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Causes of Blindness and Visual Impairment in Latin America

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Abstract. We review what is known in each country of the Latin American region with regards to blindness and visual impairment and make some comparisons to Hispanic populations in the United States. Prevalence of blindness varied from 1.1% in Argentina to 4.1% in Guatemala in people 50 years of age and older, with the major cause being cataract. Diabetic retinopathy and glaucoma are starting to make serious inroads, although epidemiological data are limited, and age-related macular degeneration is now a concern in some populations. Infectious diseases such as trachoma and onchocerciasis are quickly diminishing. Although progress has been made, retinopathy of prematurity remains the major cause of childhood blindness. If VISION 2020 is to succeed, many more epidemiological studies will be needed to set priorities, although some can be of the Rapid Assessment of Avoidable Blindness design. Developing the infrastructure for screening and treatment of ophthalmic disease in Latin America continues to be a challenge. (**Surv Ophthalmol 57**:149–177, 2012.

Key words. Latin America • epidemiology • blindness • visual impairment

Introduction

In 2010 the World Health Organization (WHO) estimated that 285 million people have visual impairment. Of these, 246 million present low vision and 39 million were blind primarily from cataract, glaucoma, and age-related macular degeneration.[A] The figures for the Americas, including the Caribbean and countries such as Belize, Guyana, and Surinam, are 3.2 million blind and 26.6 million visually impaired. In 1999 the WHO and the International Agency for the Prevention of Blindness (IAPB) launched "VISION 2020: the Right to Sight," with the goal of eliminating avoidable blindness by 2020.[223,224] The key elements of this ambitious global plan are defining targets and strategies for sustainable disease control and the development of necessary human resources, infrastructure, and technology. In order to design national plans, it is necessary to have a better idea of the

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prevalence of eye diseases in each country and how they affect blindness and visual impairment. In Latin America, the program was launched in 2004 as a three-way partnership between the Pan American Health Organization (PAHO), the IAPB, and the Pan-American Association of Ophthalmology.

For Argentina, Brazil, Chile, Colombia, Cuba, the Dominican Republic, Ecuador, Guatemala, Mexico, Paraguay, Peru, and Venezuela, recent studies have used the Rapid Assessment of Cataract Surgical Services (RACSS) or Rapid Assessment of Avoidable Blindness (RAAB) methodology. These have not been performed for many countries and are unlikely to be conducted in the near future because of financial and infrastructure constraints. Also, more than one study is necessary in each country for different populations (e.g., rural and urban) and need to be repeated at 5- to 10-year intervals to determine the effectiveness of each country's plan.

A major limitation of RACSS/RAAB studies is that some diseases are not well evaluated, such as age-related macular degeneration (AMD), glaucoma, and diabetic retinopathy (DR). Another limitation is that only the main cause of blindness/visual impairment is considered. When there are multiple disorders contributing equally to visual loss, only the "most readily curable" or the "most easily preventable" is recorded.[B] For example, this potentially underestimates the impact of diabetic retinopathy, glaucoma, or other diseases when the patient presents with cataract.[131] In addition, infectious diseases, primarily trachoma and onchocerciasis, still play an important role in some areas of Latin America.

We review what is known in each country of the Latin American region about the causes and prevalence of blindness and visual impairment and attempt to identify the gaps in data that must be addressed in order that national VISION 2020 plans may succeed.

Summary of Publications

Those studies that we considered to be of good quality have an asterisk appended to the citation in the text (e.g.,[15*]).

Table 1 summarizes the number of articles indexed and not indexed in PubMed found for each country and the non–peer-reviewed publications found for each country. Table 2 summarizes articles found in each country with epidemiological data about blindness and visual impairment in adults. Studies describing more than one disease are cited more than once. Brazil has the highest number of articles; few or none were found for Bolivia, Costa Rica, El Salvador, Honduras, Nicaragua, and Panama. Table 3 summarizes articles concerning blindness and visual

TABLE 1

Number of Articles Indexed/Not Indexed in PubMed and Non–peer-reviewed Publications Found for Each Country

Peer-reviewed Articles Indexed in PubMed		Peer-reviewed Articles not Indexed in PubMed		Data from Non–peer-reviewed Sources	
Country/Region	Number	Country/Region	Number	Country (Number)	Description
Argentina	7	Argentina	7	Dominican Republic (1)	RAAB documents published by local government
Brazil	88	Bolivia	1	Ecuador (1)	
Chile	2	Brazil	15	Peru (1)	Report from IAPB
Colombia	4	Chile	6	Mexico (1)	Report of refractive errors in children published by local government
Ecuador	3	Colombia	8	Colombia (1)	Articles from nonscientific journals and thesis presentation
Guatemala	5	Cuba	13	Argentina (6)	
Mexico	24	Mexico	17	Paraguay (1)	Thesis presentation
Paraguay	3	Peru	9		
Puerto Rico	1	Uruguay	1		
USA	48	Venezuela	6		
Europe	1				
Multiple countries	5				

TABLE 2

Number of Articles Found by Disease and Country (Adults)

Country	BL/VI	AMD	Cataract	DR	Glaucoma	Pterygium	RE	OT	OTP	Trachoma	ONC
Argentina	3	0	3	0	3	0	3	0	0	0	0
Bolivia	0	0	0	0	0	1	0	0	0	0	0
Brazil	7	9	9	13	12	2	7	10	6	7	1
Chile	3	2	2	5	2	0	1	1	0	0	0
Colombia	2	1	2	3	3	1	1	0	3	0	0
Costa Rica	0	0	0	0	0	0	0	0	0	0	0
Cuba	1	3	3	5	3	2	1	1	0	0	0
Dominican Republic	1	1	1	1	1	0	0	0	0	0	0
Ecuador	2	2	2	2	2	0	3	0	0	0	1
El Salvador	0	0	0	0	0	0	0	0	0	0	0
Guatemala	1	0	1	0	0	0	0	0	0	0	3
Honduras	0	0	0	0	0	0	0	0	0	0	0
Mexico	1	0	2	14	2	0	1	5	1	1	1
Nicaragua	0	0	0	0	0	0	0	0	0	0	0
Panama	0	0	0	0	0	0	0	0	0	0	0
Paraguay	2	0	2	2	1	0	1	0	0	0	0
Peru	3	1	4	0	3	0	0	1	0	0	0
Puerto Rico	1	1	1	1	1	0	0	0	0	0	0
Uruguay	0	0	0	1	0	0	0	0	0	0	0
Venezuela	1	1	2	3	3	1	2	0	1	0	0
Hispanics in USA	11	6	11	13	11	1	5	3	0	0	0
Hispanics in Europe (Spain)									1		
Multiple countries			2								1
TOTAL	39	27	47	63	47	8	25	21	12	8	7

Note that studies describing more than one disease are cited more than once.

AMD = age-related macular degeneration; BL/VI = blindness and visual impairment; DR = diabetic retinopathy; ONC = onchocerciasis; OT = ocular trauma; OTP = ocular toxoplasmosis; RE = refractive errors.

impairment for children. Again, Brazil has by far the largest number of articles.

Blindness and Visual Impairment

There is considerable variation in the prevalence of blindness and visual impairment within the region, as well as the proportion of blindness and visual impairment from different ophthalmic diseases and conditions. Moreover, there are considerable data for a few countries, with little data for others. The results are sufficient in some cases to provide estimates of blindness and visual impairment that would be useful for national planning purposes.

Although VISION 2020 has been implemented in Latin America, most blindness and visual impairment is still from avoidable causes, mainly cataract (blindness, 38–74%) and refractive errors (blindness, 0–11.9%; visual impairment, as high as 72%).

We found RACSS or RAAB studies in 12 countries: Argentina,[138*,190*] Brazil,[9*] Chile,[18] Colombia,[219*] Cuba,[263*] the Dominican Republic,[C*] Ecuador,[D*] Guatemala,[20*] Mexico,[156,157] Paraguay,[65*] Peru,[212*] and Venezuela.[266*] The prevalence of bilateral blindness in individuals aged over 50 varied from 1.1% in Argentina (Buenos Aires province, visual acuity [VA] < 20/400 with available correction) to 4.2% in Venezuela (nationwide, VA < 20/200 with available correction, which really reflects visual impairment and not blindness) (Table 4). The major cause of blindness in all of the studies was cataract, and the proportion varied from 40.9% (Campinas City, Brazil) to 68% (Guatemala). The prevalence of blindness in individuals aged over 50 appears to be generally lower compared with developing countries outside of Latin America; RAAB studies have shown a prevalence of 2.0% in Kenya,[172] 3.7% in China,[309] and 3.6% in India.[191]

From publications describing other studies besides RACSS or RAAB studies, the prevalence of blindness for individuals in Brazil over 50 years was 1.5%.[243*] The definition of blindness was VA < 20/200; best-corrected visual acuity (BCVA) blindness prevalence was 1.1%, 2.2% for a sample from all ages.[252*] Two-thirds were blind due to uncorrected refractive errors; BCVA blindness prevalence was 0.4% and 8% over 80 (this study lacked good methodology).[236] In another study from Chile, Terán et al[273] and Barría[17*] found a similar prevalence of blindness in those over 60 and 1.8% in people over 65. In Peru 2.4% of patients from

TABLE 3

Number of Articles Found by Disease and Country (Pediatric)

Country	Cataract	Glaucoma	COT	OT	RE	ROP	Trachoma
Argentina	1	1	0	0	2	10	0
Bolivia	0	0	0	0	0	0	0
Brazil	6	6	8	3	11	23	12
Chile	2	2	1	1	3	2	0
Colombia	1	1	1	1	1	2	0
Costa Rica	0	0	0	0	0	0	0
Cuba	0	0	0	0	0	3	0
Dominican Republic	0	0	0	0	0	0	0
Ecuador	0	0	0	0	0	0	0
El Salvador	0	0	0	0	0	0	0
Guatemala	0	0	0	0	0	1	0
Honduras	0	0	0	0	0	0	0
Mexico	0	1	0	3	6	6	2
Nicaragua	0	0	0	0	0	0	0
Panama	0	0	0	0	0	0	0
Paraguay	0	0	0	0	0	0	0
Peru	0	0	0	0	3	0	0
Puerto Rico	0	0	0	0	0	0	0
Uruguay	0	0	0	0	0	0	0
Venezuela	0	0	0	0	0	0	0
Hispanics in USA	0	0	0	0	5	1	0
Multiple countries						2	
TOTAL	10	11	10	8	31	50	14

Note that studies describing more than one disease are cited more than once.

COT = congenital ocular toxoplasmosis; OT = ocular trauma; RE = refractive errors; ROP = retinopathy of prematurity.

a nonrandomly selected sample composed of all age groups were determined to be blind, but this study had very limited data.[66] In an urban area of Paraguay, a population-based study with over 400 subjects aged 40 or older found a prevalence of blindness of 1.24% (presenting VA ≤ 20/400), cataract being the cause in 80%.[204]

In Mexico, a bulletin published by the local Ministry of Health in 2005 described cataract as the main cause of blindness (40–50%), followed by DR (20–30%), and glaucoma (15–25%), although the methodology used is not described.[E]

In older studies, Hispanics living in the United States were found to have a lower percentage of impairment of both corrected and uncorrected binocular distance vision compared with non-Hispanic whites.[141,147] On the other hand, Wilson et al reported a lower percentage of visual impairment among non-Hispanic whites compared with African American or Hispanics. In this study, however, more than half of the Hispanic sample was under 40 years, and non-Hispanic whites constituted only 34.5%.[304]

Among the Hispanic population living in the United States, the prevalence of blindness was 0.4% in Los Angeles[290*] and 0.3% in Arizona (BCVA of 20/200 or worse in the better-seeing eye in both studies.).[229*] A recent publication also described a 4-year incidence of blindness of 0.3% (both eyes open during the exam; VA< 20/200).[284*] In addition, in a self-report visual impairment (VI) survey, Cubans, Dominicans, and Puerto Ricans living in the United States reported a higher prevalence of severe VI.[142] 4.9% of Mexican Americans over 65 had a VA < 20/200 in both self-report and examined subjects, although not all patients were examined by the same methods.[62] By comparison, the Salisbury Eye Evaluation Study estimated the prevalence of legal blindness of 0.54% for whites and 0.83% for African Americans[189] (VA < 20/200 in the better eye). Compared with RAAB and RACSS studies, however, these studies have different subject ages and definition of blindness. In RACSS and RAAB studies, blindness is defined as VA < 20/400 in the better eye and subjects are ≥50 years old, whereas in the LALES and Proyecto Ver studies, blindness is defined as VA < 20/200 in the better eye and subjects are ≥ 40 years old.

It is estimated that 15.6% (48 million) people living in the United States are of Hispanic origin.[F] Hispanics living in the United States have a higher prevalence of blindness and visual impairment compared to non-Hispanic whites.[13] Moreover, a high proportion of undetected eye diseases (63%) were noted among Latinos living in Los Angeles, a substantial proportion of whom never

TABLE 4

Blindness and Percentage of Blindness Due to Various Ophthalmic Diseases

Country	LOC	Year	n	BL (%)	CAT (%)	GLA (%)	AMD (%)	DR (%)	PP (%)	RE (%)	CO (%)	SC
Argentina[190]	U	2006	4,302	1.1	54	—	—	—	—	—	—	—
Argentina[138]	U & R	2010	2,227	1.8	51	—	—	—	—	—	—	—
Brazil[9]	U	2009	2,224	2.0	41	11.4	—	15.9	20.5	2.3	2.3	6.8
Chile[17]	U & R	2007	2,715	1.6	57	4.3	4.3	8.5	17.0	2.1	4.3	—
Colombia[219]	U & R	2009	4,082	1.8	68	2.8	—	1.4	14.1	1.4	8.5	1.4
Cuba[263]	U	2006	2,760	2.3	51	26.2	—	9.2	6.1	0	4.6	2.7
Dominican Republic[C]	U & R	2009	3,873	2.1	64	15.0	3.8	5.0	—	—	—	2.6
Ecuador[D]	U & R	2010	4,012	1.7	74	7.1	4.3	7.1	20.0	0	1.4	2.9
Guatemala[20]	U & R	2007	4,806	4.1	68	—	—	—	—	—	—	—
Mexico[156,157]	U & R	2005	3,780	1.5	67	—	—	—	30.0	—	—	3.0
Paraguay[65]	U & R	2003	2,136	3.6	59	—	—	—	—	—	—	—
Peru[212]	R	2005	4,782	4.0	54	—	—	—	—	—	—	—
Venezuela[266]	U & R	2005	3,317	4.2	66	15.0	2.9	2.9	2.1	5.0	2.1	2.1

Data from RACSS and RAAB studies, VA < 20/400, available correction, not adjusted for sex and age, except for Venezuela (VA < 20/200), and Mexico (adjusted for sex).

AMD = age-related macular degeneration; BL = blindness; CAT = cataract; CO = corneal opacities; DR = diabetic retinopathy; GLA = glaucoma; LOC = location (U = urban, R = rural); PP = other posterior pole diseases; RE = refractive errors; SC = surgical complications; VA = visual acuity; Year = year of publication.

had an eye exam.[287*] Hispanics also have a higher percentage of DR than non-Hispanic whites and African Americans,[132] although a lower prevalence of glaucoma compared to African Americans.[89] Cataract, glaucoma, and DR play a more prominent role in blindness in Hispanics compared to white Americans (for whom AMD is the leading cause of blindness).[46,49*,189,229*]

In the United States, an estimated 0.78% of the population ≥ 40 years old was blind in 2000 and an additional 1.98% (2.4 million) had low vision.[46] In Barbados, 1.7% of those of African descent were reported as blind, and 5.9% were visually impaired.[126]

Cataract

Cataract is the major cause of blindness in Latin America. The cataract surgical rate (CSR) is the number of cataract surgeries performed per 1 million people in 1 year.[143*] Although a CSR of 3,200 has been estimated to eliminate blindness from cataract,[271] the CSR by itself cannot ensure that individuals who are blind do in fact have surgery or that the sight restoration rate is satisfactory.[143*] In some countries the CSR is higher than 2,000, and in other countries it is under 1000—a large effort will be needed to increase this (Table 5). Moreover, there are large local disparities. In Peru, for example, the CSR in Lima is 2,250, whereas in Puno this number is ten times lower.[G] Although RACSS and RAAB studies randomly select samples, the data obtained sometimes cannot be extrapolated to the whole country. The RACSS performed in Brazil, for example, was carried out in Campinas City, and in Argentina, in Buenos Aires—both among each country's wealthiest areas; blindness from cataract in rural areas is likely to be higher.[9*,190*]

Among the barriers to cataract surgery in Latin America, lack of awareness of the existence of treatment, the cost of the surgery, and fear of surgical treatment are the most common (Table 5).[157] The contribution of these factors differs. In Guatemala, for example, 68% of the people blind due to cataract were unaware of surgical treatment.[20*] In Argentina,[190*] Venezuela,[266*] and Peru,[212*] almost one-third of blind patients answered that they could not afford the surgery.[157] For Latinos living in the United States, lack of health insurance and inability to speak English are the most important barriers to cataract surgery.[29*] An estimated 30% of Latinos in the United States who need cataract surgery do not have access to it.[225]

Lack of ophthalmologists is not generally a problem in Latin America. The number of ophthalmologists per million population in the region is greater

TABLE 5

Challenges in Latin America Regarding Ophthalmic Disease and What Needs To Be Done

Disease	Challenges	What Needs To Be Done
Cataract	Aging of the population	Improve training to increase number of cataract surgeons and also provide better outcomes; correct refractive errors after surgery.
	Many patients are unaware or have difficulties of access or payment; unmet needs of cataract surgery	Provide high-quality affordable surgeries; generate consensus among training centers for appropriate techniques and technology as well as cost recovery policies to ensure sustainability.
Diabetic retinopathy	Aging of the population	Develop educational campaigns about diabetes mellitus and diabetic retinopathy.
	Lack of awareness of the disease	Train general ophthalmologists to diagnose the disease, treat mild-to-moderate cases, and provide referral for advanced diabetic retinopathy.
	Lack of data or evidence for best practices for screening and treatment	Generate multidisciplinary teams with primary care physicians, endocrinologists, and health educators
Glaucoma	Aging of the population	Develop educational campaigns about the disease.
	Lack of awareness of the disease	Train general ophthalmologists to diagnose the disease, treat mild-to-moderate cases, and provide referral for advanced glaucoma.
	Medical treatment is expensive	Provide early trabeculectomy in poor areas.
	No appropriate screening tool generally accepted except for opportunistic detection	Conduct research on screening tools for developing-country settings to determine best approaches.
Refractive errors	Unmet needs for spectacles	Provide affordable eye examination and spectacles.
	Low compliance for the use of glasses in children	Develop behavioral research to improve compliance.
Retinopathy of prematurity	Not all newborns at risk are examined	Provide trained personnel and adequate equipment in all neonatal care units.
	Usual screening criteria for developed countries are not ideal for Latin America	Disseminate the adjusted screening criteria for the region.
	Few data available about the disease in most of the countries	Design more studies in the area to determine the prevalence, risk factors, and impact of the disease in all of the countries.
Age-related macular degeneration	Expensive treatment	Provide affordable treatment.

than 40,[143*] a number that ought to be adequate to provide cataract surgery for those who need it. However, what is less accurately known is how many ophthalmologists in each country regularly perform cataract surgery. In the United States, for example, the average ophthalmologist performs almost 200 cataract surgeries a year, whereas in Argentina this number is almost ten times lower.[143*]

Not only is the number of surgeries important, but also the outcome. The WHO considers that 2 months after cataract surgery, at least 90% of eyes should have a VA > 20/60 and fewer than 5% worse than 20/200.[299] More ophthalmologists should be trained to perform cataract surgeries, especially in areas with a low CSR, and each surgeon or hospital should monitor the results.[155] Better surgical outcomes means a reduction in surgical complications that also may decrease fear as a barrier to cataract extraction. In addition, a fast and inexpensive way of improving outcomes is to perform refraction after cataract extraction.[299]

The RAAB and RACSS studies show that cataract is the main cause of blindness in Latin America, varying from 41%[9*] (Campinas City, Brazil) to 74%[D*] (Ecuador). By comparing the huge difference between the CSR in Honduras (750) and Uruguay (3,933),[143*] we infer that fewer blind people need cataract surgeries in Uruguay, even if no RACSS or RAAB data are available. Data from 2008 show there are five countries with a CSR ≤ 1,000 (Bolivia, the Dominican Republic, Guatemala, Honduras, and Paraguay), seven countries with a CSR between 1,000 and 2,000 (Colombia, Ecuador, El Salvador, Mexico, Nicaragua, Panama, and Peru), six countries with a CSR between 2,000 and 3,000 (Argentina, Brazil, Chile, Costa Rica, Venezuela, and Cuba), and only one country with a CSR higher than 3,000 (Uruguay).[143*] The CSR in Brazil was 1,179 in 2007, although this estimate did not include surgeries paid for privately.[30]

Surgical complications of cataract extraction were also mentioned in six RACSS/RAAB studies in the region[9*,219*,263*,266*,C,D] contributing from 1.4%[219] (Santander Province, Colombia) to 6.8%[9*] (Campinas City, Brazil) of the total cases of blindness. In a recent study performed in Sao Paulo City (Brazil), 12.2% of the individuals who received cataract surgery had a final BCVA worse than 20/200.[245*] In another study performed in the same city, surgical complications caused blindness in 16% of the eyes that had cataract extraction, although subjects were not randomly selected.[7] Oliveira et al also reported causes of visual impairment after surgery as concurrent eye disease (56%), surgical complications (28.8%), and refractive error (15.2%).[198] In Hispanics living in the United States (California) that underwent cataract surgery, uncorrected refractive errors (33%), AMD (13.3%), and diabetic retinopathy (10.8%) were the major causes of visual impairment.[16*]

Some studies not of RACSS or RAAB design were also performed. In Ecuador, one study found that cataract was the cause of 23% of the total cases of blindness in a sample from an ophthalmology clinic, although this result cannot be extrapolated as it is not population-based.[38] In Peru, population-based studies found that cataract contributed to 37.7% of the blindness in an urban area and 43.9% in a rural area[307] and that 2.8% of almost 5,000 patients aged over 40 were blind from cataract.[108] In a study performed in 1990 in Peru (Chimbote City) and Brazil (Campinas City), the combined prevalence of blindness was high (5.5%), with two-thirds caused by cataract.[129] In one population-based study performed in Colombia, cataract also contributed to more than half of the total cases of blindness (54.7%).[H] The methodology of these studies is questionable.

In Cuba, 10.8% of a sample composed of patients from all age groups[276] (and 33.8% of patients aged over 50 years old) had cataract compromising visual acuity. Both of these studies suffered from selection basis and had limited data[74] and the latter was a clinic-based study whose results cannot be extrapolated to other Cuban populations.

Among Hispanics living in the United States, cataract is also an important issue. In a large sample from Arizona, cataract was the cause of visual loss in 42% (defined as VA < 20/40 in the better eye),[229*] and 2.8% of the whole sample had visually significant cataract.[29*] In 2006 Cotter et al found that 38.2% of the cases of low vision in a population in Los Angeles were also attributable to cataract, but none of the patients were blind because of the disease.[49*] In another study 1.9% of people over 40 years old had significant cataract in at least one eye.[225*] A recent study published by Varma et al also reported a 4-year incidence of lens opacity at 14.2% in a sample of Latino patients aged over 40 years old living in the greater Los Angeles area.[288*] The same group reported that 41% of Hispanics had VI after cataract extraction, mainly from uncorrected refractive errors.[16*]

In Puerto Rico a chart review from an ophthalmologic clinic demonstrated that 22.1% of people aged from 40 to 79 years old had cataracts.[69] In Chile, 16.4% of people aged over 40 years in a screening campaign with questionable methodology were found to have cataract.[273] In Venezuela, Mitchell et al found a prevalence of 7.9% in women and 5.8% in men over 45 years old, although this study had some selection bias.[182]

Brazil is the country with the highest number of publications describing epidemiological aspects of

cataract. In two studies that used random samples, blindness from cataract varied from 40%[243*] to 50%.[252*] One study of randomly selected households from all ages reported a cataract prevalence of 4.9%, with blindness in 0.52%, although not all subjects were examined.[37] In a sample of more than 10,000 individuals over 50, Arieta et al found that 23.6% of visual impairment was from cataracts.[67] Moreover, in a population over 80 years old, cataract was present in 85.6%.[236] That study, however, had questionable methodology. Another report indicated a cataract prevalence of 18.3% among the indigenous population, but no data about proportion of blindness from cataract was available.[203*]

Finally, in Mexico, in a sample composed of 813 individuals (all ages) invited to attend a humanitarian eye service, almost 10% of them had cataract, all of them 40 years or older.[280] One major limitation of this study is that it was clinic-based.

Refractive Errors

Twenty articles reported epidemiological aspects of refractive errors in Latin American adults; refractive errors in children will be discussed later under "Retinopathy of prematurity."

Uncorrected refractive errors (UREs) are one of the leading causes of blindness and visual impairment in the world.[86] From RACSS and RAAB studies performed in the region, it was found that UREs contributed 1.4% of blindness in Colombia,[219*] 2.1% in Chile,[17] 2.3% in Brazil,[9*] and 5.0% in Venezuela.[266*] In the recent RAAB study from Ecuador, UREs contributed to almost 30% of the total cases of visual impairment.[D]

In two studies that used a random sample of subjects in Brazil, UREs were the cause of 5.5% of the total cases of blindness[243*] and were present in 72% of those with low vision.[252*] Arieta et al also found that almost half of the patients with visual impairment had UREs as the main cause.[67] Another Brazilian study also showed that, in a sample of people aged 60 years or older, 71.0% had uncorrected refractive errors.[7] Unsurprisingly, in a sample of individuals over 30 years, presbyopia was found in more than half and was positively related with age.[64]

A population-based study described the refractive errors in almost 2,500 people aged 1–91 years old in Botucatu (state of Sao Paulo, Brazil). In this study astigmatism, anisometropia, and hyperopia had a positive association with age, whereas myopia has its maximum prevalence in the fourth decade of life.[253*]

One study found a prevalence of 2.7% of myopia in the illiterate indigenous population living in the north of Brazil.[274*] In Colombia, one article published in 2001 described UREs as contributing to 11.9% of the total cases of blindness,[H] but this study had poor methodology and description of results.

In Ecuador, more than one-third of blindness was found to be caused by UREs in a hospital-based study (although extrapolation outside of this setting is not possible),[38] and another investigation in the same country that employed retinoscopy with cycloplegia found a prevalence of myopia in 4.7% in the indigenous population and 5.5% among those of European descent.[128]

In Venezuela, Mitchell et al found myopia in 4.5% of women and 12.3% of men[182]—considerably lower than in Argentina, where almost 30% of urban subjects in an office setting had myopia.[48] Studying myopic patients in Argentina, Iribarren et al found the mean age of first prescription was 20 years.[127]

Among Mexican Americans, UREs with presenting VA $< 20/40$ were found in almost three-quarters of patients,[188*] Varma et al found a prevalence of 15.1% of UREs among the US Hispanic population examined.[289*] In another study, myopia was present in 16.8% of patients over 40 years old.[269*] In Cuba, refractive errors were present in almost 25% of a sample from all age groups,[276] although this study suffered from poor methodology and description of results.

In Mexico, among 865 individuals of all ages assisted in a humanitarian campaign, approximately half were prescribed glasses, with hyperopic astigmatism being most common.[164] Among those who needed glasses, the average visual acuity was 20/55.4, 20/30 after prescription. More recently, Uribe et al[280] studied the prevalence of refractive errors in Hispanic adults 40 years or older in the United States and found that approximately half had refractive errors in both eyes, and 35% had UREs in at least one eye, almost 20% in both eyes.

As refractive errors can be easily diagnosed and treated, the high percentage of visual impairment from UREs in Latin America suggests that many patients needing spectacle correction either do not have access to eye care or cannot afford glasses. The barriers to eye care do not totally explain the problem, as in Mexico few children used spectacles, even when distributed free of charge.[39*]

Glaucoma

Glaucoma is also important in Latin America, and the number of blind adults from this disease is likely to increase as the population lives longer (Table 5). The impressively high contribution of glaucoma to blindness in Cuba may be explained partially by its

relative high CSR (which reduces the importance of cataract as a cause of blindness) and also because of the high percentage of Cubans of African descent. Prevalence of the disease varies from 1% to 3.4%, although the proportion of those blind from glaucoma was high in several countries (15–20%). Estimating the importance of this disease is difficult because as the treatment of one disease improves over time, as in Cuba, the prevalence of another may rise. The number of individuals with blindness due to glaucoma is alarmingly high, however, and suggests that many cases go undiagnosed or untreated. The low cost-effectiveness of glaucoma diagnosis and treatment compared to cataract makes it hard to move forward in this area, but one possible strategy is to determine early indications for trabeculectomy in low-income countries.[4] In addition, conducting research on screening tools in Latin America will be a high priority (Table 5).

We located 47 articles concerning glaucoma in 12 Latin American countries and in Latin Americans living in the United States. Among RACSS or RAAB studies, Cuba had the highest prevalence of glaucoma as a cause of blindness (26.2%),[263*] whereas in Colombia only 2.8% of blindness was the result of glaucoma.[219*]

In Colombia another study using a random sample of subjects found a higher contribution of glaucoma in the total cases of blindness (4.8%).[H] In the same country, in a sample of patients aged from 40 to 92 years old, the prevalence of open-angle glaucoma was 1%, although this figure is probably subject to selection bias.[97]

Brazil, again, was the country that had the highest number of articles on glaucoma (12). In the RACSS study performed in 2009 in that country, 11.4% of blindness was from glaucoma.[9*] In a randomly selected sample of subjects 50 years old or older, Salomão et al found that 20% of the total cases of blindness were the result of glaucoma.[243*] However, in a large sample of patients who were participants in the "Cataract Free Zone" project, Arieta et al found only 4.0% caused by glaucoma.[67] In another Brazilian study, glaucoma was the cause of 7.4% of the total cases of visual impairment.[252*]

Sakata et al examined 76.5% of all residents over 40 years of age in a southern Brazilian city and found a glaucoma prevalence of 3.4%.[241*] Póvoa et al found a prevalence of 7.3% in patients 40 years or older,[214] and Araújo Filho et al found that 1.3% had the disease, although this was not a randomly selected sample.[7] In a chart review of 321 glaucoma patients referred to a tertiary glaucoma service, 52.3% had a BCVA less or equal 20/200 at their first visit. Primary open-angle (54.2%) and chronic angle-closure (11.5%) were the most prevalent,[201] although this might not be the case for other populations. Clinic-based studies also showed the majority of cases were primary open-angle glaucoma (56.2%), followed by chronic angle-closure glaucoma (20.4%) in one instance,[279] and only 2.3% of the cases classified as primary angle-closure glaucoma in the other.[180]

In Chile the only data reliable enough to extrapolate the impact of the disease came from the RAAB study performed by Barría et al.[18*] In that investigation, 4.3% of the cases of blindness were caused by glaucoma. Similar figures were elicited in a campaign that invited patients from all ages for screening in which Terán et al found that 3.2% presented with the disease,[273] although methodological and data presentation issues probably limit findings.

Eight articles present data concerning glaucoma in US Hispanics. The studies performed in California[49*,290*] found a prevalence of open angle glaucoma of 4.7% in patients aged 40 years and more, but in this same sample, Cotter et al observed that none were blind.[49*] Studying the same age group in a retrospective cohort, Stein et al described a prevalence of open angle glaucoma in 6.4% of the Hispanics.[267*] In contrast, Rodriguez et al found that 28.6% of the total cases of blindness were caused by glaucoma in a population over age 40 living in Arizona.[229*] It was recently estimated that more than 400,000 Hispanics living in the United States have open-angle glaucoma, and 75% are still undiagnosed.[134] This estimate was determined from a sample of 213 glaucomatous patients, 75% of whom were diagnosed for the first time during the study.[174*] It has also been reported that type 2 diabetes mellitus patients older than 40 years have a higher prevalence of open-angle glaucoma[45*] and that this type of glaucoma was also associated with high systolic blood pressure.[179*]

In Ecuador, Cass et al discovered 17% of blind patients from an ophthalmologic clinic had glaucoma, although again this was not a population-based study.[38] However, the only data derived from a random sample came from the recently conducted RAAB study,[D*] and the contribution of glaucoma to the total cases of blindness (7.1%) is likely an underestimate as this study design had limited tools to diagnose this disease.

In Puerto Rico, the only data available describing epidemiological aspects of the disease showed that 42.6% of the patients from an ophthalmologic clinic had glaucoma (some selection bias likely present).[69] In Peru, in a sample composed of 57,212 patients of all ages, Wong et al found that glaucoma was the cause of 10.6% of blindness,[307] but this study lacked good methodology and results presentation. In two older reports from the same country, glaucoma was found in 1.9% and 2.1%, respectively, in population samples

aged over 30, but not randomly selected,[206,238] and both studies were not well designed.

In Venezuela, a RACSS study performed on a population of those aged ≥ 50 years sampled in 2004 showed that 15% of of blindness was caused by glaucoma.[266*] This is in direct contrast to the study conducted by Mitchell et al, who found a prevalence of glaucoma in 1.9% of women and 2.8% of men over 45 years of age,[182] although some selection bias was present in that study. The prevalence of the disease in patients living in a rural area was 4%.[112] The only data from the Dominican Republic concerning glaucoma comes from a RAAB study that found glaucoma to be the cause of blindness in 15% of the total.[C]

Cuba has the highest percentage of blindness from glaucoma among RACSS and RAAB studies: 26.2%.[263*] Studies performed on non–randomly selected patients found a prevalence of 12% in patients over 40 years old[42] and of 2% in a sample composed of patients from all age groups,[276] although both investigations were poorly reported. The overall results, however, could reflect better management of other causes of blindness in the Cuban health system.

In Mexico, 40% percent of patients attending glaucoma services for the first time had a diagnosis of primary open-angle glaucoma, 17% were glaucoma suspects, 8.2% had angle-closure glaucoma, 6.5% had neovascular glaucoma, and 5.7% had pseudoexfoliation syndrome;[120] examination methods were not rigorous, however. Again in Mexico, in a chart review of more than 20,000 patients who attended an ophthalmological service, 1.2% had glaucoma of any type. Although there is probably some selection bias, this is partially mitigated by the size of the study.[163]

In Argentina, a sample of patients from all age groups recruited for a surgical campaign demonstrated a glaucoma prevalence of 3.5%,[I] although this was not a well-designed investigation. In a study performed in the Malvinas (Falkland) Islands, investigators found a high prevalence of pseudoexfoliation among individuals aged over age 60, and 20% of them had glaucoma,[209] and another investigation in Argentina also showed a high percentage (24%) of glaucoma secondary to pseudoexfoliation.[88] In Paraguay a ratio of 4:1 primary to secondary glaucoma was determined with glaucoma secondary to pseudoexfoliation syndrome in 20% of cases, neovascularization in 22%, and 26% related to trauma.[268]

Diabetic Retinopathy

Diabetic Retinopathy is an emerging problem in Latin America because of the explosive increase in number of type 2 diabetic patients, resulting from changes in dietary habits, sedentary lifestyles, and obesity (Table 5). Data indicate that DR prevalence varies considerably across the region with the highest numbers (20%) in the most economically developed countries; the proportion of blindness due to DR in Brazil was 16%. Developing best practices for screening and treatment, as well as educating diabetic patients and creating proper referral systems between primary care physicians and ophthalmologists in each country is likely to be a significant challenge (Table 5).

We located 63 publications (RACSS and RAAB studies included) describing DR in the following countries: Brazil (13), Chile (5), Colombia (3), Cuba (5), the Dominican Republic (1), Ecuador (2), Mexico (14), Paraguay (2), Puerto Rico (1), Uruguay (1), and Venezuela (3). Concerning Latin Americans living in the United States, there were 13 articles. One limitation of several of these studies is that the relative contributions of type 1 versus type 2 diabetes mellitus were not addressed.

Diabetic retinopathy data for RACSS and RAAB studies were found for Brazil,[9*] Chile,[18*] Colombia,[219*] Cuba,[263*] the Dominican Republic,[C] Ecuador,[D] and Venezuela.[266*] In those countries, the contribution by DR to the total cases of blindness varied from 1.4% in Colombia to 15.9% in Brazil. These studies are adequate in terms of selecting the subjects for the survey, but as the examination was performed at the patient's home, this is not ideal diagnostically, and DR and other posterior segment diseases may be underestimated.[140]

One study performed in Ecuador demonstrated that DR caused 7% of the total cases of blindness,[38] whereas in Puerto Rico 7.5% of a sample of people aged from 40 to 79 years had the disease.[69] Both of these studies were from ophthalmological clinics and thus do not take into account those who do not have access to medical care and are not population-based studies.

In Paraguay, in a sample composed of diabetes mellitus (DM) patients randomly selected from an endocrinology clinic, 43.8% had DR, and 2.3% were blind due to the disease.[35] Another study in this country reported a DR prevalence of 37% in a sample composed of 199 DM patients.[J]

In Chile, the only study that used random samples of subjects found a prevalence of 25.7% of DR among type 2 DM patients,[6] although the reporting of the study was poor. Three other investigations found a prevalence of DR in 19.8% (Venezuela), 23.5%, and 28.5% in DM patients, respectively,[94,273,292] although none of these studies were well designed. In a brief report of an RAAB study performed by Barría et al, DR contributed to 8.5% cases of blindness.[17]

In Brazil, three investigations performed among type 2 DM subjects noted a prevalence of the disease varying from 34.4% to 47%.[130,160,248] Another study compared the prevalence of the disease among different ethnic groups and found a higher prevalence of DR in Brazilians of African heritage compared to those of European ancestry, although this study had some selection bias.[98]

A retrospective chart review of DM patients attending a screening program performed in the state of Pernambuco, Brazil, found that almost 25% of patients coming from urban areas and 40% from rural areas had DR. Although not a population-based study, these data suggest that patients from rural areas might have difficulties accessing eye care services.[70]

Two more studies of type 1 DM patients also reported a prevalence of DR of 44.4% and 43.3%, respectively, although the former study had poor quality data.[73,226] In terms of blindness, DR was the cause in 16.4%[243*] and 20% (nonrandomly selected sample)[7] of cases in two other studies, but was responsible for only 4.0% of visual impairment.[67]

Among the Hispanic population living in the United States, one study determined that 46.9% of type 2 DM patients had DR. In this instance, DR contributed to visual loss in 13% of cases,[229*] whereas another study showed that 8.3% of blindness was from DR.[49*] Although one earlier study from 1998 described a higher prevalence of DR in Mexican Americans compared to the non-Hispanic white population in the United States,[124] another study published in the same year did not confirm this finding.[277] More recently, a study of Latinos with DM living in the Los Angeles area found a 4-year incidence of DR of 34%.[283*] West et al observed a high percentage of DR (47%) among type 2 DM Hispanic patients, with almost two-thirds having moderate to severe lesions.[302*] The same authors described that the prevalence of DM as higher among Hispanics than non-Hispanic whites, but the DR prevalence was comparable with reports of whites.[301*] In another study, Hispanics had a similar prevalence of DR among DM patients compared to African Americans (37.4% vs 36.7%), but higher than non-Hispanic whites (24.8%).[308*] Although not statistically significant, a recent investigation studying DM patients also found a higher prevalence of DR in Mexican Americans than non-Hispanic whites.[311*]

In other studies among DM patients, the prevalence of DR was 18.3% in Colombia,[227] 19.8% to 85% in Cuba,[40,44,205] 76.7% in Venezuela,[8,94,281] 20.5% in Uruguay,[207] and 31–80% in Mexico,[12,149,216–218,234,282] but the varying designs of these studies make it hard to extrapolate data on a nationwide basis, and some studies do not differentiate between type 1 and type 2 DM (several of these studies had some selection bias and were poorly designed).

In Mexico, the 3-year incidence in 52 type 2 DM patients was 23%,[235] and in another study of 164 DM patients the 4-year incidence of DR was 22.5%.[114] In 1994, a study with 214 DM patients living in poor areas of Mexico City aged 35–64 years found DR in half, and 5.6% of them had proliferative retinopathy.[116] Three years later in the same country, investigators used a mobile unit to examine 220 DM patients aged 50–75 years, and 38% had DR.[115] Caution must be exercised in interpreting these studies, as they cannot be extrapolated to general populations.

In 1997, a study compared DR among randomly selected Mexicans living in two poor neighborhoods: one in Mexico City and another in San Antonio, Texas. Investigators found a nonsignificant higher prevalence of DR among those living in Mexico (49% vs 41%), but a higher prevalence of moderate to severe DR among individuals living in Mexico (26% vs 18%; $p < 0.05$).[117] More recently, in a survey performed with 1,000 DM type 2 patients in ophthalmological hospitals in Mexico, half reported DR and 16% self-reported being blind, although no eye examination was performed.[233] A nationwide survey published in 1994 found a higher percentage of blindness (0.6%) among DM patients than non-diabetics (0.2%), although they used self-reported data and no eye examination or blood test was performed.[208] A recent population-based investigation performed in individuals over age 50 years from Chiapas (Mexico; area both rural and urban) found that DR was responsible for 8% of blindness (VA < 20/400) and 11% of severe visual impairment (S. Polack, personal communication).

Age-related Macular Degeneration

Despite the fact that Argentina and Uruguay have the highest percentages of the elderly in Latin America, no reports about AMD were found for those countries. In fact, in almost half of Latin American countries, we found no publications about epidemiological aspects of AMD. Collectively, this is a cause for concern, as AMD is now starting to consume a high level of resources in developed countries. RAAB studies suggest that the proportion of individuals blind from AMD is low, around 3% to 4%, but these studies are not really powered to detect AMD.

A total of 27 articles were located that describe epidemiological aspects of age-related macular degeneration in Latin America: 9 in Brazil, 2 in Chile, 1 in Colombia, 3 in Cuba, 1 in the Dominican

Republic, 2 in Ecuador, 1 in Peru, 1 in Puerto Rico, 1 in Venezuela, and 6 among the Hispanic population living in the United States.

In Brazil Salomão et al found that in patients living in Sao Paulo City and over 50 years old who were randomly selected, 16.4% of the presenting blindness (< 20/200) was due to AMD.[243*] In a vision examination campaign, Arieta et al selected 11,462 patients who had poor VA, and AMD was found responsible in 5.5%.[67] Oliveira et al also observed that AMD caused 2.7% of visual impairment cases (< 20/200) in a sample of patients over 50.[198] In Japanese immigrants and descendents aged 60 years or older living in the south of the Brazil, the prevalence of AMD was 15.1%, considerably higher than studies from Japan, which suggests that environmental factors play an important role in the etiology of the disease.[194]

In patients who underwent cataract surgery 2 years earlier, AMD was responsible for almost 15% of the cases of poor visual outcome.[58] Thus, the disease was responsible for 3.1% of visual impairment cases in non–randomly selected patients over age 60 years.[7] In reports based on non–randomly selected patients, AMD was found in 31.5% of patients over 80 years[236] and in 26.7% of the eyes from patients aged over 55 years.[249] Finally, AMD contributed to 16.7% of visual impairment cases of in a recent investigation performed in southeast Brazil.[252*]

Varma et al reported a prevalence of 9.4% for early AMD and 0.4% for advanced AMD in Hispanics aged ≥ 40 years living in the United States.[286*] Recently, the same group reported a 4-year incidence of early and late AMD for at-risk participants of 7.5% and 0.2%, respectively.[285*] Again, among Hispanics, Rodriguez et al found that AMD caused 14.3% of the total cases of bilateral blindness (BCVA < 20/200).[229*] Hispanics living in the United States have a higher percentage of AMD (4.2%) compared to African Americans (2.4%), but less than non-Hispanic whites (5.4%).[136*] A recent publication also found a higher prevalence of AMD among Mexican Americans (5.1%) than African Americans (2.4%) aged 40 years or older. Although not statistically significant, non-Hispanic whites have a higher prevalence of AMD than Mexican Americans.[135*] An earlier study published in 1995 also found a higher prevalence of AMD among non-Hispanic whites (9.3%), but similar prevalences in African American (7.4%) and Mexican Americans (7.1%).[137*]

In the Dominican Republic[C] and Venezuela,[266*] the only data concerning AMD came from RACSS or RAAB studies. In the Dominican Republic, 3.8% of blindness was from AMD, whereas in Venezuela AMD contributed to 2.9%.

In Cuba from the RACSS study published in 2006, 1.5% of the cases of blindness were due to AMD.[263*] In one study performed in 2008[125] 8% of the patients with AMD had a visual acuity < 0.1, however, whereas another study published in 2009 described a prevalence of 0.3% of the disease in a sample composed of almost 35, 000 patients from all age groups;[276] both these studies had methodologic problems.

In Ecuador, the RAAB study published recently stated that 4.3% of the total cases of blindness occurred due to AMD.[D] In the same country, one non–population-based study reported that in 802 patients from a clinic, 3% of blindness cases were from AMD,[38] and in Colombia the prevalence of the disease was 4.9% in a sample composed of 535 patients aged over 55 years.[228] Again, the sampling method makes it difficult to draw conclusions about the general populations. Similarly, in Puerto Rico, a chart review of 9,298 patients ≥ 40 years old demonstrated that 2.1% had AMD,[69] but may have underestimated or overestimated the prevalence for the same reasons as the Ecuadorian and Colombian studies.

In a RAAB study carried out in Chile, 4.3% of blindness was from the disease,[18*] yet in the same country, a screening campaign of non–randomly selected patients detected a prevalence of only 1.8% in people 60 years old or older.[273] In a sample of 15,479 urban residents of all ages in Peru, Wong found that 10.6% of blindness (< 20/200) was due to AMD.[307] This compares to an older study (1990) performed in Peru (Chimbote City) and Brazil (Campinas City) in which a prevalence of blindness (VA < 20/200) was noted in 39.1% of men and 66.8% of women, and 47.2% of men and 44.6% of women, respectively.[129] Of these cases in Brazil, 37.7% of non-operable bilaterally blind cataract cases (n = 69) had AMD.

Pterygium

Pterygia are common in the region, most likely because of high exposure to sunlight.[183] As some reports describe the occurrence of grade IV pterygium (covering the pupil), we can conclude it is a cause of blindness and visual impairment in Latin America. The use of eye protection should reduce this problem.[275] Also, corneal surgeries should be included in cataract campaigns in areas with a high prevalence of grade III or IV pterygia.

Two articles describe the prevalence of pterygium in an indigenous population living in the north of Brazil. One study published in 2002 noted a prevalence of 12.8%,[222] and the other, published 4 years later,

determined an overall prevalence of 18.4%, varying according to the tribe.[203*] Another Brazilian study found that of those presenting with pterygium, 1.4% had the lesion covering the pupil, a potential cause of blindness.[251] Among Hispanics living in Arizona, West et al also found a high prevalence of pterygium (16%).[300*]

The only study in Venezuela found a prevalence of 5.8% in women and 6.7% in men.[182] Similar findings were described in Cuba, where 5.5% of a large sample composed of 34,790 people from all age groups had pterygium,[276] although this study was poorly reported. Among 208 patients presenting with pterygia in another Cuban investigation, 12% were grade IV.[169] Finally, in Bolivia and Colombia, data presented by Garcia-Alcolea et al described the prevalence of pterygia in adults as 34.3% and 20.9%, respectively, although the latter study had selection bias and poor quality data.[95,96]

Ocular Trauma

Ocular trauma in Latin America occurs mainly in young men, at the workplace, in workers not using eye protection. In the United States the Hispanic population is also at a higher risk of suffering eye trauma.

We found reports describing epidemiological aspects of ocular trauma in Brazil, Chile, Colombia, Cuba, Mexico, Peru, and among Hispanics living in the United States. One article from Colombia and two articles from Brazil describe data from ocular trauma in children and will be discussed later under "Ocular trauma."

Brazil was the country with the highest number of articles describing ocular trauma.[21,41,52,145,146,210,261,293,303] Men were more affected (62–96%) in all of the reports specifying sex. Ocular trauma constituted 30–40% of all ophthalmological emergencies,[210,293] with surface foreign bodies the most common, although there were no data reported in this study regarding visual acuity.[41] Thus, most were closed-globe injuries.[21,145,210] Most accidents were in the workplace and home, although motor vehicle accidents also contributed.[41,52,261,303] Among workplace accidents, in one study only 17% were using any kind of eye protection.[41]

The only data available for Chile show a similar pattern, with almost 75% of the cases occurring at home or workplace (D. Varas and F. Andrighetti, personal communication). In Cuba, in a sample of 531 patients with mechanical trauma, approximately half were caused by fights. Again men were affected in the vast majority of the cases.[93] In Peru ocular trauma occurred mainly in men (79%) and at the workplace (28%).[242] In Mexico, three articles from 2004 to 2007 found more than 80% of the patients were men, and in more than 80% of the cases the trauma was a closed-globe injury.[150,153,154] The same group reported that 0.8% of the patients had retinal detachment and 0.3% endothalmitis.[152] Thus, approximately 68% of the eyes diagnosed with ocular trauma had VA $\geq$ 20/40 after 6 months of follow-up.[151] However, the study design, reporting, and size of the these Mexican studies mean that the results should be regarded circumspectly.

In some studies performed in the United States, Latino workers seemed at higher risk for eye injuries,[14,256*] and one investigation determined that less than 20% of the injured workers were using eye protection.[256*] A study published in 1991, however, found that ocular trauma occurs more in African Americans than in Hispanics.[305*]

Infectious Diseases

As in other parts of the world, trachoma and onchocerciasis are in decline, but it is still necessary to monitor these diseases in some areas. Ocular toxoplasmosis (OT), an important cause of posterior uveitis worldwide,[25,239] has a special importance in Brazil, where seropositivity and eye disease seems to be higher than the rest of the world.[263*] This may be partially explained by the presence of more virulent genotypes of the parasite than those found elsewhere,[133] but other factors, such as eating habits and poor hygiene, may contribute.

TRACHOMA

Data from WHO indicate that there are more than 3 million people requiring treatment for trachoma in endemic areas in Latin America, especially in Brazil, Guatemala, and Mexico. In 2005 it was believed that the prevalence of the inflammatory and follicular phase of the disease in children under 10 years old was 4.5% in Brazil, 1.9% in Guatemala, and 1.9% in Mexico. No cases of trachoma were described elsewhere in Latin America.[K]

The presence of trachoma along Brazilian borders with Peru, Venezuela, Bolivia, and Paraguay suggest the disease might be underdiagnosed in these countries[L] (Fig. 1). Studies should be performed to better define if the disease is present in areas currently classified as nonendemic.[257] This is an issue not only with trachoma surveillance, but also with all infectious disease.

In Mexico, Goldschmidt et al recently found conjunctival follicles in 22%, 30%, and 42% in a sample composed of children aged 6–12 years old from different cities in a rural area of the

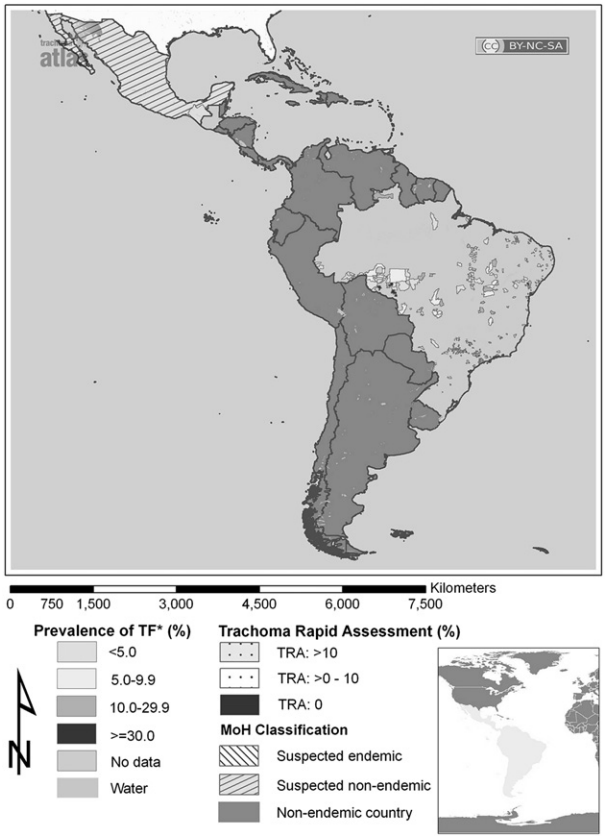

Fig. 1. Prevalence of active trachoma in Latin America. (Figure courtesy of the Trachoma Atlas Project.)

country.[110*] An older report from Taylor et al described a high prevalence of the inflammatory stage of the disease in children in Chiapas (25%), and almost everyone aged over 40 years had some degree of cicatricial trachoma, attributed to the low frequency of face washing.[272*] A recent survey in Guatemala described that a few pockets of active trachoma are still present in some of the former endemic areas (S. West, personal communication).

Eighteen articles describe the occurrence of trachoma in Brazil. The prevalence of the disease varied from 2.2% in children in Sao Paulo City[139*] to more than 30% or even over 50% in some indigenous population in the north of the country.[3,202*,222] WHO has suggested that the burden of trachoma has been decreasing worldwide, and this mirrors what has been happening in Brazil.[86] For example, Medina et al noted a trachoma prevalence of 11.9% in children living in 1992 in Botucatu in the state of Sao Paulo,[175*] but by 2005 the prevalence in that same city has been reduced to 3%.[254,255] In 1992, in Bebedouro City (state of Sao Paulo), 7.2% of the population (all ages) had trachoma.[168*] In another city in the state of Sao Paulo, it was recently noted that 3.8% of children aged 6–14 years had inflammatory trachoma.[76*]

Comparing recent data from the north and the northeast of Brazil—among the poorest parts of the country—a higher prevalence of trachoma was found compared to the southeast. Thus, Lucena et al found in Ipubi (a city in the state of Pernambuco, in the northeast of the country) a prevalence of 20.5% in a sample composed of 1,239 children and adults.[166] Recently, the same group reported a prevalence of trachoma in 26.2% in the sample studied (all ages) in Araripe City in the northeast.[165]

In another northeast state, Damasceno et al found a trachoma prevalence of 4.5% in a sample of 6,424 children and adolescents, although examinations were conducted by medical students and not ophthalmologists,[55] and Cruz et al found that 8.9% of a population sample analyzed in São Gabriel da Cachoeira (a city in the north) had the disease.[53*] By contrast, in the southeast, the prevalence of the disease in children from Sao Paulo City was reported as only 2.2%,[139*] or 5.9%,[176] with 4.7% having active trachoma.[31*]

One study associated poor social conditions, facial hygiene habits, and contact with cases of the disease in the same house or family as risk factors of the disease, although some selection bias was involved.[54] In another study, children sleeping in the same room had a higher chance of having the disease.[177*]

OCULAR TOXOPLASMOSIS

We found publications concerning OT in four countries: Brazil, Colombia, Mexico, and Venezuela. Also, one article citing the occurrence of ocular toxoplasmosis in Latin American immigrants living in Spain was included. Some of these reports described congenital infection and will be presented later under "Congenital toxoplasmosis."

An observational cohort study was performed in Colombia in which 200 young adults were screened by indirect ophthalmoscopy and 6% had retinal scars compatible with toxoplasmosis.[59] In the same country, de la Torre et al noted that in a sample of 693 patients with uveitis, the condition was caused by *Toxoplasma gondii* in 39.8%, although this was a chart review in a hospital setting.[60] The same group also described in a retrospective study that the mean number of recurrences of the eye disease was two in 11 years, although this case series was small.[61]

In a study published in 2005, OT was the leading cause of uveitis (26%) in 760 patients from a uveitis clinic in Mexico,[296] although good diagnostic description was lacking. The only data available for Venezuela came from 1,247 patients with OT, with almost half having a VA $< 20/100$, and 80% percent having macular scars; however, the quality of the study is poor.[63]

In Brazil, Glasner et al[109*] found that 17.7% of the population in a city located in the south of the country had OT. In the same city, where seropositivity for the disease can go as high as 98% depending on the age group studied,[264] Silveira et al also showed that in a sample composed originally of 109 seronegative subjects, 19.3% became seropositive after 7 years and 9.5% developed eye disease.[265*] Other investigations conducted in different parts of the country showed a lower prevalence of OT: 1.2% and 3.8%, although the first cited study did not use randomly selected subjects.[1,56*] In a retrospective study of 200 HIV patients with uveitis, 11% had OT.[11] Also, in a low-vision service in northeast Brazil, in a sample composed of patients of all ages from 96 months to 86 years old, ocular toxoplasmosis was the overall major cause of low vision, contributing almost 11% of the cases.[262]

In Spain, a retrospective study performed with 22 immigrants (20 of them immunocompetent), presenting with OT (91% with active lesions, 9% retinal scars) showed that almost 80% of them were Latin Americans.[2]

ONCHOCERCIASIS

WHO has a program to eradicate the disease in six countries of the Latin America subcontinent (Brazil, Colombia, Ecuador, Guatemala, Mexico, and Venezuela).[5] In these countries, there are approximately a half million people at risk (Fig. 2).

Since the Mectizan (ivermectin) donation program started,[22] transmission has decreased, blindness due to onchocerciasis is rare, and ocular lesions related to the disease have been eliminated in almost 70% of the foci.[M] The aim of the Onchocerciasis Elimination Program is to eradicate the disease in Latin America by the year 2012.[5]

In Mexico, in the late 1980s, more than 100 cases/year of blindness from oncocerciasis were registered.[170] More recently, no microfilaria in the anterior segment were seen in the last evaluation performed in southern Chiapas, and all of the children studied remained seronegative during a 3-year follow-up in Oaxaca.[231,232*]

In the Escuintla region of Guatemala, no microfilaria were found in the anterior segments 329 people. In addition, no antibodies to *O. volvulus* were noted in a sample of 6,432 children, nor *O. volvulus* DNA in 14,099 *S. ochraceum*.[111*] These data suggest that the transmission of the disease has been arrested. In the Department of Santa Rosa in Guatemala, a study performed in 2007 showed that the disease is no longer active, and the authors suggest that ivermectin distribution can be stopped.[158*] Thus, exposure of migrant coffee workers to onchocerciasis seems to be low and does not contribute perpetuation of the disease in endemic areas.[159] In 2006, Winthrop et al reported that microfilaria were found in only 1.2% of the sample from the endemic area, and in none of the people from the nonendemic region. In the same study, it was also demonstrated that corneal inflammatory lesions are not reliable indicators of onchocerciasis.[306*]

In Ecuador and Colombia, most of the infected subjects are indigenous peoples or African descendents who live next to rivers.[250] An old study performed in Ecuador found that 0.4% of the people infected had blindness from the disease, and 8.2% had visual impairment in the Esmeraldas province, although details of subject selection were lacking.[47] A more recent report from Ecuador in 2007 found no eye disease in sentinel communities used to monitor the effects of ivermectin distribution.[294*]

In the frontier between Brazil and Venezuela, the indigenous population, especially the Yanomami tribe, is continuously exposed to vectors of the disease. Botto et al found a prevalence of skin disease in 46.2% on the Alto Orinoco-Casiquiare Biosphere Reserve (Venezuela), but did not study eye lesions.[26]

In Brazil, massive treatment consisting of six rounds of ivermectin administration has reduced the prevalence of skin disease from 87% to 42%.[15] Unfortunately, despite the efficiency of the treatment and the lowered number of foci, a recent study demonstrated that in 83 individuals from the Yanomami tribe, 55% still had skin disease and 39% had microfilaria in the anterior chamber.[193*]

Colombia had a single endemic focus, but ivermectin distribution was halted in 2008 based on the Onchocerciasis Elimination Program recommendation that transmission had been interrupted there. Colombia would be the first country in the Americas to request certification from PAHO/WHO in 2011. At the end of 2007, active eye disease attributable to onchocerciasis (defined as a $>1\%$ prevalence of microfilariae in the cornea or anterior chamber of the eye) was only found in Brazil and Venezuela. There has been no blindness attributable to onchocerciasis in the region since 1995.[5]

Childhood Blindness and Eye Problems

Childhood blindness is relatively rare, making prevalence in a country or region difficult to determine. Ideally, there would be population-based studies with very large samples.[101] Although no studies with these characteristics have been conducted in Latin America, we can estimate the

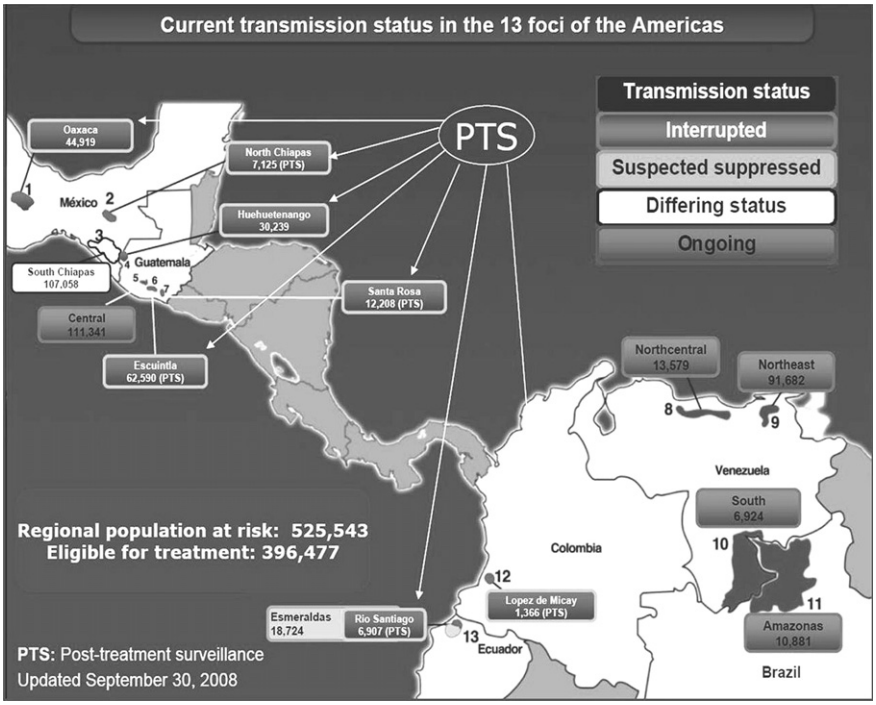

Fig. 2. Geographic distribution of onchocerciasis in Central and South America. (Figure courtesy of the World Health Organization.)

impact of each eye disease using studies performed in schools for the blind and also at low vision services. Table 6 describes these articles and the most important diseases found. Hereditary diseases were found responsible for 22.4% of severe visual impairment and blindness in Colombia, 29.6% in Chile, and 38.7% in Ecuador in one study published in 1995.[103]

Childhood blindness is a priority for the VISION 2020 program, because when we analyze the "blind years" produced, its impact on society is similar to cataract in adults.[101] Moreover, most causes of childhood blindness are avoidable. The small number of publications and variable results make childhood blindness hard to analyze, but we believe retinopathy of prematurity (ROP) is the main cause of avoidable blindness in Latin American children, contributing from 2.7%[57*] to 38.6% of the total cases.[100*] One review estimates that 24% of childhood blindness in Latin America and Caribbean (24,000 children) is due to ROP.[99] Moreover, more than 4,000 newborns annually develop severe ROP in Latin America, half of whom become blind (A. Zin, personal communication). Comparing the data to other geographic areas, former socialist countries have the highest percentages of ROP as a cause of childhood blindness (37.4%), whereas in developed countries this percentage is 10%. For comparision, it is 1.9% in China, and only 0.1% in India.[99]

RETINOPATHY OF PREMATURITY

We found articles concerning ROP in the following countries in the region: Argentina, Brazil, Chile, Colombia, Cuba, Ecuador, Guatemala, Mexico, Paraguay, Peru, and from the Hispanic population living in the United States. An epidemic is occurring in developing countries that have been instituting improvements in their healthcare systems, such as Brazil, Argentina, Chile, and Mexico.[102*] Few ROP studies have been carried out in Latin American countries, however. Thus, broader criteria for ROP screening should be used in Latin America than those for developed countries (Table 6).[313*,N]

Gilbert et al has presented data on ROP in schools for blind children in Argentina,[100*,102*,O] Brazil,[100*] Colombia,[100*,102*] Cuba,[102*] Ecuador,[102*] Guatemala,[102*] Paraguay,[102*] and Peru.[100*] The proportion of children with ROP varied substantially from 4.1% (Guatemala) to 60% (Argentina).

In Guatemala, the single study investigating ROP in a neonatal unit in Guatemala City found a prevalence of 49% in a group of 88 infants born at <35 weeks of gestational age or weighing less than 2,000 g at birth and referred for specialized evaluation.[246] Three neonates were evaluated too late, and no therapy could be applied In 11 neonates therapy was indicated, with 9 receiving laser treatment and 2 receiving intravitreal injections of bevacizumab. In Chile and Peru, the only

TABLE 6

Prevalence of Eye Disease Among Children from Schools for the Blind and Low-vision Services

Author (Year)	Country	Setting	Sample Size (n)	First Cause VI (%)	Second Cause VI (%)	Third Cause VI (%)	Notes
de Carvalho et al[57] (1998)	Brazil	LVS	395	OT (43.5)	OA (11)	CC (10)	ROP: 2.7% CG: 2.3%
Haddad et al[123] (2007)	Brazil	LVS	1,826	OA (21.8)	OT (15.45)	ROP (10)	CG: 7% CC: 6.79%
Haddad et al[121] (2006)	Brazil	LVS	385	CG (30.6)	OT (16.7)	CC (12.8)	ROP: 3.1%
Gilbert et al[105] (1994)	Chile	SFB	267	ROP (17.6)	Retinitis pigmentosa, retinal dystrophy, and rubella (6 each)		HD: 29.6% OT: ~1% CC: 5.3% CG: 1.4% (percentages of blindness or SVI)
Gilbert et al[103] (1995)	Colombia and Ecuador	SFB	Colombia: 94 Ecuador: 142	HD: Colombia (22.4) Ecuador (38.7)	—	—	—
Banchio et al[P] (2008)	Argentina	SFB	83	ROP (24)	URE (10.8)	CC (7.2)	CG: 2.4% Chorioretinitis: 2.4%
Brito et al[28] (2000)	Brazil	SFB	174	CG (18.3)	Unknown (16.2)	ROP (12.0)	Cataract: 6.6% OT: 4.2%
Zuluaga et al[314] (2005)	Colombia	SFB	124	ROP (33.8)	OT (15.3)	CG (9.6)	CC: 2.4%
Gilbert et al (1993)[104]	Chile	SFB	217	ROP (17)	CC (7)	CG (6)	—
Gilbert et al (2005);[100] Arrazola[O]	Argentina Brazil Colombia Peru	SFB	Argentina: 177 Brazil: 148 Colombia: 226 Peru: 217	ROP (60, Argentina) (14.2, Brazil) (23.9, Colombia) (16, Peru)	—	—	ROP only, no data about other diseases
Gilbert et al (1997)[102]	Colombia Cuba Ecuador Guatemala Paraguay	SFB	Colombia: 94 Cuba: 70 Ecuador: 142 Guatemala: 73 Paraguay: 36	ROP (10.6, Colombia) (38.6, Cuba) (14.1, Ecuador) (4.1, Guatemala) (33.3, Paraguay)	—	—	ROP only, no data about other diseases
Silva et al (2010)[262]	Brazil	LVS	32	CG (15.6)	OT (12.5) OA (12.5) Albinism (12.5) Nistagmus (12.5)		Individuals aged 0–19 years
Zepeda-Romero (2011)[310]	Mexico	SFB	144	ROP (34.7)	CG (14.6)	Retinal distrophy (5.6) Microphthalmos (5.6)	

CC = congenital cataract; CG = congenital glaucoma; HD = hereditary diseases; LVS = low vision service; OA = optic atrophy; OT = ocular toxoplasmosis; ROP = retinopathy of prematurity; SFB = schools for the blind; URE = uncorrected refractive errors; VI = visual impairment.

data available come from studies performed in a school for blind children. The prevalence of ROP was 24% in Peru and 17.6% in Chile.[104*,105*,G]

In one Argentinean study not well reported, ROP was found to have contributed to 24% cases of blindness.[P] In premature neonates, Bouzas et al reported that 55% were classified as severe cases of ROP, although subject-selection procedures were poorly described,[27] and Franz et al found that 25% of those premature infants who completed follow-up had the disease.[Q] On the other hand, Fabiani et al found that only 5.5% of premature babies present in their study had ROP, probably because of changes in management of newborns.[75] Laurencio et al verified a prevalence of ROP in 56.9% of premature neonates from 1999 and 2003, but from 2003 through 2009 this was reduced by 20% after implementation of better oxygen management in newborns.[144] In a 2006 survey performed in 36 neonatal care units in Argentina, severe ROP was found in only 4.5% of premature infants,[118] suggesting that better management developed in the last decade was having a positive effect. Recently, Lomuto et al stated that 1 out of 900 live births is treated for severe ROP, but this number could be an underestimate as not all of the neonatal care units performed ROP screening.[161] The same authors have also noted an ROP prevalence of 26.3% in newborns under a birth weight of 1,500 g.[162] Finally, Waisman et al found a prevalence of ROP in 35.4% of neonates in one study,[297] and 38.4% in another, but 14.2% of newborns were not screened.[298]

The incidence of ROP varied from 22.2% to 58% in preterm newborn infants in Mexican hospitals.[77*,113,200,220,247] The prevalence of type 1 ROP in Mexico is 6–15.9% of preterm babies with weight less than 1,750 g and <35 weeks of gestational age, and a hospital-based study (Hospital Civil de Guadalajara) showed that over 4 years, of 1,018 premature babies included in the ROP protocol, 162 (15.9%) developed severe ROP (L.C. Zepeda-Romero, personal communication). In another study performed with 144 children attending a school for the blind in Guadalajara City (Mexico), ROP was the main cause of visual loss (34.7% of the cases), followed by congenital glaucoma (14.6%).[72] The only report found concerning ROP in Hispanics living in the United States noted a prevalence of 41.4%, and there was no difference between Hispanics and non-Hispanic whites.[68]

In Brazil, 4 studies analyzed the impact of ROP in low-vision services or schools for the blind, and the other 16 were focused on neonatal care units. Of the subjects attending a low-vision service, 3.1% had the diagnosis of ROP in one study,[121] and 2.7% in another.[57*] Analysis of a larger sample revealed that ROP was the third highest cause of visual impairment (11.8%),[123*] however, and in children attending schools for the blind, ROP was present in 12%, although selection of subjects in this latter study was poorly described.[28] In neonatal care units, the incidence of ROP in preterm newborn infants varied from 16.9% to 62.4%,[23,34,78,79*–86,148*,184,211,213,258,260,312*,313*] and the incidence of severe ROP varied from 3.6% to 7.4%. The large variation in ROP incidence is most likely due to the different methodology used (e.g., some studies performed with newborns weighing less than 1,000g only and other studies using criteria of weight less than 1,500 g). One conclusion is that countries such as Brazil should use wider criteria for ROP screening than those used for the United States and United Kingdom.[313*]

In Colombia, one-third of students starting in a school for blind children had ROP,[314] although this study was poorly described. The only study performed in a neonatal care unit described 19.5% of premature newborns as having this diagnosis.[32] In Cuba studies performed in neonatal care units described a prevalence of ROP varying from 11.2% to 13.7%,[10,171,237] although all suffered from poor reporting.

REFRACTIVE ERRORS

In an important article Salomão et al in 2008 showed that UREs contributed in more than three-fourths of children presenting with visual impairment in one or both eyes in Brazil.[244*] Garcia et al reported that among those presenting refractive errors in a group of 1,024 school children, hyperopia was the most common (71%), followed by astigmatism (34%).[92*] In this sample the prevalence of anisometropia was 2%.[91*] Gaiotto et al also examined 950 children with VA worse than 0.8, and astigmatism was the most common refractive error (49.2%),[90] although one of these studies[90] could be considered poor in execution.[90–92*] In a sample of 1,800 children, it was found that 5.1% needed glasses, and that 2% had amblyopia, although biased selection was probably present.[50] In another, albeit poorly conducted study, 3.9% of the children had refractive errors, but a high percentage missed their appointments, which may have affected the reliability of the results.[71] In addition, myopia higher than 1 diopter (D) was found in 7.9% among those presenting with a VA < 0.8 (bias selection again present and methodological issues).[51]

An unusually high prevalence of strabismus (8.4%), anisometropia (11.9%), and ametropia (15%) was found in one family healthcare facility. The small size of the sample and the high number of patients who did not keep appointments could

explain these findings, however.[196] Finally, Oliveira et al found that 3.9% of 4,623 children needed glasses.[197]

In Colombia, a prevalence of 59.2% for hyperopia, 28.2% for astigmatism, and 4% for myopia was found in children from 5 to 14 years old, although poor reporting in this study was apparent.[167] Myopia was found in one-third of Mexican children aged from 6 to 15,[230] and in another study of 12- to 13-year-olds, the prevalence was even higher (44%)—only 20% of these myopic children were using spectacles.[295] Conversely, another report indicated a prevalence of 8% of myopia among children not wearing glasses.[221]

In a recent nationwide study performed by the Mexican government, 10% of the students 10 years old or older reported the use of spectacles. (Upper age limit was not reported and there were 11 subjects over age 16; this report also lacked many details.) Thus, 15.4% of these students had presented VA ≤ 20/30 in at least one eye.[R] In the state of Oaxaca, Mexico, investigators provided free spectacles for children who needed them, but 1.5 years later only 13.4% who came for a follow-up appointment were wearing them.[39*] The authors thought the appearance of the round spectacles, leading to teasing, were reasons for spectacle nonwear in older urban children, compared to younger, rural children. However, the same group described one year later 88 scholars who received free spectacles, and who were re-examined in 4 weeks. Those previously presenting with a VA of 20/20 in the better seeing eye did not have any improvement in any aspect tested (visual acuity, satisfaction, perception, and symptoms) after that period, but all of the other children presented improvement in at least one aspect tested.[72]

In Argentina, an investigation of low vision in school children determined that refractive errors contributed to 10.8% of blindness.[P] Also in that country, in a sample composed of 1,401 children aged 5 to 14 years old, 11% of the ones presenting VA ≤ 0.7 had myopia.[S]

In Peru, the prevalence of refractive errors in children aged 5 to 19 years old was 4.6%[199] whereas another investigation demonstrated a high prevalence of refractive errors (46.3%), with 6.5% of the children having a VA < 20/70 in one or both eyes.[195] A sample of 800 children aged 3 to 15 years also showed that myopia was present in 8.7%, although they was not randomly selected.[33] Poor reporting was evident in all these studies, however.

In Chile, UREs were the cause of reduced vision (VA < 20/40) in more than half of the eyes examined in children aged 5 to 15 years,[173*] with a prevalence of 0.2% of VA < 20/200 without glasses[19] (note: this latter report was a transcription from a conference). Another 0.2% had functional low vision, defined as BCVA lower than 6/18 but better than light perception in the best eye, from untreatable causes.[106]

Finally, among Hispanics living in the United States, the prevalence of hyperopia was found in 29.6%, myopia in 3.7%,[187*] amblyopia in 2.6%,[186*] with spherical equivalent anisometropia in 4.3% and cylindrical anisometropia in 5.6% of children aged 6 to 72 months.[24*] Only 0.3% of children aged 30 to 72 months had a VA varying from 20/80 to 20/160 in the better eye.[185*] A recent study performed in children aged 6 to 72 months in California described a higher prevalence of astigmatism (≥1.5 D and ≥3.0 D) in Hispanics compared to African American children.[87*]

CONGENITAL TOXOPLASMOSIS

The prevalence of congenital infection, including ocular toxoplasmosis, is higher in Brazil than other parts of the world. For example, Gilbert et al compared the prevalence of retinochoroiditis in newborns with congenital toxoplasmosis in Brazil and Europe and reported that the prevalence was much higher in the South American country (50% vs 10% in the first year).[107] Another large screening for toxoplasmosis also described a high prevalence of retinal lesions in newborns (79.8%).[291*] They also reported an unusually high prevalence (1/770 live births). In 43 newborns with congenital toxoplasmosis, Safadi et al observed an unusually high prevalence of eye lesions (95%),[240] and Neto et al found a prevalence of 10.6% for toxoplasmosis in a prospective study of congenitally infected newborns.[192*] In addition, it was recently reported that 65.9% of newborns with congenital toxoplasmosis had retinal lesions, 76% in the papillomacular area.[178]

Macular scars are common in children referred for services for the visual impaired; toxoplasmosis was one of the main causes of VI in four studies, contributing to 20.7%, 16.6%, 43.5%, and 12.5% of cases.[57*,121,123*,262] Brito et al found a lower prevalence among children in schools for the blind than other studies performed in Brazil, however—only 4.2%, although how subjects were selected was unclear.[28] Zuluaga et al reported that toxoplasmosis contributed to 15.3% of blindness in a study conducted in a Colombian school for blind and deaf children.[314]

Data from Brazil and Colombia show that, together with ROP, toxoplasmosis is a leading cause of blindness found in schools for blind and low-vision services. No reports about the disease were found for most Latin American countries, however.

CONGENITAL CATARACT

Few data exist concerning congenital cataract in Latin America. In Chile, for example, congenital cataract was the cause of 5.2% of blindness in one study and 7% in another,[104*,105*] whereas in Argentina this number was 7.2%.[P] In Brazil, again in schools for blind children, the prevalence of congenital cataract was 10%[57*] in one study and 6.3% in another, although in this latter study patient selection was poorly reported.[28] In a low-vision service it was found that the mean VA of patients with congenital cataract was 20/150, and 95.5% had previously undergone cataract surgery.[181]

CONGENITAL GLAUCOMA

Like congenital cataract, there is a lack of data concerning congenital glaucoma in Latin America. In Chile and Argentina congenital glaucoma contributed to 1.4% and 2.4%, respectively, of the visual loss of children in schools for the blind,[105*,P] and Gilbert et al in 1993 noted a prevalence of 6% for congenital glaucoma among children from a school for the blind in Chile.[104*]

In Brazil, a study of 100 children with congenital glaucoma showed that 45% had a VA $\leq$ 20/200.[122] The same group also noted congenital glaucoma in 7% of blind children and that it was the main cause of blindness in a low-vision service, contributing to 30.6% of the cases.[121] In schools for the blind, congenital glaucoma was the most prevalent cause of blindness, with 18.3% of cases, although subject selection was not clear.[28] In contrast, an older study found it was the primary disease in only 2.2%.[57*] A recent study performed in a low-vision service in Brazil described that congenital glaucoma was the main cause of low vision among patients under 20 years of age (15.6% of the total).[262]

OCULAR TRAUMA

In Chile, 1.4% of cases in a school for blind children were related to trauma.[105*] Three publications have described ocular trauma in Mexican children. Among 52 children who needed hospitalization for ocular injury, the main cause was metallic intraocular foreign bodies.[278] Another study demonstrated that almost 75% of patients affected were boys, and one-third of cases had a final VA $<$ 20/100.[270] A third report noted that closed globe injury was the most common type of ocular trauma.[119] In Colombia most of the cases occurred in boys (65%), at home (44.4%), with 82.4% being closed globe injuries.[259*]

In Brazil, three publications described ocular trauma in children. In one that analyzed cases of open globe injuries, 76% occurred in boys, and in more than half of the cases the perforation was with a sharp object.[215] The other studies showed similar patterns: Most injuries occurred at home[36,261] and were of the closed-globe type, although visual acuity was not reported.[36]

Most childhood ocular injuries occur at home, and parents should be instructed to keep sharp and other potentially dangerous objects away from children.

Conclusion

Despite all of the improvements resulting from the VISION 2020: The Right to Sight, it will be difficult to achieve the goal of eliminating avoidable blindness in Latin America by the year 2020. Although cataract, refractive errors, and ROP screening and treatment are current priorities, it may be that, 10 years from now, diabetic retinopathy, glaucoma, and macular degeneration will come to the fore as populations continue to age and other diseases are effectively treated. In many cases, this will require new infrastructure. For example, low vision service coverage in most of the Latin American countries is less than 10%.[43]

Worldwide, cataract, trachoma, onchocerciasis, childhood blindness, and refractive errors are WHO's first priorities.[T] In Latin America, the PAHO's second priority for adults is diabetic retinopathy, with glaucoma being the third; for children it is ROP and URE.[U] Although these priorities are based on what we know, there are still many gaps to be filled, primarily in countries in which we have limited or no epidemiological data regarding blindness and visual impairment.

The true economic cost of blindness and visual impairment in Latin America is not known. Using a simple model based on loss of wages, Carter and Lansingh estimated that annual economic losses for the region are between US$ 8 and US$ 29 billion, and these figures do not include the cost of caregiving, disability payments, family economic losses, and so forth.[V] These figures alone should provide incentive to do better and meet Vision 2020 goals.

Method of Literature Search

We cited only peer-reviewed publications that provided information about epidemiology in our reference list. Other published documents that might be considered part of the "gray literature" are included in the Other Cited Material list, but data from such publications should not automatically be considered low quality—simply not peer-reviewed. Due to the large number of articles

included, we could not systematically review all studies. As noted earlier, those studies that we considered to be of good quality have an asterisk (e.g.,[15*]); we have also commented in the text on poor-quality studies, or studies that have significant limitations.

We considered publications in all languages, although in practice we found that only those in Spanish or Portuguese needed to be translated (one article about glaucoma in Paraguay was written in German, but the abstract contained sufficient information). The data collected were divided by eye disease, ocular injury, and country and expressed as prevalence, incidence, or proportion of population blind or visually impaired from a particular disease or condition.

The following databases were searched from 1985 to 11 June 2011: PubMed, Lilacs, Bireme, Google Scholar, WebMD, Healthline, LATINDEX, PUBLINDEX, as well as Scholars Portal, DOAJ Directory of Open Access Journals, Free E-journals, Elsevier Science Direct, Ovid, and Scielo, all of which were available to us on the University of Toronto's Web site through the Ptolemy project. We also contacted the president of each national society of ophthalmology, VISION 2020 national committee, and Ministry of Health for each Latin American country, and national universities and non-governmental organizations operating in the region to help search for potential references. The World Health Organization Web site (www.who.int) and the Pan American Health Organization Web site (www.paho.org) were also used a as a source of information concerning eye diseases in the region.

Searches generally employed combinations of ocular key words and specific countries (e.g., cataract AND Argentina). Ocular key words used in our searches included *astigmatism, blindness, cataract, childhood blindness, congenital cataract, congenital glaucoma, congenital toxoplasmosis, diabetic retinopathy, glaucoma, macular degeneration, myopia, ocular toxoplasmosis, ocular trauma, onchocerciasis, pterygium, refractive errors, retinochoroiditis, retinopathy of maturity, strabismus, trachoma,* and *visual impairment.* Because RAAB studies showed that bilateral blindness due to corneal pathology is almost nonexistent, we decided not to review that cause.

The specific countries included Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, the Dominican Republic, Uruguay, and Venezuela. We also used the term "Latin America" to locate studies carried out in more than one country at the same time. In addition, we used the expression "Hispanics" in order to find studies performed in the United States of America, targeting the Hispanic population living in this country and one group in Spain.

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