Chapter

Visual Disability and Causes of Preventable Blindness

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Abstract

The World Health Organization (WHO) estimates, worldwide, approximately 1300 million people with a form of visual impairment. More than 314 million have a severe visual impairment. Of these, 37 million are blind and 124 million suffer from low vision. Eighty percent of all these cases are considered avoidable. The main causes of blindness from one country to another, in order of frequency, are cataract (39%), uncorrected refractive errors (18%), and glaucoma (10%). In Latin America and the Caribbean, the loss of vision in adults continues to be a public health problem. Blindness and visual impairment tombs have a remarkable impact on the socioeconomic development of individuals and societies and the prevention of avoidable visual disabilities in the long term in terms of attention to health care and social expenditures. Of all the organs of the body, the eye is more accessible to direct examination. The visual function can be evaluated by means of simple subjective tests. The same can be taken care of from an adequate primary care service.

Keywords: blindness, cataract, refractive errors, glaucoma, visual acuity

1. Introduction

The universal aging of the population is a global concern because of its association with degenerative diseases, which can cause disabilities in humans, limit their productivity in society, and negatively affect their quality of life [1–5].

In all societies, blindness has profound human and socioeconomic consequences. The costs of loss of productivity, rehabilitation, and education for the blind constitute a significant economic burden for the individual, the family, and society [6].

Thus, it is interesting to know that total or partial opacification of the lens is the main cause of bilateral blindness and severe visual impairment represents about 48% of cases of visual impairment in the world and is known to have a multifactorial cause. In addition, it incapacitates the individual and increases their dependence and early retirement from life [7].

2. Classification

According to the WHO, visual function is subdivided into four levels: normal vision, moderate visual impairment, severe visual impairment, and blindness. Visual disability includes moderate and severe visual impairment and blindness [8, 9], see **Table 1**.

Category	Visual acuity
Normal vision	20/20–20/60
Moderate visual impairment	20/60–20/200
Severe visual disability	20/200–20/400
Blindness	≥20/400
	Count the fingers at 1, 2, 3 m
	HM
	PL
	DNPL

Symbology: Hand movement (HM), perceive light (PL), do not perceive light (DNPL), meter (m).

Table 1.
Classification of visual function according to the WHO.

The International Classification of Diseases (WHO ICD-10) contains the following definitions:

1. Blindness: visual acuity (AV) less than 20/400 in the best eye with the available correction (AVCD), with the best possible correction AVMC or with pinhole hole (AVAE)

2. Severe visual impairment (DVG): AV 20/200–20/400 in the best eye with the AVCD, AVMC, or AVAE

3. Moderate visual impairment (MVD): AV 20/60–20/200 in the best eye with AVCD, AVMC, or AVAE [7, 10, 11]

4. Low vision: alteration of visual function, even after treatment and/or standard correction of refraction and an AV less than 20/60 to perception of light but useful for planning or executing a task [7, 8, 10, 11]

3. Epidemiology

According to the WHO data, it is estimated that, worldwide, approximately 1300 million people live with some form of visual impairment. More than 314 million have a severe visual impairment. Of these, 37 million are blind and 124 million suffer from low vision. Eighty percent of all these cases are considered avoidable [12, 13].

According to WHO estimates, of the more than 26 million people with visual disorders in the Region of the Americas in 2010, more than 3 million were blind, and most of them were 50 years of age or older [12].

Most of the national and local surveys were published and published in Latin America, and refractive errors were not corrected in the main cause of visual impairment, both severe (19.7%) and moderate (58.6%) [14–16].

Between 1990 and 2010, the prevalences normalized according to the age of blindness, and moderate and severe visual impairment decreased in Latin America and the Caribbean [17].

The WHO estimated the prevalence of blindness in 2002 in people over 50 years by subregions [18], see **Table 2**. In Latin America, the prevalence of blindness in people over 50 responds between 1% in urban areas with good socioeconomic

WHO subregion	Country	Prevalence of blindness in people aged 50+ (%)
Amr-A	Canada, Cuba, USA	0.4
Amr-B	Argentina, Bahamas, Belize, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, El Salvador, Grenada, Guyana, Honduras, Jamaica, Mexico, Panama, Paraguay, Suriname, Uruguay, Venezuela	1.3
Amr-C	Bolivia, Ecuador, Guatemala, Haiti, Nicaragua, Peru	2.6

Source: Silva [18].

Table 2.
Estimates of the prevalence of blindness in 2002 in people over 50 years of age by subregion of the WHO.

Country	Uncorrected refractive error (%)	Uncorrected cataract (%)	Non-trachomatous corneal opacity (%)	Glaucoma (%)	Diabetic retinopathy (%)	Age-related macular degeneration (%)
Argentina	8.0	44.0	0.0	8.0	16.0	4.0
El Salvador	4.0	68.7	7.1	5.1	5.1	4.0
Honduras	3.0	59.2	2.6	21.1	0.0	3.9
Panamá	0.1	66.4	2.2	10.2	1.5	5.1
Paraguay	3.1	43.8	9.4	15.6	6.3	9.4
Peru	1.5	58.0	5.3	13.7	0.8	11.5
Uruguay	2.9	48.6	0.0	14.3	5.7	8.6

Source: Silva [23].

Table 3.
Main reported causes of blindness adults over 50 years, Latin America, 2011–2013.

development and more than 4% in rural and marginal areas [19]. In Central America, the prevalence of blindness is 2.1% (95% CI: 1.7–2.7) [17], and in countries such as Panama, it is 3.0% (95% CI: 2.3–3.6) [20], Costa Rica 1.7% (2.1%, IC95%: 1.7–2.7) [21], and Honduras 1.9% (95% CI: 1.4–2.4%) [22].

In Latin America, cataract without correction represents by far the main cause of blindness in adults over 50 years, followed by glaucoma, diabetic retinopathy (DR), age-related macular degeneration, and uncorrected refractive errors [23], see **Table 3**.

4. Etiology

The causes from one country to another. The visual impairment attributable to cataract is greater in low- and middle-income countries than in high-income countries. In high-income countries, diseases such as diabetic retinopathy, glaucoma, and macular degeneration are related to the most frequent age [24].

Johns Hopkins University has found that the main cause of blindness in white people is macular degeneration associated with age, while in the black population, it is due to glaucoma or cataract. In addition, in the elderly, blindness is three times more frequent in blacks than in whites [25].

Causes	Definition
Cataract	It is the opacity of the lens, which is understood as the passage of light to the retina, causes a slow and progressive loss of vision, and can appear at any stage of life, from birth to older age than being human [27–30]
Glaucoma	It is an optic neuropathy that presents with a characteristic structural damage, associated with the progressive death of retinal ganglion cells, loss of nerve fibers, and loss of pathognomonic visual field [31–34]
Uncorrected refraction	In myopia, the point of focus is in front of the retina, because the cornea has too much curvature or the axial length of the eye is excessive In hyperopia, the focus point is behind the retina because the cornea has too flat a curvature or the axial length is too short Astigmatism, a non-spherical (variable) curvature of the cornea or lens, causes light rays of different orientations (e.g., vertical, oblique, horizontal) to focus on different points [35] Presbyopia is a clinical loss of the amplitude of accommodation or, in other words, the loss of the ability to change the shape of the lens to focus on nearby objects [35, 36]

Table 4.
The most common causes of visual disability and blindness.

The main causes of blindness in order of frequency are cataract (39%), uncorrected refractive errors (18%), glaucoma (10%), macular degeneration related to age (7%), corneal opacities (4%), diabetic retinopathy (4%), trachoma (3%), childhood eye diseases (3%), and onchocerciasis (0.7%). Cataract is the leading cause of easily curable blindness [7, 26].

For this reason, a description of the main causes is made, see **Table 4**.

5. Risk factors

The different etiologies are known to have multifactorial causes; in cataract modifiable risk factors are identified as exposure to ultraviolet rays, mainly UV-B, deficiency in the diet of antioxidants and proteins, smoking, diabetes mellitus, the use of corticosteroids, and severe dehydration. And non-modifiable risk factors are genetic, with a probability three times higher in relatives of people with the disease [37–41].

In glaucoma it is said that age increases the probability of suffering ocular hypertension. A glaucoma can evolve of various etiologies. The prevalence increases from 4 to 10 times in people older than 60 years [42]. Other risk factors are myopia, inheritance, African-American race, exfoliation, and pigmentary dispersion [43].

Refractive errors are associated with racial factors, the myopia and astigmatism are more prevalent in the Chinese population and hyperopia is the most common in the Hispanic population [44].

Regarding diabetic retinopathy (DR), it corresponds to one of the microvascular complications of diabetes mellitus.

The risk factors are the time of evolution of DM and poor glycemic control, glycosylated hemoglobin (HbA1c) level greater than 6.9% [45], associated arterial hypertension [46, 47], juvenile type 2 DM of early onset [48], and genetic susceptibility (the haptoglobin genotype 1-1) [49].

In **Figure 1**, the relationship between glycemic control and the duration of diabetes with diabetic retinopathy is shown as a function of the time of follow-up, with different curves for the different HbA1C values [50].

Between 80 and 95% corresponds to simple or nonproliferative DR and the remaining 5–10% to proliferative DR [51].

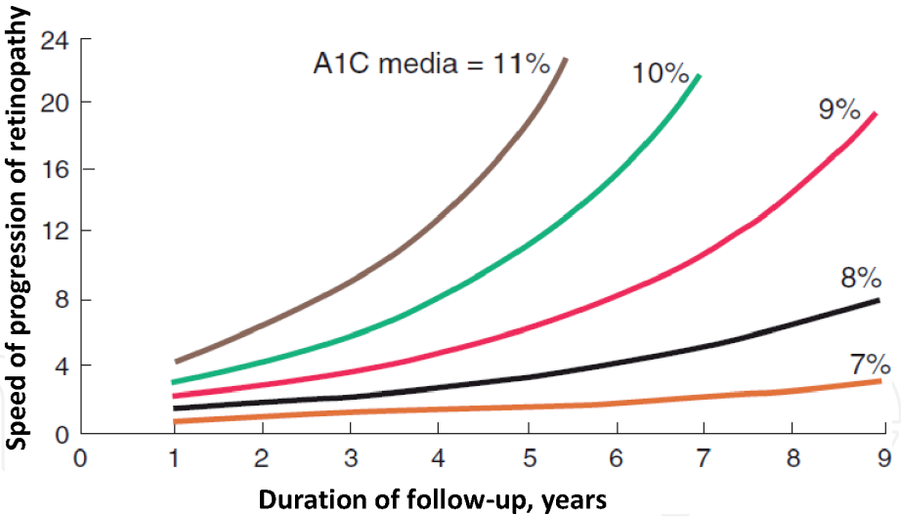


Figure 1.
The relationship between glycemic control and duration of diabetes with diabetic retinopathy. Source: Longo et al. [50].

6. Differential diagnosis

Basic knowledge of ocular symptoms is required to perform an adequate ophthalmological evaluation. It is always necessary to completely define the characteristics of the symptoms and discomforts.

The ocular symptoms can be classified in the fundamental categories: abnormalities of the eyes, anomalies of the ocular aspect and abnormalities of the sensations, pains, and ocular discomforts.

Therefore, it can be useful to make one order and ask the following questions:

1. Has the disorder **started** gradually, quickly, or asymptomatically? For example, was blurred vision in one eye discovered until the other eye was inadvertently covered?

2. Was the **duration** of the problem brief, or did the symptom persist until the current consultation? If the symptom has been intermittent, how has been its frequency?

3. Is the **location** of the disorder focal or diffuse, and is it a unilateral or bilateral condition? Finally, does the patient rate the degree of the disorder as mild, moderate, or severe?

In **Table 5**, some of the main characteristics of the most common pathologies associated with preventable blindness are observed.

6.1 Physical exam

Of all the organs of the body, the eye is the most accessible to direct examination. The visual function can be evaluated by means of simple subjective tests. The same can be taken care of from an adequate primary care service.

The clinic plays a decisive role in the initial evaluation of any patient, so the correct approach orderly and systematic is essential in the sequence of subsequent processes for the consolidation of a presumptive diagnosis and complementary tests and to achieve an accurate diagnosis and therapeutic approach suitable.

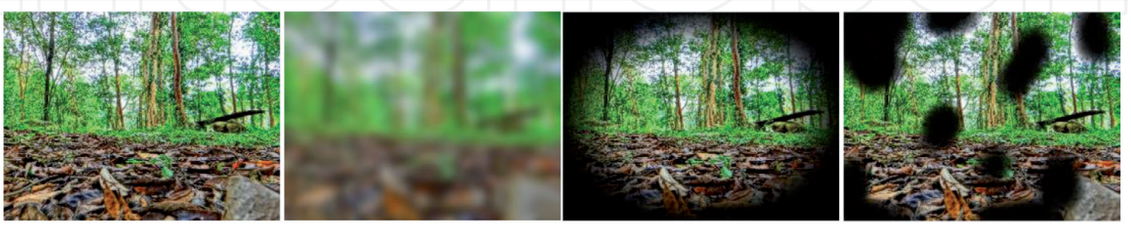
Clinic	Cataract [52]	Uncorrected refraction [53]	Glaucoma [54, 55]	
			Primary open-angle glaucoma	**Closed-angle glaucoma**
			60–70%	10%
Evolution	Chronicle		Chronicle Asymptomatic until very advanced phases Discovery is usually casual	Acute Preceded intermittent attacks, or else it occurs suddenly It represents a true ophthalmological emergency
Visual acuity	Decreases progressively	• Myopia, difficulty to see clearly distant objects • Long-range difficulty to clearly see nearby objects • Astigmatism or distorted vision • Presbyopia, difficulty reading or focusing well in the distance	Losses of the visual field: central vision is the last to be affected, peripheral vision is lost first	Decreases
Blurry vision	Present	Present		
Pain			There may be headaches and eye pain	Intense pain in the distribution zone of the V cranial nerve
Diplopia	Present			
Symmetry of affectation			Bilateral and asymmetric	Unilateral but both eyes are susceptible to affectation in different evolutionary moments
Association	With presbyopia and myopia			With vegetative symptoms (profuse sweating, nausea, vomiting, tachycardia, etc.)
				
Normal Vision	**Cataract**		**Glaucoma**	**Diabetic retinopathy**

Table 5.
Clinic of the main causes of visual disability and blindness.

Therefore, an adequate anamnesis that includes general, sociodemographic data, personal and family pathological history, and ocular and non-ocular as well as traumatic surgical history is imperative and invariably its symptomatology.

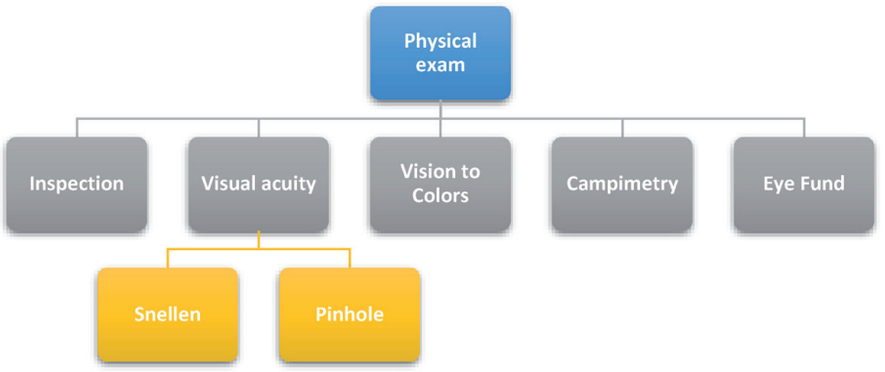


Figure 2.
Basic ophthalmologic exploration.

	Physical examination
Cataract [56]	Opacification of the lens Pupillary reflexes may be slowed down, but they do not disappear
Uncorrected refraction [52]	Improvement of the AV with the pinhole hole test
Glaucoma [54, 55]	Closed-angle glaucoma • Conjunctival and ciliary injection • Corneal edema with loss of transparency of the cornea • Difficult to visualize the details of the iris compared to the contralateral eye • Oval ovarian suture in a reactive mean mydriasis • The eye is hard (stony) to pressure
Diabetic retinopathy [57]	Vascular microaneurysms, hemorrhage, cotton-wool exudates, vein caliber alterations, neovascularizations

Table 6.
Findings of the physical examination in the main causes of visual disability and blindness.

The external anatomy of the eye is visible and can be examined with the naked eye or with simple instruments.

The eye is the only part of the body where you have direct vision to blood vessels and tissues of the central nervous system (retina and optic nerve). Thanks to this it is possible to identify, by ocular examination, important systemic effects of infectious, autoimmune, neoplastic, and vascular diseases.

And so, a basic physical examination aimed at the search of suspected abnormalities that merit its timely reference to a higher level of specialty is essential in the primary care physician, see **Figure 2**.

And it is in this sense that it can describe certain characteristic findings of these pathologies, the same ones that can guide our mental scheme to achieve a presumptive diagnosis; some of them are described in **Table 6**.

7. Prevention

The Latin America and the Caribbean region are considered one of the most inequitable in the world in terms of the distribution of goods and services, social determinants, and health.

Using a standard methodology for international use [58], it has been possible to determine the prevalence of blindness and visual impairment, coverage, and the quality of cataract services and barriers to access them in several countries [56].

The Vision 2020 program in Latin America, with the participation of PAHO/WHO, the Christian Blind Mission, and the International Agency for the Prevention of Blindness, has proposed to document the problem of blindness and visual impairment in people over 50 years of age and designed a statistical instrument called "rapid assessment of avoidable blindness" (ERCE). To date, ERCE activities have been conducted to determine the prevalence of blindness [16, 49, 50–63].

And it is through this instrument that in nine countries of Latin America, the following barriers have been determined for cataract surgery: lack of knowledge about the existence of a treatment, it is thought to be the destination, there is no availability of surgery services or very distant, fear of the operation or loss of vision, cannot pay for the operation, indication of waiting until it "matures" (possible waiting list), no one can accompany to the ophthalmological care, and other diseases and contraindications for surgery [64–66].

All are surmountable through information and education campaigns.

8. Conclusions

To control blindness and visual impairment, it is essential to implement plans to (a) detect cases of low vision and operate cataract cases, (b) detect and give optical correction to cases with refractive errors and presbyopia, and (c) integrate eye care in primary health care. These three interventions could solve around 67% of cases of blindness and could help detect people with glaucoma, in order to treat them in early stages.

Eighty percent of all these cases are considered avoidable. Therefore, the exhaustive evaluation in the patient with determining risks plays a key role, together with the fact that the visual function can be evaluated by means of simple subjective tests and be attended to by an adequate primary care service.

The difficulties in the supply of surgeries vary according to the country, being very available for most of the population in developed countries and becoming the most performed surgery in the elderly. In developing countries, the situation varies according to the regions or countries.

Visual disability and blindness correspond to one of the microvascular complications of diabetes mellitus, where the relationship that keeps the glycemic control in function of the time of presenting the disease is widely demonstrated. Between 80 and 95% corresponds to nonproliferative DR and the remaining 5–10% to proliferative DR. Here is the need for a holistic approach to the patient aimed at prevention and proper medical management.

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References

[1] Rodríguez Masó S, Rojas Rondón I, Vázquez Adán Y, Venereo Rodríguez A, Baute Puerto B, Landrove Y. Caracterización clinico-epidemiológica de la baja visión en el adulto mayor y su rehabilitación visual. Revista Cubana de Oftalmología. 2014;**27**(3):416-426

[2] López-Alemany A, Uson E. Low vision and contact lenses. Revista Española de Contactología. 2007;**14**(14):8. ISSN: 1989-7111. Available from: http://www.oftalmo.com/sec/07-tomo-1/03.htm

[3] Bayarre H, Pérez Piñero J, Menéndez Jiménez J. Las transiciones demográficas, epidemiológicas y la calidad de vida objetiva en la tercera edad. GEROINFO. 2006;**1**:1-34. Available from: http://www.sld.cu/galerias/pdf/sitios/gericuba/las_transiciones_demograficaepidemiologica_y_la_calidad_de_vida_objetiva_en_la_tercera_edad.pdf

[4] Salomao SR, Cinoto RW, Berezovsky A, Araujo-Filho A, Mitsuhiro MR, Mendieta L, et al. Prevalence and causes of vision impairment and blindness in older adults in Brazil: The Sao Paulo eye study. Ophthalmic Epidemiology. 2008;**15**(3):167-175

[5] Moreno Domínguez JC, De la Portilla Castro MM, Correa Rojas O, Iviricu Tielves R, Sanabria NJ. Afecciones visuales y su tratamiento en la población de Pinar del Río, Misión Milagro de 2006-2010. Revista Cubana de Oftalmología. 2012;**25**(2):264-277

[6] Rojas H et al. Catarata, una causa prevenible de ceguera. Revista Médica Hondureña. 2014;**82**(4):160-163

[7] World Health Organization. Global Initiative for the Elimination of Avoidable Blindness: Action Plan 2006-2011. Geneva: WHO; 2007

[8] OMS. Ceguera y Discapacidad Visual Organización Mundial de la Salud. Nota Descriptiva No. 282. 2018. Available from: https://www.who.int/es/newsroom/ fact-sheets/detail/blindnessand-visual-impairment

[9] OMS. Change the Definition of Blindness. Definitions of Blindness and Visual Impairment. Ginebra: Organización Mundial de la Salud; 2012

[10] World Health Organization. Change the Definition of Blindness [En Internet]. 2014. Disponible en: http://www.who.int/blindness/Change%20the%20Definition%20of%20Blindness.pdf [Consultado el 17 de abril del 2019]

[11] Guisasola L et al. Informe de la Salud Visual en Suramérica. Cátedra Unesco de Salud Visual y Desarrollo. 2008. Available from: https://unescovision.upc.edu/es/materiales/materiales-de-lacatedra/investigacion/savim/informe-de-la-salud-visual-en-sudamerica-2008

[12] World Health Organization. Global Data on Visual Impairment 2010. Geneva: WHO; 2012. WHO/NMH/PBD/12.01. Disponible en: http://www.who.int/blindness/GLOBALDATAFINALforweb.pdf

[13] Eckert K. Visión 2020 América Latina. Plan Estratégico [Internet]. Ginebra: OMS; 2012. Available from: http://www.v2020la.org/images/Plan_Estrategico_2012.pdf [Cited: April 05, 2019]

[14] Lewallen S, Perez-Straziota C, Lansingh V, Limburg H, Silva JC. Variation in cataract surgery needs in Latin America. Archives of Ophthalmology. 2012;**130**(12):1575-1578. DOI: 10.1001/archophthalmol.2012.2147

[15] Kuper H, Polack S, Limburg H. Rapid assessment of avoidable blindness. Community Eye Health. 2006;**19**(60):68-69

[16] Pongo Águila L, Carrión R, Luna W, Silva JC, Limburg H. Cataract blindness in people 50 years old or older in a semirural area of Northern Peru. The Revista Panamericana de Salud Pública. 2005;**17**(5-6):387-393

[17] Leasher JL, Lansingh V, Flaxman SM, Jonas JB, Keeffe J, Naidoo K, et al. Prevalence and causes of vision loss in Latin America and the Caribbean: 1990-2010. The British Journal of Ophthalmology. 2014;**98**(5):619-628

[18] Silva JC. Review of recent surveys on blindness and visual impairment in Latin America. British Journal of Ophthalmology. 2008;**92**(3):315-319

[19] Consejo Directivo OPS. Plan de Acción para la Prevención de la de la Ceguera y de las Deficiencias Visuales. 154.a Sesión del Comité Ejecutivo. Washington: OPS; 2014. 20p

[20] López M, Brea I, Yee R, Yi R, Carles V, Broce A, et al. Encuesta de ceguera y deficiencia visual evitable en Panamá. Revista Panamericana de Salud Pública. 2014;**36**(6):355-360

[21] Acevedo R, Carranza E, Cortés R, Rodríguez G. Estimación de la prevalencia de enfermedades asociadas a ceguera prevenible y discapacidad visual en Costa Rica para el año 2015 [Tesis] [Internet]. Costa Rica: Médico Especialista en Oftalmología, Universidad de Costa Rica. Sistema de Estudios de Posgrado; 2016. Disponible en: http://repositorio.sibdi.ucr.ac.cr:8080/jspui/handle/123456789/5321 [Citado 2019 Jun 19]

[22] Alvarado D, Rivera B, Lagos L, Ochoa M, Starkman I, Castillo M, et al. Encuesta nacional de ceguera y deficiencia visual evitables en Honduras. Revista Panamericana de Salud Pública. 2014;**36**(5):300-305

[23] Silva JC. Una evaluación comparativa de la ceguera y la deficiencia visual evitables en siete países latinoamericanos, prevalencia cobertura y desigualdades. Revista Panamericana de Salud Pública. 2015;**37**(1):21-28

[24] OMS. Ceguera y Discapacidad Visual [Internet]. 2018. Disponible en: www.who.int/es/news-room/fact-sheets/detail/blindness-and-visual-impairment [Citado 2019 abril 06]

[25] Highlights of Ophthalmology International. Encuentran diferencias raciales relacionadas con la ceguera. Revista Archives of Ophthalmology. 2006;**20**(2). ISSN 0864-2176

[26] World Health Organization. Action Plan for the Prevention of Avoidable Blindness and Visual Impairment 2009-2013. Geneva: WHO; 2010

[27] Merino G. Escuela de Medicina UDA Oftalmología. Curso de Oftalmología 5to año. Catarata [Serie en Internet]. 2002. Disponible en: http://www.escuela.med.puc.cl [Citado 12 de mayo de 2007]

[28] Alemañy Martorell J. Oftalmología. La Habana: Editorial Ciencias Médicas; 2005. pp. 179-186

[29] American Academy of Ophthalmology. Cataract in the Adult Eye. Preferred Practice Patterns. USA: AAO Anterior Segment Panel; 2001

[30] Kanski JJ, Menon J. Oftalmología Clínica. 5th ed. España: Editorial Elsevier España; 2005. p. 165-194, 448-465, 698-700

[31] Taylor HR, Keeffe JE. World blindness: A 21st century perspective. British Journal of Ophthalmology. 2001;**85**:261-266

[32] Coleman AL. Glaucoma. Lancet. 1999;**354**:1803-1819. DOI: 10.1016/S0140-6736(99)04240-3

[33] Quigley H. How common is glaucoma worldwide? International Glaucoma Review. 2002;**3**(3):11-12

[34] Mardin CY, Junemman AGM. The diagnostic value of imaging in early glaucoma. Current Opinion in Ophthalmology. 2001;**12**:100-104

[35] Dhaliwal DK. Generalidades de los Defectos de la Refracción. Manual MSD [Internet]. 2017. Disponible en: https://www.msdmanuals.com/es/professional/trastornos-oftálmicos/defectos-de-la-refracción/generalidades-de-los-defectos-de-la-refracción [Citado 2019 Abril 15]

[36] Glasser A, Campbell MCW. Presbyopia and the optical changes in the human crystalline lens with age. Vision Research. 1998;**38**(2):209-229

[37] Leite Arieta CE, Duerksen R, Lansingh V. Manual de Ceguera Por Catarata en América Latina. Bogotá: Imagen & Diseño producciones Ltda; 2011

[38] Lindblad BE, Håkansson N, Wolk A. Smoking cessation and the risk of cataract: A prospective cohort study of cataract extraction among men. JAMA Ophthalmology. 2014;**132**(3):253-257

[39] Wu R, Wang JJ, Mitchell P, Lamoureux EL, Zheng Y, Rochtchina E, et al. Smoking, socioeconomic factors, and age-related cataract: The Singapore Malay eye study. Archives of Ophthalmology. 2010;**128**(8):1029-1035

[40] Rautiainen S, Lindblad BE, Morgenstern R, Wolk A. Total antioxidant capacity of the diet and risk of age-related cataract: A population-based prospective cohort of women. JAMA Ophthalmology. 2014;**132**(3):247-252

[41] Robin AL, Thulasiraj RD. Cataract blindness. Archives of Ophthalmology. 2012;**130**(11):1452-1455

[42] Courtright P. Género y salud ocular. Salud Ocular Comunitaria. 2010;**4**(8):10-12. ISSN 1993-7229

[43] Van Veldhuisen PC. et al, The advanced Glaucoma Intervention Study (AGIS): The relationship between control of intraocular pressure and visual field deterioration. American Journal of Ophthalmology. 2000;**130**:429-440

[44] Pan CW, Klein BE, Cotch MF, et al. Racial variations in the prevalence of refractive errors in the United States: The multi-ethnic study of atherosclerosis. American Journal of Ophthalmology. 2013;**155**:1129-1138. DOI: 10.1016/j.ajo.2013.01.009

[45] Saum SL, Thomas E, Lewis AM, Croft PR. The effect of diabetic control on the incidence of, and changes in, retinopathy in type 2 non-insulin dependent diabetic patients. The British Journal of General Practice. 2002;**52**(476):214-216

[46] Herold P, Craig ME, Hing S, Donaghue K. Role of blood pressure in development of early retinopathy in adolescents with type 1 diabetes: Prospective cohort study. BMJ. 2008;**337**:a918

[47] Wong TY, Mitchell P. The eye in hypertension. Lancet. 2007;**369**(9559):425-435

[48] Wong J, Molyneaux L, Constantino M, Twigg SM, Yue DK. Timing is everything: Age of onset influences long-term retinopathy risk in type 2 diabetes, independent of traditional risk factors. Diabetes Care. 2008;**31**(10):1985-1990

[49] Nakhoul FM, Marsh S, Hochberg I, Leibu R, Miller BP, Levy AP.

Haptoglobin genotype as a risk factor for diabetic retinopathy. Journal of the American Medical Association. 2000;**284**(10):1244-1245

[50] Longo DL, Fauci AS, Kasper DL, Hauser SL, Jameson JL, Loscalzo J, editors. Harrison Principios de Medicina Interna. 18th ed. Vol. 2. México: McGraw-Hill; 2012. p. 2981

[51] Rodriguez J, Sanchez R, Munoz B, West SK, Broman A, Snyder RW, et al. Causes of blindness and visual impairment in a population-based sample of U.S. Hispanics. Ophthalmology. 2002;**109**(4):737-743

[52] Garbín Fuentes I, Pérez Chica G. Patología del Cristalino. Cataratas. Disponible en: http://www.sepeap.org/archivos/libros/OFTALMOLOGIA/Ar_1844APR8.pdf [Fecha de acceso. 15 de mayo del 2019]

[53] Vicente T, Ramirez M, de la Torre I, Garcia L, Lopez A, Terradillos M, et al. Prevalencia de defectos visuales en trabajadores españoles. Repercusión de Variables Sociodemográficas y Laborales. 2016;**90**(2):49-100. Disponible en: https://www.elsevier.es/es-revista-revista-mexicana-oftalmologia-321-articulo-prevalencia-defectos-visuales-trabajadores-espanoles--S0187451915000931

[54] Piñeiro RT, Lora M, Andres MI. Glaucoma. Offarm. 2005;**22**:88-96

[55] González del Valle F. Sección I: Oftalmología. In: Diagnóstico y Tratamiento Médico. Oftalmología General. Vaughan & Asbury. Mexico: McGraw-Hill; 2011. pp. 230-245. Chapter 11. ISBN: 978-0-07-163420-5

[56] Mura J. Cirugía actual de la catarata. Departamento de Oftalmología, Clínica Las Condes. 2010;**21**(6):864-1005. Disponible en: https://www.elsevier.es/es-revista-revista-medica-clinica-las-condes-202-articulo-cirugia-actual-catarata-S0716864010706155

[57] Mohamed Q, Gillies MC, Wong TY. Management of diabetic retinopathy: A systematic review. Journal of the American Medical Association. 2007;**298**(8):902-916

[58] Pan American Health Organization. Health in the Americas, 2012 ed. Regional Outlook and Country Profiles. Washington: PAHO; 2012

[59] Kuper H, Polack S, Limburg H. Rapid assessment of avoidable blindness. Community Eye Health. 2006;**19**:68-69

[60] Limburg H, Meester W, Hannah K, Polack S. ERCE 5 Manual de Evaluación Rápida de la Ceguera Evitable. Reino Unido: Centro Internacional de Salud Ocular; 2012

[61] Limburg H, Barria von-Bischhoffshausen F, Gomez P, Silva JC, Foster A. Review of recent surveys on blindness and visual impairment in Latin America. The British Journal of Ophthalmology. 2008;**92**(3):315-319

[62] Nano ME, Nano HD, Mugica JM, Silva JC, Montaña G, Limburg H. Rapid assessment of visual impairment due to cataract and cataract surgical services in urban Argentina. Ophthalmic Epidemiology. 2006;**13**(3):191-197

[63] Beltranena F, Casasola K, Silva JC, Limburg H. Cataract blindness in 4 regions of Guatemala: Results of a population-based survey. Ophthalmology. 2007;**114**(8):1558-1563

[64] Limburg H, Silva JC, Foster A. Cataract in Latin America: Findings from nine recent surveys. The Revista Panamericana de Salud Pública. 2009;**25**(5):449-455

[65] Suárez Escudero JC. Discapacidad visual y ceguera en el adulto: Revisión de tema. Medicina UPB. 2011;**30**(2):170-180

[66] Burga HG, Hinds CN, Lansingh VC, Samudio M, Lewallen S, Courtright P, et al. Is the cost the primary barrier for cataract surgery in Paraguay? Arquivos Brasileiros de Oftalmologia. 2014;77(3):164-167