attributable cause in blindness and visual impairment, along with the reduction of cataract-related vision loss, may be due to increased programmatic attention to cataract surgical interventions.[15 29] However, the rise in vision loss due to macular degeneration, diabetic retinopathy and glaucoma is alarming and warrants further intervention. Nearly half of all estimated MSVI is attributable to uncorrected refractive error, which can be managed with refractive services and spectacle correction, a very cost-effective intervention in primary eye health systems.[30 31] It is imperative to acknowledge, analyse and address those 'other' attributable causes including important public health concerns such as injury, vitamin A deficiency, trachoma, onchocerciasis, ocular toxoplasmosis, rubella, retinopathy of prematurity, retinitis pigmentosa and genetic or congenital defects.

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