

Prevalence of refractive errors in Villa Maria, Córdoba, Argentina

Victoria M. Sánchez¹, Rafael Iribarren², Santiago G. Latino¹, Víctor E. Torres³, Ana L. Gramajo¹, María N. Artal¹, María B. Yadarola¹, Patricia R. Garay¹, José D. Luna¹, Claudio P. Juarez¹

¹Fundación VER, Centro Privado de Ojos Romagosa, Córdoba, Argentina; ²Department of Ophthalmology, Centro Médico San Luis, Buenos Aires, Argentina; ³CIES (Conicet y UNC), Facultad de Ciencias Económicas, UNC, Córdoba, Argentina

Contributions: (I) Conception and design: AL Gramajo, MN Artal, PR Garay, MB Yadarola, JD Luna, CP Juarez; (II) Administrative support: JD Luna, CP Juarez; (III) Provision of study materials or patients: JD Luna, CP Juarez; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: VM Sánchez, R Iribarren, SG Latino, VE Torres, AL Gramajo, JD Luna, CP Juarez; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Claudio P. Juarez, MD, PhD. Fundación VER, Centro Privado de Ojos Romagosa, Deán Funes 432, (5000) Córdoba, Argentina. Email: claudiopjuarez@hotmail.com.

Background: Refractive errors are among the most frequent reasons for demand of eye-care services. Publications on refractive errors prevalence in our country are few. This study has the purpose to assess the prevalence of refractive errors in an adult population of Villa Maria, Córdoba, Argentina.

Methods: The Villa Maria Eye Study is a population-based cross-sectional study conducted in the city of Villa Maria, Córdoba, Argentina from May 2008 to November 2009. Subject's aged 40+ received a demographic interview and complete ophthalmological exam. Visual acuity was obtained with an ETDRS chart. Cycloplegic auto refraction was performed. The spherical equivalent was highly correlated between right and left eyes, so only data of right eyes are presented. Myopia and hyperopia were defined with a ± 0.50 diopters (D) criterion and astigmatism >1 D.

Results: This study included 646 subjects, aged 40 to 90 (mean age: 59.6 ± 10.3 years old). Four hundred and sixty two (71.5%) were females. The mean spherical equivalent was $+0.714 \pm 2.41$ D (range, -22.00 to $+8.25$ D) and the power of the cylinder was, on average, -0.869 ± 0.91 D (range, 0 to -6.50 D). In this sample, 61.6% subjects were hyperopic, and 13.5% were myopic. Myopia prevalence was lower in men (9.8% versus 14.9%) but this difference among genders was not statistically significant. There were 141 subjects (21.8%) with anisometropia greater than 1 D, and 168 subjects (26.0%) with astigmatism greater than 1 D.

Conclusions: The present study shows the prevalence of cycloplegic refractive errors in an adult population of Argentina. The prevalence of hyperopia was high, while myopia prevalence was very low.

Keywords: Hyperopia; myopia; astigmatism; population-based study; refractive errors

Submitted Dec 19, 2015. Accepted for publication Jun 12, 2016.

doi: 10.3978/j.issn.1000-4432.2016.06.06

View this article at: <http://dx.doi.org/10.3978/j.issn.1000-4432.2016.06.06>

Introduction

According to World Health Organization (WHO) report in 2004, refractive errors are the second leading cause of Years Lost due to Disability (YLD) in low- and middle-income countries (1). There have been numerous population surveys all over the world in the last 20 years (2-22), showing the prevalence of refractive errors in adults. However, only one population-based study of refractive

error is currently available in Argentina (23). As refractive errors are among the most frequent reasons for demand of eye-care services, prevalence data are important for public health care planning, in order to improve vision-specific quality of life. The paper by Barrenechea *et al.* showed that the prevalence of severe visual impairment and blindness in subjects older than 50 years old in Argentina was 2.5% and uncorrected refractive errors were the main cause of visual impairment.

The country's last census [2010] showed that Argentina had a population of 40,117,096 inhabitants (51.3% females) and 35.25% were older than 40 (54% females). The literacy rate in older than 10 years old was 98%. Ninety two [92] percentage of the population lived in urban areas.

Villa Maria City, in the province of Córdoba, Argentina is located in the southeast of the province and has 93,819 inhabitants according to the 2008 Provincial Census (INDEC). It is an urban area, located in the central rural areas of the Argentinian plains, which represent about 60% to 70% of the entire country. It was chosen to perform this study since is representative of the rest of the country regarding exhibiting an important economic development that preclude emigration and has a high percentage of population older than 45 years. In this study, we report the prevalence of cycloplegic refractive errors in the adult population aged ≥ 40 years of Villa Maria, Argentina.

Methods

The study was developed in Villa Maria City, in the province of Córdoba, Argentina from May 2008 to November 2009. A simplified general method for cluster-sample size surveys of health in developing countries (probability proportion to size, PPS) was used (24). The sample size was calculated from the size of the population for a confidence interval of 5% to obtain a confidence level of 95% (24,25). Eleven districts were randomly selected from Villa Maria City. Two stage cluster design were used. First stage sampling was fractions selection. All the fractions available were used (5 fractions). On the second stage two districts inside each fraction were randomly selected. We also added one district from Villa Nueva. These randomized districts were selected by censal-ratio methods, defined according to the concentration of the Villa Maria population given by the 2001 Provincial Census. Household were randomly selected (Kish Grid) from each ratio and all the adults >40 years of age were targeted. A local University helped in promoting the study.

The tenets of the Declaration of Helsinki were followed and the study was approved by the Institutional Ethics Committee Oulton-Romagosa Joint Committee on Clinical Investigation (C.I.E.I.S. Oulton Romagosa). All concerned volunteers were briefly informed about the scope and purpose of the study. Subjects were ensured strict confidentiality, and then informed consent was taken from each of the participants before procedure. Skilled interviewers approached 40+ year-old members of the

targeted households, who explained the characteristics of the study, completed the preliminary data forms and performed a demographic interview at the household. This interview included information about education achievement and family income. Then the subjects were invited to have a complete eye examination at peripherals centers (11 state outpatient clinics). This last exam day was scheduled on Saturdays to avoid losing subjects due to work responsibilities. Only subjects aged 40+, who had good cooperation for the eye examination were included in the analysis.

A team of 13 trained ophthalmologists of the Centro Privado de Ojos Romagosa (Fundación VER) performed the eye examinations at the peripheral center scheduled for that visit. The tasks were distributed according to the field of expertise of each trained doctors (glaucoma specialist, retinal specialist, etc.). Visual acuity was obtained with an ETDRS chart (Sloan Letter Folding Eye Chart 10 ft/3 m, Good Lite Company, USA) for each eye at a distance of 3 m. After tonometry, two drops of a commercially available combination of 5% phenylephrine +0.5% tropicamide (Fotorretin, Poen Laboratories, Argentina) were instilled 5 minutes apart, and after 30 minutes rest, with the objective of obtaining a rapid, persistent and maximum possible dilatation for the fundus examination. Auto refraction was performed in both eyes with a Canon R-10 auto refractor (Canon, USA). The mean of five measurements was registered. The eye examination was then completed with biomicroscopy of the cornea and lens, applanation tonometry and fundus examination. Lens opacity was graded using the Lens Opacities Classification System II (LOCS II) (26). The spherical equivalent was calculated based on the mean auto refraction outcome, adding half of the cylinder value to the recorded sphere. Myopia was defined as a spherical equivalent more negative than -0.50 diopters (D) and hyperopia was defined as a spherical equivalent greater than $+0.50$ D. Anisometropia was defined as a difference of more than 1 D in spherical equivalent between both eyes. Four age groups were defined with intervals of 10 years. For those with astigmatism greater than 1 D, the axis of the astigmatism was classified to be with-the-rule when the minus cylinder was at the $0^\circ \pm 15^\circ$, and to be against-the-rule when the minus cylinder was at the $90^\circ \pm 15^\circ$. Other astigmatisms were registered as oblique.

The significance of the differences in percentages of prevalence was obtained with chi square test. One-way ANOVA was used to compare means of spherical equivalent

Table 1 Monthly income in Villa Maria

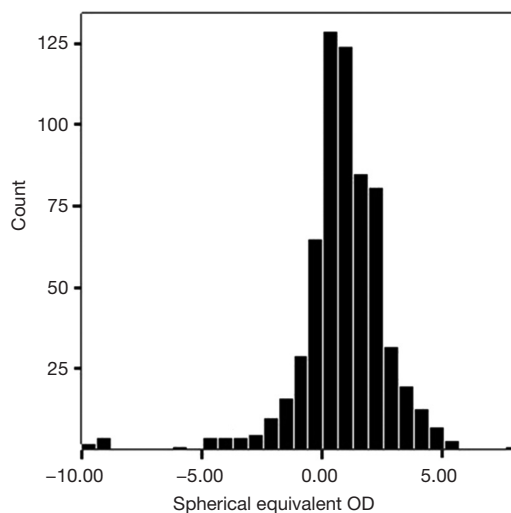
Monthly income	%
Less than 125 US dollars	12%
125 to 250 US dollars	32%
250 to 376.6 US dollars	28%
377 US dollars or more	28%

by age groups. In addition to descriptive analyses, odds ratios (OR) with 95% confidence interval (95% CI) were calculated with univariate logistic regression analysis. Univariate logistic regression models were performed with myopic, hyperopic and astigmatic refractive error as dichotomous dependent variables, adding age, sex, nuclear cataract, education, and annual family income as the independent variables. All P values less than 0.05 were considered statistically significant. Data analyses were performed with statistical software (SPSS version 15.0, SPSS Inc., Chicago, IL, USA).

Results

There were 1,192 eligible participants from Villa Maria. Three hundred eighteen subjects (26.7%) cooperated only for the household interview and did not attend the eye examination. Therefore, only 874 subjects reached the health centers for the exam. Nevertheless refractive examinations were performed just in 646 subjects (total sample size of the study) for the following reasons: refusal to dilate (190 subjects, 15.9%), wearing contact lenses (7 subjects, 0.6%) or pseudophakic status at the time of examination (31 subjects, 2.6%). Thus, response rate for those that had refractive exam was 73.9%, who represented 54.2% of the original eligible individuals. Participants who only cooperated for the interview were more likely to be older (mean age: 70.3 years old), reported lower income (66.7% less than 377 US dollars), and had fewer years of formal education (90.4% less than 12 years of study). On the other hand, participants who had the eye examination but incomplete refractive error data had similar characteristics except that they were more likely to be males (54.5% males).

The study population consisted of 646 subjects with complete cycloplegic refraction data. The sample included patients over the age of 40 up to 90, with a mean age of 59.6 ± 10.3 years old. Seventy-one point five percent (71.5%)

**Figure 1** Leptokurtic distribution of right eyes spherical equivalent.

were females. The level of education of the studied subjects was low, having 28.3% of them incomplete primary school and only 5.2% reaching a university level of more than 12 years of study. Only 28% had a family income that reached more than 377 US dollars per month (*Table 1*).

The spherical equivalent was very similar and highly correlated for both eyes ($r=0.81$, $P<0.001$) so only data of the right eyes are presented. The mean spherical equivalent was $+0.719 \pm 2.41$ D (range, -22.00 to $+8.25$ D, kurtosis 21.16, skewness -3.38) and its distribution is shown in *Figure 1*.

In our sample, hyperopia (greater than $+0.50$ D) was the most common condition at all ages, with a mean of 61.6% (95% CI, 57.8–65.4), compared with 24.9% for emmetropia and only 13.5% for myopia (95% CI, 10.9–16.1). There were significant differences between the distributions of refractive errors according to age (*Table 2*). Although the most frequent refractive error was hyperopia greater than $+0.50$ D, emmetropes were more prevalent in the youngest age group (40 to 49 years old) while hyperopia was more prevalent in older subjects (*Table 2*, $P<0.001$). The mean spherical equivalent was similar for both genders ($+0.896$ D for men and $+0.649$ D for women, $P=0.24$, Student *t*-test). The spherical equivalent was also lower in the younger group (*Figure 2*). When this analysis was stratified by gender, it was clear that the tendency for more hyperopic refractive error with age was more prevalent in women (*Figure 3* and *Table 2*).

The general prevalence of myopia was lower in men

Table 2 Prevalence of refractive error according to age groups, stratified by gender

Age groups	40–49 (%)	50–59 (%)	60–69 (%)	>70 (%)	All ages (%)
Males (n)	31	55	63	35	184
Myopia <−0.50 D	6.5	10.9	7.9	14.3	9.8
Emmetropia (−0.50 to +0.50 D)	38.7	21.8	25.4	28.6	27.2
Hyperopia >+0.50 D	54.8	67.3	66.7	57.1	63.0
Total	100	100	100	100	100
Females (n)	92	158	127	85	462
Myopia <−0.50 D	16.3	17.1	9.4	17.6	14.9
Emmetropia (−0.50 to +0.50 D)	30.4	32.3	15.7	14.1	24.0
Hyperopia >+0.50 D	53.3	50.6	74.8	68.2	61.0
Total	100	100	100	100	100

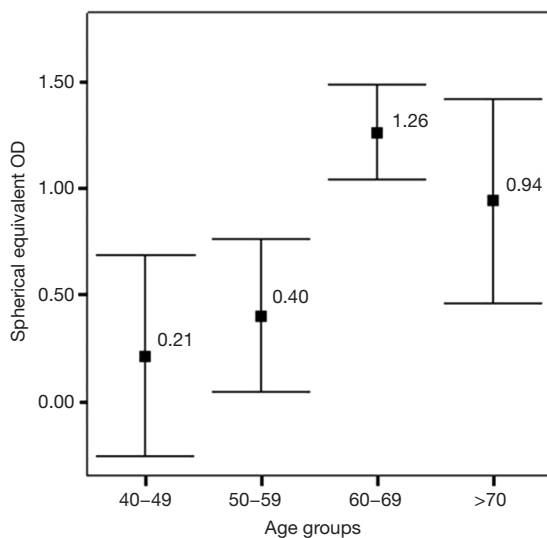


Figure 2 Means and 95% confidence interval (95% CI) of the right eyes spherical equivalent according to age groups.

(9.8% vs. 14.9%) but this difference was not statistically significant ($\chi^2 = 3.03$, $P=0.202$). The prevalence of high myopia, defined as a spherical equivalent over -6 D, was 2.0% (95% CI, 0.9–3.1). Myopes showed a similar distribution in all age groups. Accordingly, the mean spherical equivalent changed with age, with participants becoming more hyperopic after age 60 (Figures 2, 3, $P<0.001$). There were no significant differences in myopia prevalence according to tertiles of years of study in this population (Table 3).

There were 141 subjects (21.8%, 95% CI, 18.6–25.0)

with anisometropia greater than 1 D. The power of the cylinder was on average -0.869 ± 0.91 D (range, 0 to -6.50 D). There were 168 subjects (26, 0%, 95% CI, 22.6–29.4) with astigmatism greater than 1 D and 60 subjects (9.3%, 95% CI, 7.0–11.5) with astigmatism greater than 2 D and only 22 subjects (3.4%, 95% CI, 2.0–4.8) with astigmatism greater than 3 D. The prevalence of with-the-rule astigmatism was 53.6%, against-the-rule 25.6% and oblique 20.8%. The axis of the astigmatism changed with age, being more frequently with-the-rule in younger subjects and against-the-rule in older subjects (Table 4, chi square: 15.94, $P<0.001$).

Univariate logistic regression analyses were performed for the different refractive error groups: for myopic refractive error the univariate logistic regression analysis showed that independent variables such as age, sex, nuclear opacity, years of schooling and family income were individually not significantly associated with this refractive error. On the other hand, when hyperopic refractive error was considered as the dependent variable, patients with mild lens opacities were significantly more likely of being hyperopic than those with advanced opacity (OR =2.702; 95% CI, 1.135–6.433; $P=0.025$), and this was the only independent variable associated with this refractive error. As regard astigmatism, younger were also more likely to have astigmatism than older (OR =1.040; 95% CI, 1.022–1.058; $P=0.001$). Compared with advanced opacity, patients with clear lens or mild lens opacities were significantly more likely of being astigmatic (OR =0.225; 95% CI, 0.093–0.548; $P=0.001$ and OR =0.377; 95% CI, 0.158–0.900; $P=0.028$ respectively). Sex, income and education were non-

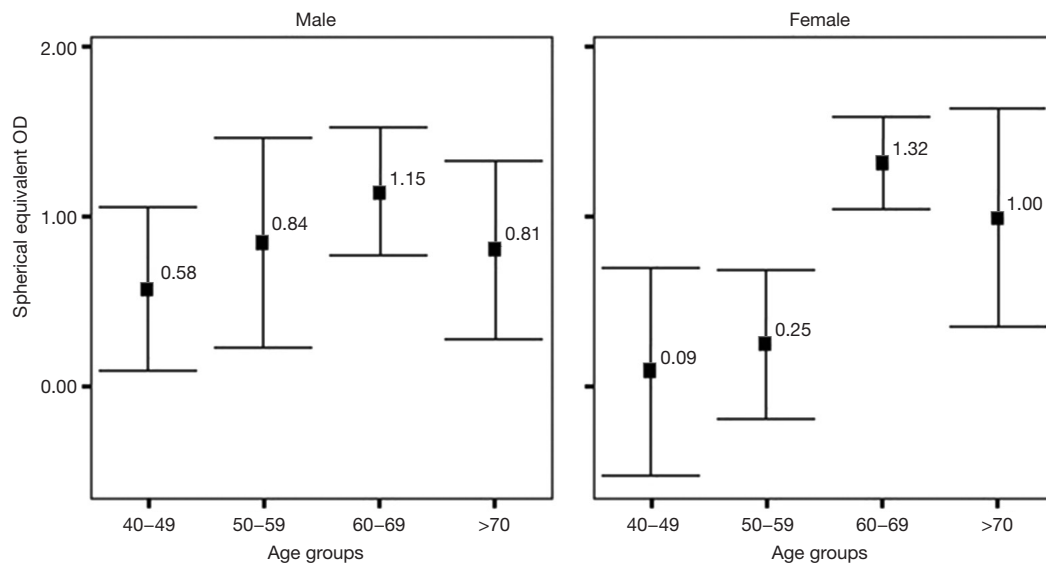


Figure 3 Means and 95% confidence interval (95% CI) of right eyes spherical equivalent according to gender.

Table 3 Education by age groups and prevalence of myopia (n=516)

Age groups	40-49 (%)	50-59 (%)	60-69 (%)	>70 (%)	All ages (%)	Myopia prevalence (%)
Less than 6 years of education	13.6	28.1	28.4	42.1	28.3	13.0
From 6 to 12 years of education	79.5	63.5	69.7	54.7	66.5	12.2
From 13 to 18 years of education	6.8	8.4	1.9	3.2	5.2	14.8

Table 4 Percentage of the different types of astigmatism with age

Age groups	40-49 (%)	50-59 (%)	60-69 (%)	>70 (%)	All ages
n	54	110	95	80	339
Against the rule	5.6	20.9	26.3	33.8	23.0
Oblique	57.4	54.5	56.8	58.8	56.6
With the rule	37.0	24.5	16.8	7.5	20.4
Total	100	100	100	100	100

significant variables for astigmatism.

Discussion

The Villa Maria Eye Study is a population-based, cross-sectional study of prevalence of refractive errors in the adult population aged ≥ 40 years of Villa Maria, Argentina. Refractive errors are the principal cause of ocular disease around the world. Moreover, according to the paper by

Barrenechea *et al.*, in Argentina refractive errors are the first and second causes of moderate and severe visual impairment respectively (23).

This study reports the prevalence of refractive errors based on cycloplegic auto refraction. This method is not frequently used in refractive errors studies that include adults older than 40 years old, which are generally performed with non-cycloplegic auto refraction. Nevertheless, it has been reported that pharmacologic cycloplegia is required

for epidemiological studies of refractive errors up to at least the age of 50 (27). In studies without cycloplegia, hyperopic subjects with borderline refractive error status could perhaps conceal hyperopia because of the remaining accommodation still present above 40 years.

With this cycloplegic approach, we found that hyperopia was the most common condition at all ages. The spherical equivalent was also noted to be lower in the younger group (Figure 2) and hyperopia was more frequent than myopia in this sample (61.6 % versus 13.5%, respectively). It is noteworthy that we choose OD to calculate prevalence in contrast to other studies as the Latino eye study (19) or the Andhra Pradesh study (5) that used the worse eye method to calculate prevalence, however we found only small differences between both methods. If we have used the worse eye method with the same cut point for myopia the prevalence would rise only to 16.5%. The analysis split by gender showed that this increment in hyperopia with age was more noticeable in women, although also present in men to a lower extent (Table 2).

This cycloplegic prevalence of hyperopia was found to increase from age 40 to 69, thus confirming previous findings of a larger cycloplegic population study (27,28). Moreover, the mentioned Tehran Eye Study showed that the prevalence of cycloplegic hyperopia increased from ages 25 to 70 (15). This is probably related to an age-related loss of lens power, as corneal power and axial length seem to be stable at those ages (28). A recent prospective population study with biometry and lens power calculation has confirmed that loss of lens power is the main cause of these age related hyperopic shifts and that this phenomenon is greater in magnitude in women (29).

The myopia prevalence found in this study was very low. Table 5 shows the prevalence of myopia with a -0.50 D cut point in the principal population-based studies performed in the last 20 years. The graph shows that Villa Maria has the lowest prevalence of myopia, along with locations such as Barbados, Mongolia, India, Bangladesh, and the American Latino population. On the other hand, the prevalence of myopia in the same age group reaches 40–50% in well-developed populations, like those of Singapore or American Caucasians from the NHANES, Baltimore or Beaver Dam studies. Moreover, the prevalence of myopia reaches 70–80% in younger generations of Indians, Malays and Chinese in Singapore (30,31). However, one recently published study suggests that in rural China the prevalence of myopia can be as low as the percentage found by us in Villa Maria (32,33).

The present study compares well with the Latino Eye Study (19), which reported the prevalence of myopia in a Mexican Hispanic population. For the age range 40–50, with a similar cut-off point of -0.50 D, that study reports 19.6% myopia for men and 22.3% for women. In that population, 36% (901/2,472) of males had more than 12 years of education, so their academic achievement was somehow higher than that of Villa Maria subjects and this could be the cause of higher myopia prevalence in US Latinos.

The prevalence in both studies is low compared to that of East Asian urban environments (30), in which subjects have very high academic achievement and low outdoor exposure. The prevalence of high myopia (cut-off point of -5 D) was very low in both Hispanic studies (2.4% for Latino Eye Study and 2.17% for the present one). This prevalence of high myopia in low academic environments with high outdoor exposure probably represents the cases with genetic background for myopia. The Latino Eye Study has not presented data of spherical equivalent or hyperopia prevalence so studies cannot be compared in that sense. It is noteworthy that according to recent genetic analysis in Argentineans, 78.9% of the mean ancestry components come from European descent, 15.8% from Amerindian and only 4.15% from African descent (34). A recent publication from the European Eye Epidemiology Consortium with a similar population, when compared to our study, showed that the prevalence of myopia with a cut point of -0.75 D was 40.2% in subjects aged 40–44. This higher prevalence of myopia may be possibly due to the different academic achievement and outdoor exposure of people living in Argentina compared to Europe (35). Another study on refractive errors in our country (36), based on non-cycloplegic refractions in an unselected sample of office-workers coming for a general health checkup aged 25–65, with high academic degrees (mean of 6 years of University study), showed a prevalence of myopia of 32.9% for subjects aged 40–50 (with the same cut point), much higher than the results obtained in our report (13.5%). This greater prevalence of myopia in the study by Cortinez *et al.* (36) could be related to greater academic achievement of that sample, as it was shown in other studies (30,31). In the present study, the low prevalence of myopia goes along with the lack of academic achievement (90% less than 12 years of studies), and very low income (66.7% less than 377 US dollars). The low prevalence of myopia is in accordance with recent data from Iran in Shahrud (37), where the prevalence has been low in similarly aged subjects.

Table 5 Prevalence of myopia in 40–50 years old for different studies

Study	Age range	n	40–50 years old participants	Myopia definition	Cycloplegia	Prevalence (%)	Reference
Villa Maria Eye Study	40–90	646	123	<−0.50	Yes	13	–
Mongolia	≥40	1,617	609	<−0.50	No	15	(17)
Latino Eye Study*	≥40	5,927	2,337	≤−1.00	No	16	(19)
Bangladesh	≥30	11,189	2,947	<−0.50	No	16	(14)
India (rural)	>39	2,508	1,456	<−0.50	No	16	(16)
Barbados Study	40–84	4,709	1,235	<−0.50	No	17	(6)
India (Andra Pradesh)	>0	2,321	382	<−0.50	No	18	(5)
China (Handan)	≥30	6,491	1,295	<−0.50	No	20	(22)
Iran (Tehran)	≥5	4,354	631	≤−0.50	Yes	21	(15)
Beijing Eye Study*	40–90	4,342	1,449	<−0.50	No	22	(18)
Australia (Victoria)	≥40	4,532	1,236	<−0.50	No	24	(8)
Blue Mountains Study (Australia)	49–97	3,174	465	<−0.50	No	25	(7)
Indonesia (Sumatra)	≥21	1,043	184	≤−0.50	No	29	(12)
Iceland (Reykjavik)	≥50	1,045	212	<−0.50	No	30	(10)
Norway	20–45	3,137	1,889	≤−0.50	No	30	(11)
Framingham Study	23–78	1,585	581	≤−1.00	No	38	(4)
Beaver Dam Study	43–84	4,275	1,468	<−0.50	No	42	(2)
Baltimore (Caucasian)	≥40	2,659	531	<−0.50	No	42	(3)
Japan	40–79	2,168	–	≤−0.50	No	42	(13)
Singapore (Chinese)	40–81	1,113	275	<−0.50	No	48	(9)
USA (NHANES)	≥20	12,010	3,776	≤−0.50	No	50	(21)

*, the data of the Beijing Eye Study and the Latino Eye Study are for all participants older than 40.

Considering nuclear opacity, only 3.6% of the sample had advanced nuclear opacity, which has been related to the development of myopic shifts in refraction (38,39), however, the involved numbers were very low to reach significance. As the number of hyperopic subjects was greater, we found that clear lenses were significantly related to hyperopic refractive error.

As regard astigmatism, we found a prevalence of 26.0%, which is comparable with studies that used a similar methodology as our study showing a range between 18.5–29.6% (12,15,40). On the other hand, the prevalence is much higher in studies that use a >0.50 D criterion to define astigmatism (40–42). In spite of a majority of with-

the-rule astigmatism found in our sample, there was a tendency to increase to against-the-rule astigmatism with age (*Table 4*). This tendency has already been described in other studies (14–20,41). A possible cause of this finding could be changes in lens opacity or more probably due to corneal modifications as other studies have suggested (42–45).

In spite of the randomly selected sites according to the local population census, some variables could be biased due to different factors. In this report there was a higher participation of women. This result was probably linked to the voluntary nature of the examination that may reflect factors like time availability and major possibility of

awareness about the campaign, cultural factors that make women more predisposed to assist. Many similar studies also showed a higher enrolment of women (7,15,19,46). Other concern is the low participation rate in this study, probably related to the fact that the demographic interview was scheduled first and the eye examination in a different visit (26.7% failed to return). Future studies in our country could improve this participation rate if scheduled as only 1-day visit for the whole procedure.

In summary, our work shows the prevalence of refractive error in an adult population of Hispanic residents in Argentina. The prevalence of myopia was very low when compared with the hyperopic refractive defect that was found in the studied participants. Refractive errors are an important cause of vision impairment in Córdoba, Argentina. We believe that this study shows that there is a great need of eye-care services and spectacle distribution to help improving visual-specific quality of life. Since our study data were collected several years ago, further studies are needed to report the trends on refractive error or current situation in the province, to evaluate if new policies or interventions are required currently.

Acknowledgements

The authors are grateful to Dr. Paul Hobson, native speaker, for the language correction of this manuscript.

Funding: The authors have received Grant from Fundacion Ver, and from Fondo para la Investigación Científica y Tecnológica (FONCYT), Argentina (# PICT 977).

Footnote

Conflicts of Interest: This manuscript was partially presented at Pan-American Research Day, oral presentation, April 30th, 2011; Fort Lauderdale, Florida, USA; A.R.V.O. Poster presentation Abstract # 2511/D826, May 2nd 2011; Fort Lauderdale, Florida, USA and SAO (Sociedad Argentina de Oftalmología) annual meeting; Oral presentation July, 2014, Buenos Aires, Argentina.

Ethical Statement: The tenets of the Declaration of Helsinki were followed and the study was approved by the Institutional Ethics Committee Oulton-Romagosa Joint Committee on Clinical Investigation (C.I.E.I.S. Oulton Romagosa). All concerned volunteers were briefly informed about the scope and purpose of the study. Subjects were ensured strict confidentiality, and then informed consent

was taken from each of the participants before procedure.

References

1. World Health Organization. Part 3: Disease incidence, prevalence and disability. In: The global burden of disease: 2004 update. World Health Organization. Geneva: 2008:27-37.
2. Wang Q, Klein BE, Klein R, et al. Refractive status in the Beaver Dam Eye Study. *Invest Ophthalmol Vis Sci* 1994;35:4344-7.
3. Katz J, Tielsch JM, Sommer A. Prevalence and risk factors for refractive errors in an adult inner Framingham Offspring Eye Study Group1. city population. *Invest Ophthalmol Vis Sci* 1997;38:334-40.
4. Framingham Offspring Eye Study Group. Familial aggregation and prevalence of myopia in the Framingham Offspring Eye Study. *Arch Ophthalmol* 1996;114:326-32.
5. Dandona R, Dandona L, Srinivas M, et al. Population-based assessment of refractive error in India: the Andhra Pradesh eye disease study. *Clin Experiment Ophthalmol* 2002;30:84-93.
6. Wu SY, Nemesure B, Leske MC. Refractive errors in a black adult population: the Barbados Eye Study. *Invest Ophthalmol Vis Sci* 1999;40:2179-84.
7. Attebo K, Ivers RQ, Mitchell P. Refractive errors in an older population: the Blue Mountains Eye Study. *Ophthalmology* 1999;106:1066-72.
8. Wensor M, McCarty CA, Taylor HR. Prevalence and risk factors of myopia in Victoria, Australia. *Arch Ophthalmol* 1999;117:658-63.
9. Wong TY, Foster PJ, Hee J, et al. Prevalence and risk factors for refractive errors in adult Chinese in Singapore. *Invest Ophthalmol Vis Sci* 2000;41:2486-94.
10. Gudmundsdottir E, Jonasson F, Jonsson V, et al. "With the rule" astigmatism is not the rule in the elderly. Reykjavik Eye Study: a population based study of refraction and visual acuity in citizens of Reykjavik 50 years and older. Iceland-Japan Co-Working Study Groups. *Acta Ophthalmol Scand* 2000;78:642-6.
11. Midelfart A, Kinge B, Midelfart S, et al. Prevalence of refractive errors in young and middle-aged adults in Norway. *Acta Ophthalmol Scand* 2002;80:501-5.
12. Saw SM, Gazzard G, Koh D, et al. Prevalence rates of refractive errors in Sumatra, Indonesia. *Invest Ophthalmol Vis Sci* 2002;43:3174-80.
13. Shimizu N, Nomura H, Ando F, et al. Refractive errors and factors associated with myopia in an adult Japanese

- population. *Jpn J Ophthalmol* 2003;47:6-12.
14. Bourne RR, Dineen BP, Ali SM, et al. Prevalence of refractive error in Bangladeshi adults: results of the National Blindness and Low Vision Survey of Bangladesh. *Ophthalmology* 2004;111:1150-60.
 15. 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.
 16. Raju P, Ramesh SV, Arvind H, et al. Prevalence of refractive errors in a rural South Indian population. *Invest Ophthalmol Vis Sci* 2004;45:4268-72.
 17. Wickremasinghe S, Foster PJ, Uranchimeg D, et al. Ocular biometry and refraction in Mongolian adults. *Invest Ophthalmol Vis Sci* 2004;45:776-83.
 18. Xu L, Li J, Cui T, et al. Refractive error in urban and rural adult Chinese in Beijing. *Ophthalmology* 2005;112:1676-83.
 19. Tarczy-Hornoch K, Ying-Lai M, Varma R, et al. Myopic refractive error in adult Latinos: the Los Angeles Latino Eye Study. *Invest Ophthalmol Vis Sci* 2006;47:1845-52.
 20. Saw SM, Chan YH, Wong WL, et al. Prevalence and risk factors for refractive errors in the Singapore Malay Eye Survey. *Ophthalmology* 2008;115:1713-9.
 21. Vitale S, Ellwein L, Cotch MF, et al. Prevalence of refractive error in the United States, 1999-2004. *Arch Ophthalmol* 2008;126:1111-9.
 22. Liang YB, Wong TY, Sun LP, et al. Refractive errors in a rural Chinese adult population the Handan eye study. *Ophthalmology* 2009;116:2119-27.
 23. Barrenechea R, de la Fuente I, Plaza RG, et al. National survey of blindness and avoidable visual impairment in Argentina, 2013. *Rev Panam Salud Publica* 2015;37:7-12.
 24. Bennett S, Woods T, Liyanage WM, et al. A simplified general method for cluster-sample surveys of health in developing countries. *World Health Stat Q* 1991;44:98-106.
 25. Bartlett JE II, Kotrlík JW, Higgins CC. Organizational research: determining appropriate sample size in survey research. *Information Technology, Learning, and Performance Journal* 2001;19:43-50.
 26. Chylack LT Jr, Leske MC, McCarthy D, et al. Lens opacities classification system II (LOCS II). *Arch Ophthalmol* 1989;107:991-7.
 27. Fotouhi A, Morgan IG, Iribarren R, et al. Validity of noncycloplegic refraction in the assessment of refractive errors: the Tehran Eye Study. *Acta Ophthalmol* 2012;90:380-6.
 28. Hashemi H, Iribarren R, Morgan IG, et al. Increased hyperopia with ageing based on cycloplegic refractions in adults: the Tehran Eye Study. *Br J Ophthalmol* 2010;94:20-3.
 29. Hashemi H, Khabazkhoob M, Iribarren R, et al. Five Year Change in Refraction and its Ocular Components in the 40-64 Year Old Population of the Shahroud Eye Cohort Study. *Clin Experiment Ophthalmol* 2016. [Epub ahead of print].
 30. Morgan IG, Ohno-Matsui K, Saw SM. Myopia. *Lancet* 2012;379:1739-48.
 31. Morgan I, Rose K. How genetic is school myopia? *Prog Retin Eye Res* 2005;24:1-38.
 32. Pan CW, Chen Q, Sheng X, et al. Ethnic variations in myopia and ocular biometry among adults in a rural community in China: the Yunnan minority eye studies. *Invest Ophthalmol Vis Sci* 2015;56:3235-41.
 33. Morgan IG, Rose K. Yunnan Minority Eye Study Suggests That Ethnic Differences in Myopia Are Due to Different Environmental Exposures. *Invest Ophthalmol Vis Sci* 2015;56:4430.
 34. Corach D, Lao O, Bobillo C, et al. Inferring continental ancestry of argentineans from Autosomal, Y-chromosomal and mitochondrial DNA. *Ann Hum Genet* 2010;74:65-76.
 35. 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.
 36. Cortinez MF, Chiappe JP, Iribarren R. Prevalence of refractive errors in a population of office-workers in Buenos Aires, Argentina. *Ophthalmic Epidemiol* 2008;15:10-6.
 37. Iribarren R, Morgan IG, Hashemi H, et al. Lens power in a population-based cross-sectional sample of adults aged 40 to 64 years in the Shahroud Eye Study. *Invest Ophthalmol Vis Sci* 2014;55:1031-9.
 38. Iribarren R, Iribarren G. Prevalence of myopic shifts among patients seeking cataract surgery. *Medicina (B Aires)* 2013;73:207-12.
 39. Díez Ajenjo MA, García Domene MC, Peris Martínez C. Refractive changes in nuclear, cortical and posterior subcapsular cataracts. effect of the type and grade. *J Optom* 2015;8:86-92.
 40. Hashemi H, Khabazkhoob M, Yekta A, et al. High prevalence of astigmatism in the 40- to 64-year-old population of Shahroud, Iran. *Clin Experiment Ophthalmol* 2012;40:247-54.
 41. Ziaei H, Katibeh M, Solaimanizad R, et al. Prevalence of

- refractive errors; the yazd eye study. *J Ophthalmic Vis Res* 2013;8:227-36.
42. Yekta AA, Fotouhi A, Khabazkhoob M, et al. The prevalence of refractive errors and its determinants in the elderly population of Mashhad, Iran. *Ophthalmic Epidemiol* 2009;16:198-203.
 43. Gudmundsdottir E, Jonasson F, Jonsson V, et al. "With the rule" astigmatism is not the rule in the elderly. Reykjavik Eye Study: a population based study of refraction and visual acuity in citizens of Reykjavik 50 years and older. Iceland-Japan Co-Working Study Groups. *Acta Ophthalmol Scand* 2000;78:642-6.
 44. Ueno Y, Hiraoka T, Beheregaray S, et al. Age-related changes in anterior, posterior, and total corneal astigmatism. *J Refract Surg* 2014;30:192-7.
 45. Ho JD, Liou SW, Tsai RJ, et al. Effects of aging on anterior and posterior corneal astigmatism. *Cornea* 2010;29:632-7.
 46. Hyman L, Patel I. Epidemiology of refractive errors and presbyopia. In: Johnson G, Minassian DC, Weale RA, et al., editors. *The epidemiology of Eye Disease*. Third edition. London, Imperial College Press, 2012:197-240.

Cite this article as: Sánchez VM, Iribarren R, Latino SG, Torres VE, Gramajo AL, Artal MN, Yadarola MB, Garay PR, Luna JD, Juarez CP. Prevalence of refractive errors in Villa Maria, Córdoba, Argentina. *Eye Sci* 2016;31(2):68-77. doi: 10.3978/j.issn.1000-4432.2016.06.06