Prevalence of refractive errors in Colombia: MIOPUR study

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ABSTRACT

Purpose To determine the prevalence of refractive errors in Colombia and its relations with demographic and socioeconomic variables.

Methods A cross-sectional study performed in 10 Colombian administrative districts (MIOPUR study), including children and adolescents from 8 to 17 years old and adults from 35 to 55 years old.

Results 3608 individuals (100% of whom agreed to participate) were included. Prevalence estimates of refractive errors were: hyperopia 32.3% (95% CI 30.7 to 33.8), myopia 12.9% (95% CI 11.8 to 14.0), mixed astigmatism 2.8% (95% CI 2.2 to 3.3) and anisometropia 1.9% (95% CI 1.4 to 2.3). Prevalence of myopia in 15-year-old adolescents was 14.7%. In children and adolescents, the hyperopia prevalence decreased while myopia prevalence increased with age. In the adults group, the tendency was the contrary. Myopia prevalence reached 15.7% in urban and 9.2% in rural areas, and for hyperopia, the rates were 29.4% in urban and 36.1% in rural areas. In the multivariate analysis, living in an urban area significantly increased the risk of having myopia (OR: 1.45 (1.12 to 1.89); p<0.01). There were significant regional differences among diverse zones of the country.

Conclusions Prevalence estimates of myopia and hyperopia in Colombia were found to be at an intermediate point compared with global data. In adults, myopia frequency was lower than in European and Asian studies. The prevalence of myopia increased during childhood and adolescence and was higher in middle-aged adults (35–39 years) than in older adults. On the other hand, hyperopia rates increased with age, findings that suggest a cohort effect. In the multivariate analysis, residence in urban areas and living in a medium-high socioeconomic status were linked to myopia.

INTRODUCTION

Refractive errors represent the most common cause of visual impairment worldwide. Ametropias may affect quality of life and productivity, and high myopia is associated with potentially visual threatening conditions (eg, myopic maculopathy and retinal detachment). During the last three decades, prevalence of myopia in many countries has increased and if this trend continues, some projections indicate that by 2050 around 50% of the world's population will present this ametropia.[1] Several environmental factors have been related to this myopia boom.[2] There is a scarcity of studies on refractive errors in Latin America.[3–9] Our research aimed to determine the prevalence of refractive errors in young and adult population and its distribution by different demographic and socioeconomic characteristics from several regions of our country (Colombia).

METHODS

This cross-sectional investigation (MIOPUR study) was performed in 10 Colombian administrative districts (departments). The participants were selected by convenience in a non-probability sampling. People interested in participating presented in order to be examined during the weekdays. Exclusion criteria were history of refractive or intraocular surgery or corneal ectasia. All those participants were included in whom it was possible to take an appropriate refraction, and whose corrected visual acuity was better or equal than 20/40. Data collection was conducted from June 2015 to May 2017. Demographic and socioeconomic information was acquired with a questionnaire. The patient's refractive status was determined by retinoscopy and then using manifest refraction. No cycloplegic medication was used. This research was endorsed by the institutional Ethics Committee and was conducted in accordance with guidelines of the Declaration of Helsinki.

Refractive errors were classified according to the manifest refraction with the parameters shown in table 1.

Individuals were classified as having emmetropia when there was absence of ametropia in both eyes. If the participants had any ametropia in at least one eye, they were classified by the identified ametropia. Anisometropia included the participants when different ametropias were found in both eyes.

Statistical analysis

The unit of analysis for all the prevalence data were individuals. The association between refractive errors and independent variables was evaluated with the statistical test, χ^2 test. In addition, multinomial multiple logistic regression models were used. The STATA/SE 12.0 statistical package (College Station, USA) was used. The statistical significance level was set at 5%.

RESULTS

We evaluated 3.608 individuals (2.067 (57.3%) from urban and 1.541 (42.7%) from rural areas). The differences between the prevalence of refractive errors according to seven of the demographic and socioeconomic variables analysed were statistically significant (sex, age, geographical area (Colombian administrative district), health services

Table 1 Classification of refractive errors*

Refractive error	SE (Dioptres)	Sphere (Sph) (Dioptres)	Cylinder (Cyl) (Dioptres)
Emmetropia	−0.50<SE < +0.50		|Cyl|≤0.75
Myopia†	SE ≤−0.50	Sph≤0	
Hyperopia‡	SE ≥+0.50	Sph≥0	|Cyl| ≤ |Sph|
Mixed astigmatism		Sph≥0	(|Cyl|≥1.00) and (|Cyl| >|Sph|)

|=Absolute value
*Negative cylinder notation was used to apply this classification.
†Included myopia and myopic astigmatisms.
‡Included hyperopia and hyperopic astigmatisms.
SE, spherical equivalent.

system of affiliation, neighbourhood social strata (according to a government's socioeconomic categorisation system), level of education and mean monthly household income) but not for ethnicity (see online supplementary table 1). In the children and adolescents group, the hyperopia prevalence decreased as age increased and on the contrary myopia prevalence increased. In the adults group, the tendency was exactly the opposite.

The differences in the prevalence of refractive errors by area of residence were found to be in the opposite directions, for myopia (15.7% in urban area and 9.2% in rural regions) and for hyperopia (29.4% in urban and 36.1% in rural areas) and reached statistical significance (figure 1). Also, in the multivariate analysis living in an urban area significantly increased the risk of having myopia. Living in a medium-high neighbourhood strata increased the risk of having any refractive error (see online supplementary table 2).

DISCUSSION

It is striking that there were important regional differences between the different geographic areas in Colombia. For example, the proportion of individuals considered emmetropic varied between 32.6% in Santander and 60.8% in Cauca. The prevalence of myopia ranged between 8.8% and 22.1% in Cesar and Nariño, respectively. On the other hand, the range of rates for hyperopia was between 23.4% in the region of Meta and 50.5% in Santander (see online supplementary table 1). However, when analysing any association with the different variables studied, no consistent relationship was detected with these regional differences. Further studies are warranted.

The prevalence of myopia in adults of a similar age group (between 35 and 54 years) was higher in a meta-analysis of European studies than in the present study (37.4% vs 14.4%). On the other hand, the prevalence of hyperopia was markedly lower in the European studies (11.4% vs 42.1%). A notable difference between the two studies is that while in the European meta-analysis about 19.6% of the participants had only primary education and 80.4% had a level of secondary education or higher, in the group of adults in the present study in Colombia, 51.7% had a primary or lower education level and only 48.3% had secondary or higher.[10 11] The prevalence of myopia in the meta-analysis showed a tendency to decrease with age in adults, going from 40.1% (35–39 years) to 33.6% (50–54 years). In our study, a similar trend was observed changing from 19.8% (35–39 years) to 11.6% (50–55 years). An opposite tendency was observed in both studies with hyperopia, which increased with age in adults.[10]

The decrease in the prevalence of myopia with older age of adults, that is, a cohort effect, could be related to younger generations being exposed to more myopigenic environmental factors, such as a higher educational level, an intensification in near vision activities (including the increased use of computers) and spending less time outdoors.[10–12] In a study in Iran, the peak of the prevalence of myopia was observed between 16 and 25 years (29.3%).[13] In Singapore, the prevalence of myopia in adults also showed a clear cohort effect, but with much higher prevalences.

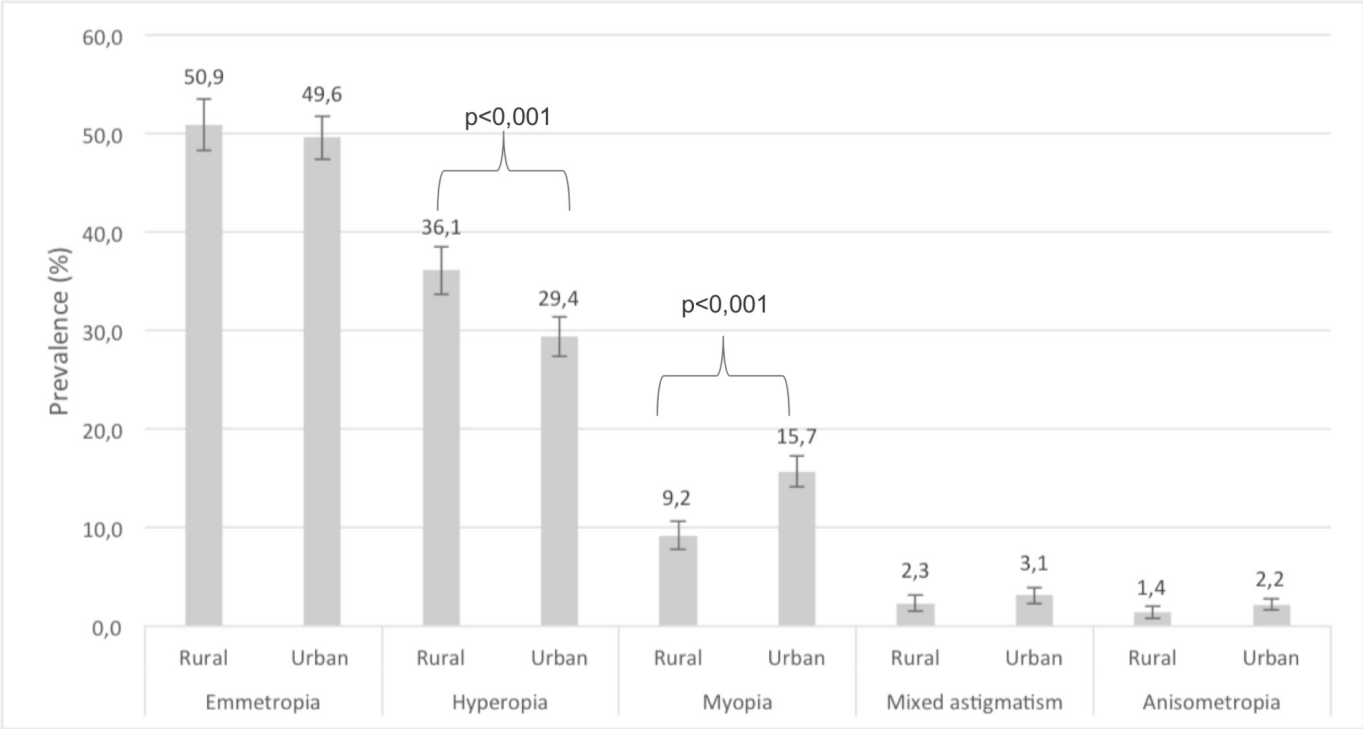

Figure 1 Differences in the prevalence of refractive errors by area of residence.

In 41-year-old adults, it was estimated to be 82.2% and at 28 years of 85.9%, similar to that found in 15 years old.[14 15] In the present study, we found a similar behaviour, although with some prevalences slightly lower than those of Iran and approximately four times lower than those of Singapore. The peak of myopia was in the age group 35–39 years (19.8%). Adolescents 16–17 years old, meanwhile, reached 16.7%. However, we did not include individuals between the ages of 18 and 34, and it is very likely that in this age group the prevalence would have been higher, since it has been recently published that in individuals older than 20 years of age, more than 45% might show progression of myopia.[16 17]

Rudnicka and coauthors published a systematic review where they found that East Asians children showed the highest prevalence of myopia in the world, reaching 69% at 15 years of age. Black children in Africa, on the other hand, showed the lowest prevalence, 5.5% at 15 years. In the present study conducted in Colombia, the prevalence in 15-year-old adolescents was 14.7%. In comparison, the data reported the meta-analysis for the group of Hispanic-Latinos was 14.3% at 15 years of age.[14]

A large study in Mexico found myopia in 36.2% of 6–19-year-old individuals. This rate was much higher than that found in 8–17 year olds in the present study (11.6%). The prevalence of hyperopia was 4.9% while in the similar age group in Colombia, we found 23.7%. In adults between 30 and 59 years, the prevalence of myopia was 19.6% while in 35–55 year olds, we found 14.4%. On the other hand, the prevalence of hyperopia in these two groups of adults was 25.6% in the Mexican study and 42.1% in the Colombian study. It seems to be a greater prevalence of myopia and a lower prevalence of hyperopia in all ages, in Mexico than in Colombia.[3]

Some environmental factors may play a role in myopia and explain the discordance in refraction found in some monozygotic twins.[18]A recent meta-analysis found a 2.6 times higher risk of developing myopia in children of urban residence compared with those who lived in rural areas, a fact that correlates with the findings of our study where we found a 1.45 higher risk for residents in the urban area.[14] In children, in a previous study in urban population in a city of the region of Santander in Colombia, a frequency of 11.2% of myopia and 23.1% of hyperopia were found. In the present study, when analysing children from the same geographical area but including also rural population, the rates were 10.3% and 50.5%, respectively.[4] This suggests that, as we found also in the multivariate analysis of the national data, living in a rural area diminishes the possibility of having myopia and increases the risk of having hyperopia. The differences could be related to a shorter time outdoors of children living in urbanised areas.[19 20] A meta-analysis showed a 2% reduction in the risk of developing myopia for each additional hour of weekly time outdoors.[20]

Another of the risk factors associated with the development of refractive errors and especially myopia is the educational level. However, some researchers have found that increased educational pressure seems to be only one of several factors that influenced the growth in the prevalence of myopia. They mentioned others like the use of computers, the increase of extracurricular activities and a decrease of time of exposure to the outdoors.[11 12] In our study, a higher prevalence of myopia was found in the population with a secondary or higher level of education, although in the multivariate analysis this association was not statistically significant (OR 1.14, 95% CI 0.86 to 1.52). Recently, Cuellar-Partida *et al* used a Mendelian randomisation approach and suggested that observational studies, such as the one we conducted, could underestimate the true effect of educational level on the prevalence of myopia in populations.[21] In the case of hyperopia, in our study, the highest educational level was shown as protective (OR 0.59, 95% CI 0.47 to 0.74).

Knowing the data on the prevalence of refractive errors in our population is very important as a starting point for comparison in the future, especially with the current 'epidemic of myopia' presenting particularly in certain regions of the world, like Asia.

Undoubtedly, from this study, others will be generated where, in a more detailed way, the possible factors (where there may be many involved) that are related to the higher prevalence of myopia in certain regions of the country will be analysed. In addition, other longitudinal studies that evaluate the impact of some interventions on these factors will be performed (in fact, currently we are carrying out a study in which the brightness level of the classrooms will be improved and will be recommended to the children to increase outdoors exposure).

In this study, we decided, as described by Marsh-Tootle and Frazier,[22] to perform a non-cycloplegic static retinoscopy that was carried out by requesting the patients to keep the fixation in a distant object in order to relax the accommodation. In addition, a careful manifest refraction was performed, the data of which was taken into account in the study. However, it could be considered a weakness of our study. Despite the meticulousness in performing these non-cycloplegic examinations, we could have overestimated the frequency of myopia and underestimated that of hyperopia, especially in 8–11 year olds.

Another weakness of this research was that the sample was taken using a non-random approach and thus we cannot exclude that biases were present within the data (v.gr. almost twice as many women presented themselves to the study than men, a circumstance possibly related to the availability of time due to job commitments).

In conclusion, we found that there was an important regional variability in the prevalence of refractive errors in Colombia. The prevalence of myopia grew during childhood and adolescence and was higher in middle-aged adults (35–39 years) than in older adults. On the other hand, hyperopia rates increased with age. Both of these findings suggest a cohort effect. A weakness of our study was that we did not include individuals in the age range of 18–34 years, where the peak of the prevalence of myopia could have been found in our population.

With regard to environmental factors, after a multivariate analysis, we confirmed that residence in urban areas and living in a medium-high socioeconomic status were related to myopia. This information will help to make decisions on possible environmental or pharmacological interventions for refractive errors.[2 23–25]

Contributors VG, AT, PAC and JPL-J conceived the idea of the presented study. VG, AT, AAS and LMG, PAC and JPL-J developed the instruments to capture information. AAS and LMG gathered the data. JO and PAC performed statistical analysis. AT, AAS and LMG wrote the draft of the manuscript. All authors discussed the results and contributed to the final manuscript. All authors made significant contributions to the conception or design of the work, the acquisition, analysis or interpretation of data. The authors sketch the work or revised and edited it critically and gave final approval of the version published. The authors agree to be accountable for all aspects of the research.

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Competing interests None declared.

Patient consent Obtained.

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REFERENCES

1 Holden BA, Fricke TR, Wilson DA, *et al*. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. *Ophthalmology* 2016;123:1036–42.
2 Galvis V, Tello A, Camacho PA, *et al*. Bio-environmental factors associated with myopia: an updated review. *Arch Soc Esp Oftalmol* 2017;92:307–25.
3 Gomez-Salazar F, Campos-Romero A, Gomez-Campaña H, *et al*. Refractive errors among children, adolescents and adults attending eye clinics in Mexico. *Int J Ophthalmol* 2017;10:796–802.
4 Galvis V, Tello A, Otero J, *et al*. Refractive errors in children and adolescents in Bucaramanga (Colombia). *Arq Bras Oftalmol* 2017;80:359–63.
5 Maul E, Barroso S, Munoz SR, *et al*. Refractive error study in children: results from La Florida, Chile. *Am J Ophthalmol* 2000;129:445–54.
6 Villarreal GM, Ohlsson J, Cavazos H, *et al*. Prevalence of myopia among 12- to 13-year-old schoolchildren in northern Mexico. *Optom Vis Sci* 2003;80:369–73.
7 Rodriguez-Abrego G, Sotelo-Dueñas HM. Prevalencia de miopía en escolares de una zona suburbana. *Rev Med Inst Mex Seguro Soc* 2009;47:39–44.
8 Moraes Ibrahim F, Moraes Ibrahim M, Pomepo de Camargo JR, *et al*. Visual impairment and myopia in Brazilian children: a population-based study. *Optom Vis Sci* 2013;90:223–7.
9 Carter MJ, Lansingh VC, Schacht G, *et al*. Visual acuity and refraction by age for children of three different ethnic groups in Paraguay. *Arq Bras Oftalmol* 2013;76:94–7.
10 Williams KM, Verhoeven VJ, Cumberland P, *et al*. Prevalence of refractive error in Europe: the European Eye Epidemiology (E(3)) Consortium. *Eur J Epidemiol* 2015;30:305–15.
11 Williams KM, Bertelsen G, Cumberland P, *et al*. Increasing prevalence of Myopia in Europe and the impact of education. *Ophthalmology* 2015;122:1489–97.
12 Williams KM, Bertelsen G, Cumberland P, *et al*. Increasing prevalence of Myopia in Europe and the impact of education. *Ophthalmology* 2015;122:1489–97.
13 Hashemi H, Fotouhi A, Mohammad K. The age- and gender-specific prevalences of refractive errors in Tehran: the Tehran eye study. *Ophthalmic Epidemiol* 2004;11:213–25.
14 Rudnicka AR, Kapetanakis VV, Wathern AK, *et al*. Global variations and time trends in the prevalence of childhood myopia, a systematic review and quantitative meta-analysis: implications for aetiology and early prevention. *Br J Ophthalmol* 2016;100:882–90.
15 Sensaki S, Sabanayagam C, Verkicharla PK, *et al*. An ecologic study of trends in the prevalence of Myopia in Chinese adults in Singapore Born from the 1920s to 1980s. *Ann Acad Med Singapore* 2017;46:229–36.
16 Pärssinen O, Kauppinen M, Viljanen A. The progression of myopia from its onset at age 8-12 to adulthood and the influence of heredity and external factors on myopic progression. A 23-year follow-up study. *Acta Ophthalmol* 2014;92:730–9.
17 Goldblum D, Brugger A, Haselhoff A, *et al*. Longitudinal change of refraction over at least 5 years in 15,000 patients. *Graefes Arch Clin Exp Ophthalmol* 2013;251:1431–6.
18 Ramessur R, Williams KM, Hammond CJ. Risk factors for myopia in a discordant monozygotic twin study. *Ophthalmic Physiol Opt* 2015;35:643–51.
19 Li SM, Li H, Li SY, *et al*. Time outdoors and myopia progression over 2 years in chinese children: the Anyang Childhood eye study. *Invest Ophthalmol Vis Sci* 2015;56:4734–40.
20 Sherwin JC, Reacher MH, Keogh RH, *et al*. The association between time spent outdoors and myopia in children and adolescents: a systematic review and meta-analysis. *Ophthalmology* 2012;119:2141–51.
21 Cuellar-Partida G, Lu Y, Kho PF, *et al*. Assessing the genetic predisposition of education on Myopia: a mendelian randomization study. *Genet Epidemiol* 2016;40:66–72.
22 Marsh-Tootle WL, Frazier MG. Infants, toddlers and children. *Borish's Clinical Refraction*. 2nd edn. Philadelphia: Buiterworth Heinemann Elsevier, 2006:1415–6.
23 Galvis V, Tello A, Parra MM, *et al*. Topical atropine in the control of Myopia. *Med Hypothesis Discov Innov Ophthalmol* 2016;5:78–88.
24 Galvis V, Tello A, Parra MM, *et al*. Re: Chia et al: Five-year clinical trial on atropine for the treatment of myopia 2: myopia control with atropine 0.01% eyedrops. *Ophthalmology* 2016;123:e40–e41.
25 Galvis V, Tello A, Rodriguez CJ, *et al*. Atropine dose to treat myopia. *Ophthalmology* 2012;119:1718–9.

Supplementary Table 1. Prevalences of refractive errors by demographic and socioeconomic characteristics

Variable	n	Emmetropia			Hyperopia			Myopia			Mixed Astigmatism			Anisometropia			p value
		%	CI 95%		%	CI 95%		%	CI 95%		%	CI 95%		%	CI 95%		
Total	**3,608**	**50.2**	**48.5**	**51.8**	**32.3**	**30.7**	**33.8**	**12.9**	**11.8**	**14.0**	**2.8**	**2.2**	**3.3**	**1.9**	**1.4**	**2.3**	
Sex																	<0.001
Female	2,311	46.6	44.5	48.6	35.1	33.1	37.0	13.3	11.9	14.7	2.9	2.2	3.6	2.1	1.5	2.7	
Male	1,297	56.6	53.9	59.3	27.2	24.8	29.6	12.2	10.4	14.0	2.5	1.7	3.4	1.5	0.8	2.1	
Age groups																	<0.001
Children and adolescents (8 - 17 years old)	**1,933**	**60.3**	**58.1**	**62.5**	**23.7**	**21.8**	**25.6**	**11.6**	**10.2**	**13.0**	**2.6**	**1.9**	**3.4**	**1.7**	**1.1**	**2.3**	
8 a 10	614	56.8	52.9	60.8	30.5	26.8	34.1	8.3	6.1	10.5	2.4	1.2	3.7	2.0	0.9	3.1	
11 a 13	678	60.8	57.1	64.4	24.0	20.8	27.3	10.6	8.3	12.9	2.9	1.7	4.2	1.6	0.7	2.6	
14 a 15	365	61.9	56.9	66.9	18.6	14.6	22.6	15.1	11.4	18.7	2.7	1.1	4.4	1.6	0.3	3.0	
16 a 17	276	64.9	59.2	70.5	14.9	10.7	19.1	16.7	12.3	21.1	2.2	0.4	3.9	1.4	0.0	2.9	
Adults (35 - 55 years old)	**1,675**	**38.4**	**36.1**	**40.8**	**42.1**	**39.7**	**44.5**	**14.4**	**12.8**	**16.1**	**2.9**	**2.1**	**3.7**	**2.1**	**1.4**	**2.8**	
35 a 39	383	45.7	40.7	50.7	27.2	22.7	31.6	19.8	15.8	23.8	4.4	2.4	6.5	2.9	1.2	4.5	
40 a 49	828	42.9	39.5	46.2	39.3	35.9	42.6	13.5	11.2	15.9	2.7	1.6	3.8	1.7	0.8	2.6	
50 a 55	464	24.6	20.6	28.5	59.5	55.0	64.0	11.6	8.7	14.6	2.2	0.8	3.5	2.2	0.8	3.5	
Department (Colombian administrative district)																	<0.001
Santander	475	32.6	28.4	36.9	50.5	46.0	55.0	10.3	7.6	13.1	4.0	2.2	5.8	2.5	1.1	3.9	
Nariño	453	39.3	34.8	43.8	30.0	25.8	34.2	22.1	18.3	25.9	5.3	3.2	7.4	3.3	1.7	5.0	
Caldas	223	43.5	37.0	50.0	28.3	22.3	34.2	20.2	14.9	25.5	5.4	2.4	8.4	2.7	0.6	4.8	
Cesar	478	54.2	49.7	58.7	34.3	30.0	38.6	8.8	6.2	11.3	1.5	0.4	2.5	1.3	0.3	2.3	
Casanare	232	47.4	41.0	53.9	34.1	27.9	40.2	12.9	8.6	17.3	4.3	1.7	6.9	1.3	-0.2	2.8	
Tolima	327	56.0	50.6	61.4	30.3	25.3	35.3	9.2	6.0	12.3	3.7	1.6	5.7	0.9	-0.1	2.0	
Atlántico	366	58.7	53.7	63.8	29.0	24.3	33.6	9.0	6.1	12.0	1.1	0.0	2.2	2.2	0.7	3.7	
Cauca	403	60.8	56.0	65.6	25.3	21.1	29.6	10.9	7.9	14.0	1.5	0.3	2.7	1.5	0.3	2.7	
Quindío	347	54.2	48.9	59.4	30.0	25.1	34.8	12.7	9.2	16.2	1.4	0.2	2.7	1.7	0.4	3.1	
Meta	304	59.2	53.7	64.7	23.4	18.6	28.1	16.1	12.0	20.3	0.3	-0.3	1.0	1.0	-0.1	2.1	
Ethnic group (self-reported)																	0.154
Mestizo	2,189	49.0	46.9	51.1	33.2	31.2	35.1	12.3	10.9	13.7	3.4	2.7	4.2	2.1	1.5	2.8	
White	644	46.3	42.4	50.1	33.2	29.6	36.9	17.1	14.2	20.0	1.9	0.8	2.9	1.6	0.6	2.5	
Afro-Colombian	53	45.3	31.7	58.8	34.0	21.1	46.8	15.1	5.4	24.8	3.8	-1.4	9.0	1.9	-1.8	5.6	
American Indian	33	66.7	50.3	83.0	15.2	2.7	27.6	15.2	2.7	27.6	3.0	-2.9	9.0	0.0	0.0	0.0	
Other	1	100.0	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Health services system																	0.002
Contributive	855	44.3	41.0	47.7	32.6	29.5	35.8	17.7	15.1	20.2	3.2	2.0	4.3	2.2	1.2	3.2	
Subsidized	2,008	50.5	48.4	52.7	33.1	31.0	35.1	11.5	10.1	12.9	3.0	2.2	3.7	1.9	1.3	2.5	
Special or exception	11	27.3	-0.3	54.9	45.5	14.6	76.3	18.2	-5.7	42.1	0.0	0.0	0.0	9.1	-8.7	26.9	
not affiliated	46	43.5	29.0	58.0	32.6	18.9	46.3	17.4	6.3	28.5	6.5	-0.7	13.7	0.0	0.0	0.0	
Neighbourhood social strata																	<0.001
Low	2,569	50.2	48.2	52.1	32.9	31.0	34.7	12.4	11.1	13.7	2.7	2.1	3.4	1.9	1.3	2.4	
Medium-High	351	36.5	31.4	41.5	33.9	28.9	38.9	21.1	16.8	25.4	5.7	3.3	8.1	2.8	1.1	4.6	
Educational level																	<0.001
None or primary (children and adolescents)	1,427	58.2	55.7	60.8	26.5	24.2	28.8	10.7	9.1	12.3	2.8	1.9	3.7	1.8	1.1	2.4	
None or primary (adults)	702	34.3	30.8	37.8	47.7	44.0	51.4	12.5	10.1	15.0	3.3	2.0	4.6	2.1	1.1	3.2	
Secondary or higher (children and adolescents)	135	63.7	55.6	71.8	12.6	7.0	18.2	20.7	13.9	27.6	2.2	-0.3	4.7	0.7	-0.7	2.2	
Secondary or higher (adults)	656	39.5	35.7	43.2	35.5	31.9	39.2	18.8	15.8	21.7	3.7	2.2	5.1	2.6	1.4	3.8	
Mean monthly household income																	0.023
≤ 1 minimum legal wage (around US $316)	1,605	50.5	48.0	52.9	33.1	30.8	35.4	11.8	10.2	13.4	2.7	1.9	3.5	1.9	1.3	2.6	

> 1 minimum legal wage (around US $316)	1,315	46.2	43.5	48.9	32.9	30.3	35.4	15.4	13.5	17.4	3.5	2.5	4.5	2.1	1.3	2.8

Supplementary Table 2. Analysis of the association between demographic and socioeconomic factors with refractive errors*

Variable	Univariate analysis[a]				Multivariate analysis[a]			
	Hyperopia OR (CI 95%)	**Myopia** OR (CI 95%)	**Mixed Astigmatism** OR (CI 95%)	**Anisometropia** OR (CI 95%)	**Hyperopia** OR (CI 95%)	**Myopia** OR (CI 95%)	**Mixed astigmatism** OR (CI 95%)	**Anisometropia** OR (CI 95%)
Area of Residence: Urban	0.83 (0.72-0.97)[b]	1.74 (1.40-2.17)[d]	1.36 (0.89-2.06)	1.60 (0.95-2.68)	0.77 (0.64-0.92)[c]	1.45 (1.12-1.89)[c]	1.02 (0.62-1.66)	1.55 (0.84- 2.85)
Sex: Male	0.63 (0.54-0.74)[d]	0.75 (0.60-0.93)[c]	0.72 (0.47-1.10)	0.56 (0.33-0.97)[b]	0.72 (0.60-0.86)[d]	0.84 (0.66-1.07)	0.77 (0.48-1.22)	0.49 (0.26-0.92)[b]
Age Group: Adults	2.78 (2.38-3.23)[d]	1.95 (1.59-2.40)[d]	1.73 (1.16-2.60)[c]	1.92 (1.18-3.11)[c]	3.03 (2.50-3.67)[d]	1.78 (1.36-2.32)[d]	1.97 (1.19-3.24)[c]	2.14 (1.17-3.93)[b]
Ethnicity: Mestizo	0.98 (0.81-1.19)	0.70 (0.55-0.89)[c]	1.60 (0.91-2.83)	1.37 (0.70-2.68)	0.93 (0.76-1.13)	0.74 (0.58-0.96)[b]	1.57 (0.88-2.79)	1.44 (0.73-2.84)
Health services system: Contributive, special or excepcion	1.13 (0.94-1.35)	1.73 (1.37-2.19)[d]	1.16 (0.72-1.85)	1.42 (0.81-2.48)				
Neighbourhood social strata: Medium-High	1.41 (1.09-1.84)[c]	2.34 (1.71-3.19)[d]	2.87 (1.69-4.88)[d]	2.09 (1.03-4.24)[b]	1.55 (1.16-2.07)[c]	1.72 (1.23-2.40)[c]	2.71 (1.50-4.89)[c]	1.67 (0.78-3.57)
Educational level: Secundary or more	1.08 (0.90-1.31)	1.94 (1.53-2.46)[d]	1.33 (0.83-2.12)	1.39 (0.79-2.47)	0.59 (0.47-0.74)[d]	1.14 (0.86-1.52)	0.74 (0.42-1.32)	0.73 (0.37-1.45)
Mean household monthly income: > 1 minimun legal wage (around US $316)	1.08 (0.92-1.28)	1.43 (1.14-1.79)[c]	1.39 (0.91-2.13)	1.16 (0.68-1.96)				

OR: Odds ratio

CI: Confidence interval

[a] The comparation group is Emmetropia.

[b] p<0,05 [c] p<0,01 [d] p<0,001

*A stepwise strategy as forced covariables was used to select the final multivariate model, with values of p <0.10 and p <0.05 set as criteria for variable removal from and addition to the model, respectively.