Blindness, Visual Impairment and the Problem of Uncorrected Refractive Error in a Mexican-American Population: Proyecto VER

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Purpose. To report the prevalence of blindness and visual impairment and the contribution of uncorrected refractive error to visual loss, in a population-based sample of Mexican Americans aged 40 and older.

Methods. Proyecto VER is a population-based study of blindness and visual impairment in Mexican Americans in Arizona. Block groups in Tucson and Nogales were randomly selected with probability proportional to the size of the Mexican-American population aged 40 and older. Participants had a complete ophthalmic evaluation, including assessment of presenting and best corrected visual acuity using standardized procedures. Those with presenting visual acuity worse than 20/30 had refraction to determine best corrected vision. A home questionnaire and a clinic examination provided data on education, perception of visual impairment, income, and acculturation.

Results. The prevalence of presenting visual acuity worse than 20/40 was 8.2%, with uncorrected refractive error accounting for 73% of the impaired acuity. In multivariate models comparing those who improved two or more lines on the acuity chart with proper refraction with those who had adequate optical correction, uncorrected refractive error showed a strong association with age, less than 13 years of education (odds ratio [OR] 1.6, 95% confidence interval [CI] 1.5–2.0), low acculturation index (OR 1.3, CI 1.1–1.3), lack of insurance coverage (OR 1.4, CI 1.1–1.7), and not having seen an eye-care provider in the past 2 years (OR 2.5, CI 2.1–3.0). Prevalence of best corrected acuity worse than 20/40 increased from 0.3% in those aged 40 to 49 years to 18% in those aged 80 years or more.

Conclusions. Visual loss in this Mexican-American population is higher than has been reported in whites and is comparable to that in African Americans. Almost three quarters of those with visual acuity impairment would improve with optical correction. Socioeconomic factors that are probable markers of limited access to health care services were associated with uncorrected refractive error. These data suggest that education programs and interventions to improve access to eye care could significantly decrease the burden of visual loss among Mexican Americans. (*Invest Ophthalmol Vis Sci.* 2002;43: 608–614)

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Accurate information on visual health status is needed to plan optimal health services for all segments of the U.S. population. Population-based data on the magnitude and causes of blindness and visual impairment are available for whites and African Americans in the United States and other countries,[1–5] but no comparable information is available for Mexican Americans in the United States or elsewhere. Yet, Mexican-American populations have high rates of diabetic retinopathy[6] and glaucoma, which are associated with visual loss. Such data suggest that visual loss may be an important problem in the Mexican-American community. This article describes the age and gender-specific prevalence of blindness and visual impairment and the amount of visual impairment due to uncorrected refractive error, in a population-based sample of Mexican Americans living in Arizona.

Methods

Population

Proyecto VER is a population-based survey of visual impairment and blindness among noninstitutionalized Mexican Americans aged 40 years and more living in Pima and Santa Cruz counties of southern Arizona. Based on the 1990 census, the total number of Mexican Americans aged 40 years or more who lived in these two counties was 47,000.[7] The majority of the population in these two counties was concentrated in the two major cities: Nogales in Santa Cruz county and Tucson in Pima county. A stratified random sample of block groups (subunits within census tracks) located in Nogales and Tucson was selected with probability of selection within the strata proportional to the size of the Mexican-American population aged 40 years or more in each block group. Every other household of the selected block groups in Nogales and two thirds of the households of the selected block groups in Tucson were listed, and eligibility was determined. A higher proportion of households in Tucson was listed because a lower proportion of eligible individuals was found than expected, based on the 1990 census.

A total of 20,622 dwelling units were listed in the census of the randomly selected block groups. Of them, 4,255 or 21% were eligible to participate in the study (had at least one household member who self-reported being Mexican American and 40 years of age or more), and 15,756 or 76% were ineligible.

After informed consent for participation was obtained, participants had an extensive home interview, and an appointment was made for a complete ophthalmic examination at a central clinic site. All procedures for the project were reviewed and approved by the Joint Committee of Clinical Investigation of the Johns Hopkins University and the University of Arizona and the study's protocol adhered to the tenets of the Declaration of Helsinki.

TABLE 1. Characteristics of the Sample by Participation Status

Characteristic	Participants		Nonparticipants		
	n	%	*n*	%	
Age group					
40–49	1594	33.4	565	37.3	
50–59	1362	28.4	391	25.8	
60–69	984	20.6	270	17.8	$\chi^2_{(4)} = 31.9$, $P < 0.001$
70–79	636	13.3	184	12.1	
80+	197	4.1	104	6.9	
NA	1	—	371	—	
Gender					
Male	1851	38.8	796	46.3	Age-adjusted $P = 0.04$*
Female	2923	61.2	925	53.7	
Missing	—	—	164	—	
Overall health					
Excellent	392	8.2	112	9.5	
Very good	633	13.3	198	16.7	
Good	1594	33.4	407	34.4	
Fair	1810	38.0	386	32.6	Age-adjusted $P = 0.037$*
Poor	341	7.1	81	6.8	
NA	4	—	701	—	
Dr told he/she had diabetes					
Yes	885	18.6	170	14.5	Age-adjusted $P = 0.07$*
No	3873	81.4	1005	85.5	
NA	11	—	710	—	
Vision problems†					
Yes	1546	32.5	283	24.0	Age-adjusted $P = 0.005$*
No	3217	67.5	897	76.0	
NA	11	—	705	—	

NA, not available.
* Adjustment for age was done using three categories: 40–59, 60–79, and 80 or older.
† Reporting having problems seeing when wearing habitual correction.

The questionnaire was administered by trained personnel and offered in English and Spanish. The Spanish version was created by translating the English version, then back-translating the Spanish version, with reconciliation of any discrepancies. The majority (80%) of home interviews were conducted in Spanish and consisted of specific questions on education, income, health status, use of health and eye-care services, history and duration of diabetes, history of vision problems, and the short version of the National Eye Institute's Visual Function Questionnaire (NEI-VFQ).[8] This questionnaire is designed to determine the psychosocial and physical function decrements associated with loss of vision. Twelve domains are part of the questionnaire, and for each one, questions were scored so that the ceiling score was 100 and the floor was 0. Questions on language preference, country of origin, and ethnic identification were used to create an index of acculturation, based on the Cuellar acculturation scale for Mexican-American populations.[9,10] The index ranges from 1 (no acculturation) to 5 (high acculturation).

At the clinic site, blood pressure was measured using standardized procedures for obtaining three readings,[11] and blood samples were obtained to determine levels of hemoglobin A1C. A complete ophthalmic clinical examination with pupillary dilation was performed, and stereo fundus photographs were taken of fields 1, 2, and 4 of each eye. Data collection started in April 1997 and ended in September 1999.

The following methods for assessing visual acuity were used in each eye: Distance acuity was tested with a modified Early-Treatment Diabetic Retinopathy Study (ETDRS)[12] chart at 3 m, illuminated at 130

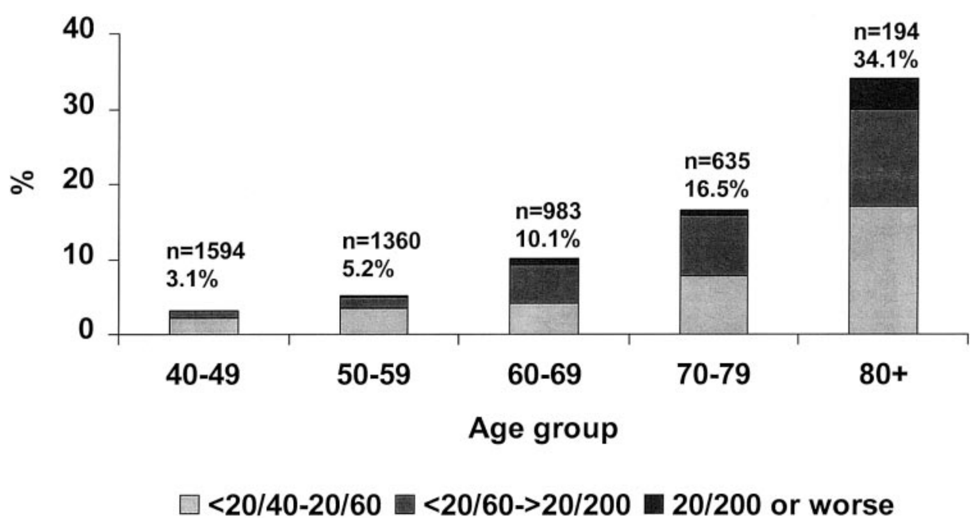

FIGURE 1. Prevalence among the study population of presenting acuity worse than 20/40.

cd/m^2, using a forced-choice procedure. Participants who failed to read the largest letters at 3 m were retested at 1.5 m, then at 1 m. Presenting acuity was measured with the participant's habitual distance correction. Best corrected acuity, after subjective refraction, was measured in each eye. Results from testing with an autorefractor (Humphrey Instruments Inc., San Leandro, CA) were used as a starting point for full subjective refraction. Visual acuity was scored as the total number of letters read correctly, transformed to log minimum angle of resolution (MAR) units. Failure to read any letters was assigned an acuity of 1.7 logMAR units, which is equivalent to an acuity of 20/1000. An E chart[12] was used for participants who were illiterate.

Blindness was defined as best corrected acuity of 20/200 or worse in the better-seeing eye, a level consistent with the definition of legal blindness in the United States. Visual impairment was defined as best corrected vision worse than 20/40 and better than 20/200 in the better-seeing eye. This level of vision is used as a screening criterion for an unrestricted motor vehicle license in many U.S. states.[13] Visual loss is the term we used to describe visual impairment and blindness together.

Prevalences and 95% confidence intervals (CIs) of visual impairment and blindness, stratified by age and gender are presented. The χ^2 test and Fisher exact test were used to compare proportions. Logistic regression models were used to examine the relationship between the main outcomes (blindness, visual impairment, and improvement in visual acuity after subjective refraction) with selected characteristics, controlling for age and gender. Odds ratios (ORs) and 95% CIs are presented. Because of the increased use of eye-care services, especially for cataract surgery, there has been a decrease in prevalence of blindness and visual impairment during the past two decades.[14–19] To make meaningful comparisons, the age-specific rates of blindness and visual impairment in Proyecto VER were compared only with data from those studies that had been performed recently and in which similar definitions of visual impairment and blindness had been used.

Results

From the 4255 eligible dwelling units, 6659 eligible subjects were identified. Among the eligible subjects, 4774 (72%) completed the home interview and the clinic examination (participants), 955 (14%) completed the home interview only, and 229 (3%) answered a short questionnaire. On the remaining 701 (11%), we had information on age and gender. Nonparticipants were more likely to belong either to the youngest age group (37% were 40–49 years old versus 33% of participants) or to the oldest age group (7% were aged 80 years or older versus 4%) and to be male (46% versus 39%, $P = 0.04$; Table 1). Nonparticipants were less likely to report having fair or poor health (39% versus 45%, age-adjusted $P = 0.04$), and to report having problems with their vision (24% versus 32%, age-adjusted $P = 0.005$). After age adjustment, similar response rates were observed in the two locations, 72% for Nogales and 71% for Tucson, and there was no significant difference in self-report of diabetes.

Overall, 8% of the participants had visual acuity worse than 20/40 in the better seeing eye while wearing their habitual correction. The prevalence of acuity worse than 20/40 with habitual correction increased with age from 3% in the 40- to 49-year age group to 34% in the 80 years or older group (Fig. 1).

As with habitual correction, visual impairment after refraction increased with age in both men and women, with women having a higher prevalence of visual impairment or blindness after age 50 (Table 2). Prevalence of bilateral blindness was low and did not differ substantially by gender in the first two age categories, but a much higher proportion of men were blind in the 80 years or older group (7.1% vs. 0.7%, Fisher exact test, $P = 0.025$). The adjusted prevalences of visual impairment and

Table 2. Best Corrected Acuity in the Better-Seeing Eye by Age Group and Gender

	Men					Women					Total				
		Unadjusted		Adjusted*			Unadjusted		Adjusted*			Unadjusted		Adjusted*	
Age Group	*n*	<20/40– >20/200	20/200 or Worse	<20/40– >20/200	20/200 or Worse	*n*	<20/40– >20/200	20/200 or Worse	<20/40– >20/200	20/200 or Worse	*n*	<20/40– >20/200	20/200 or Worse	<20/40– >20/200	20/200 or Worse
40–49	606	0.33 (0.04–1.19)	0.00 (0.00–0.61)	0.30	0.00	988	0.30 (0.06–0.89)	0.00 (0.00–0.37)	0.29	0.00	1594	0.32 (0.10–0.73)	0.00 (0.00–0.19)	0.29	0.00
50–59	531	0.38 (0.05–1.36)	0.00 (0.00–0.69)	0.37	0.00	829	0.48 (0.13–1.24)	0.24 (0.03–0.87)	0.47	0.23	1360	0.44 (0.16–0.96)	0.15 (0.02–0.53)	0.43	0.13
60–69	396	1.26 (0.16–2.36)	0.25 (0.01–1.41)	1.19	0.24	587	2.72 (1.40–4.04)	0.51 (0.11–1.49)	2.64	0.51	983	2.14 (1.23–3.04)	0.41 (0.11–1.04)	2.03	0.40
70–79	262	4.58 (2.05–7.11)	0.38 (0.01–2.12)	4.52	0.37	373	4.82 (2.65–6.99)	0.54 (0.06–1.94)	4.73	0.52	635	4.72 (3.07–6.37)	0.47 (0.10–1.38)	4.65	0.46
80+	56	8.90 (1.44–16.4)	7.14 (0.40–13.9)	6.80	6.45	138	18.1 (11.7–24.5)	0.72 (0.02–4.04)	17.5	0.60	194	15.5 (10.0–20.6)	2.58 (0.35–4.81)	14.2	2.44
Total	1851	1.40 (0.86–1.93)	0.32 (0.12–0.71)	1.29	0.34	2915	2.26 (1.72–2.80)	0.27 (0.12–0.54)	2.35	0.26	4766	1.93 (1.54–2.32)	0.29 (0.16–0.49)	1.92	0.29

Data are percentages (95% CI) or percentages. Eight missing values: Unable to measure visual acuity in seven people; one person's age was unknown.

* Adjusted for differential response by age gender and self reporting of vision problems.

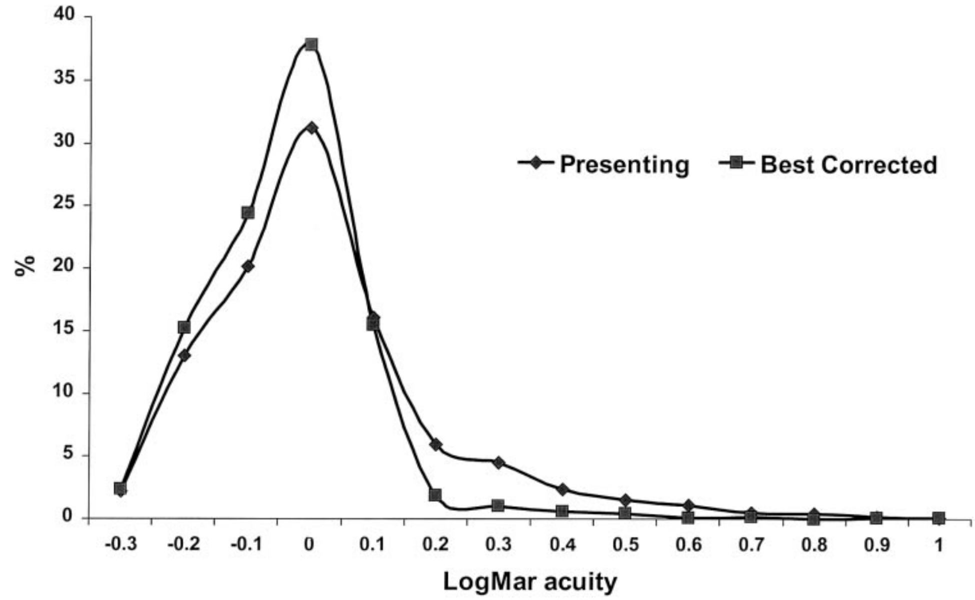

FIGURE 2. Distribution of presenting and best corrected visual acuity among the study population.

blindness, accounting for differential response by age, gender, and self-reported visual problems were lower than those observed, but the magnitude of the differences in all age groups was minimal, and the observed prevalences will be used in the remainder of the report.

The distributions of presenting and best corrected visual acuity are shown in Figure 2, with the difference between the two curves representing the amount of uncorrected refractive error in this population. Of those with presenting acuity worse than 20/40 (n = 390), 73% improved to acuity of 20/40 or better after subjective refraction was performed, 14% improved one line, 77% improved two or more lines, and 14% improved six or more lines (Fig. 3). A substantial proportion of the improvements, 43% (167/390), occurred in individuals whose presenting acuity was worse than 20/60. Of those improving two lines or more, 55% had presenting acuity between 20/40 and 20/60, 42% between 20/60 and 20/200, and 3% 20/200 or worse.

Those with uncorrected refractive error were more likely to report difficulties with general vision, near vision, distance vision, and driving tasks (Table 3). These persons were also more likely to report role difficulties, dependency, impeded social functioning, and impaired mental health. These data suggest that uncorrected error has a measurable impact on perceived quality of life in this population.

We compared risk factors for participants with uncorrected refractive error (those whose presenting acuity improved by two or more lines after refraction) to participants who were wearing adequate corrective lenses (that is, their best corrected acuity was within one line of their presenting acuity with their usual corrective lenses; Table 4). In the final multivariate model, the factors significantly associated with the presence of uncorrected refractive error were older age, less than a high school education, low index of acculturation, no health insurance coverage in the past year, and not seeing an eye-care provider in the past 2 years. Those who knew they needed glasses but could not afford them were also more likely to have uncorrected refractive error.

Risk factors for having best corrected acuity worse than 20/40 were also examined. In multivariate models, adjusted for

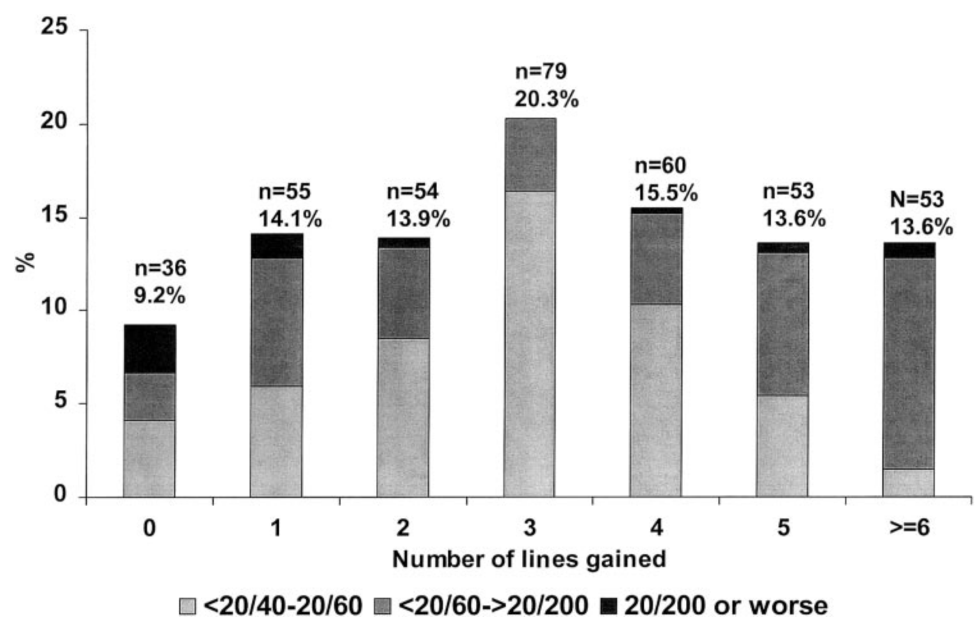

FIGURE 3. Gain in lines of the visual acuity chart after refraction among those with presenting acuity of 20/40 or worse.

Table 3. Self-Reported Visual Function in Those without Uncorrected Refractive Error and Difference in Score for Those with Uncorrected Refractive Error

NEI-VFQ Subscales	Without Uncorrected Refractive Error (Reference) (Estimated Score ± SE)	With Uncorrected Refractive Error (Estimated Difference ± SE)
General health	48.0 ± 1.30	+0.25 ± 1.29
General vision	71.8 ± 0.86	−2.47 ± 0.86*
Near vision	87.9 ± 1.08	−4.63 ± 1.08*
Distance vision	97.4 ± 0.90	−4.50 ± 0.89*
Driving	94.0 ± 1.18	−3.35 ± 1.32*
Peripheral vision	98.1 ± 0.90	−1.68 ± 0.90
Color vision	98.2 ± 0.66	−0.47 ± 0.66
Ocular pain	93.0 ± 1.08	−2.87 ± 1.08*
Vision specific		
Role difficulties	95.6 ± 1.17	−5.28 ± 1.16*
Dependency	98.2 ± 0.92	−3.54 ± 0.91*
Social functioning	98.9 ± 0.62	−1.84 ± 0.62*
Mental health	88.2 ± 1.07	−5.05 ± 1.06*

Adjusted for age, gender, acculturation, income, insurance, and education.

* $P < 0.05$.

age, Mexican-American persons with family income below $20,000/year were three times more likely to have best corrected acuity worse than 20/40, (95% CI 1.4–6.0). After age and income adjustment, no significant differences in the proportion of visually impaired or blind were found by gender, degree of acculturation, education, and medical insurance coverage during the previous year (data not shown).

The prevalence of monocular blindness (best acuity, 20/200 or worse in only one eye) was 1.1% in the first two age categories (40–59 years), increasing with age from 3.3% in the 60- to 69-year age group to 13.3% in the 80 years or older group (Table 5). After age 50, men were more often blind in one eye than were women (age-adjusted OR 1.61; 95% CI 1.07–2.43).

Table 5. Monocular Blindness by Age Group and Gender

Age Group	Men		Women		Total	
	n	%	*n*	%	*n*	%
40–49	606	0.83	988	1.52	1594	1.25
50–59	531	1.51	829	0.72	1360	1.03
60–69	396	4.04	587	2.73	983	3.26
70–79	262	6.11	373	4.29	635	5.04
80+	56	12.5	138	8.70	194	9.79
Total	1851	2.81	2915	2.23	4766	2.45

Eight missing values: Unable to measure visual acuity in seven people; one person's age was unknown.

Discussion

The Mexican-American community in the United States is expected to become the largest minority group early in this century.[20] Despite this trend, there are few data on the problem of blindness and visual impairment in this population. According to the 2000 U.S. census data, 12.5% of the total population is of Hispanic origin, with 58% of them being Mexican-American.[21] In our sample of 4774 Mexican Americans aged 40 and older in southern Arizona, we found a blindness rate of 0.3% and a visual impairment rate of 1.9%. These rates tend to be lower than rates reported in comparable ages for whites and African Americans in studies conducted 10 to 15 years before Proyecto VER.[1,2] However in comparison with more recent studies, the rates from Proyecto VER are

Table 4. Factors Associated with Uncorrected Refractive Error

Characteristic	*n*	% Improved Two or More Lines	Age-Adjusted OR (95% CI)	Multivariate OR (95% CI)*
Age Group				
40–59	1832	19.5	—	1.01 (1.00–1.02)
60–79	1381	21.9	—	(per year of age)
80+	168	28.6	—	
Gender				
Male	1220	20.3	1.00	—
Female	2162	21.2	1.06 (0.89–1.26)	—
Education				
0–12 years	2163	25.3	1.00	1.00
>12 years	1218	13.0	0.45 (0.37–0.55)	0.61 (0.49–0.66)
Degree of acculturation				
Low	1949	25.0	1.00	1.00
High	1432	15.4	0.55 (0.46–0.66)	0.78 (0.63–0.95)
Household income				
$20,000 or less	2216	24.0	1.00	—
More than $20,000	1072	14.7	0.56 (0.46–0.68)	—
Medical insurance coverage				
Yes	2430	18.3	1.00	1.00
No	950	27.5	1.91 (1.58–2.29)	1.39 (1.14–1.70)
Visit to an eye care provider in the past 2 years				
Yes	2230	14.9	1.00	1.00
No	1150	32.5	2.80 (2.36–3.32)	2.51 (2.10–3.00)
Needs glasses but unable to afford them				
Yes	451	30.6	1.90 (1.52–2.37)	1.65 (1.31–2.09)
No	2924	19.4	1.00	1.00

Uncorrected refractive error: improvement of two or more lines after refraction.

* From a multiple logistic regression model that simultaneously includes all factors presented.

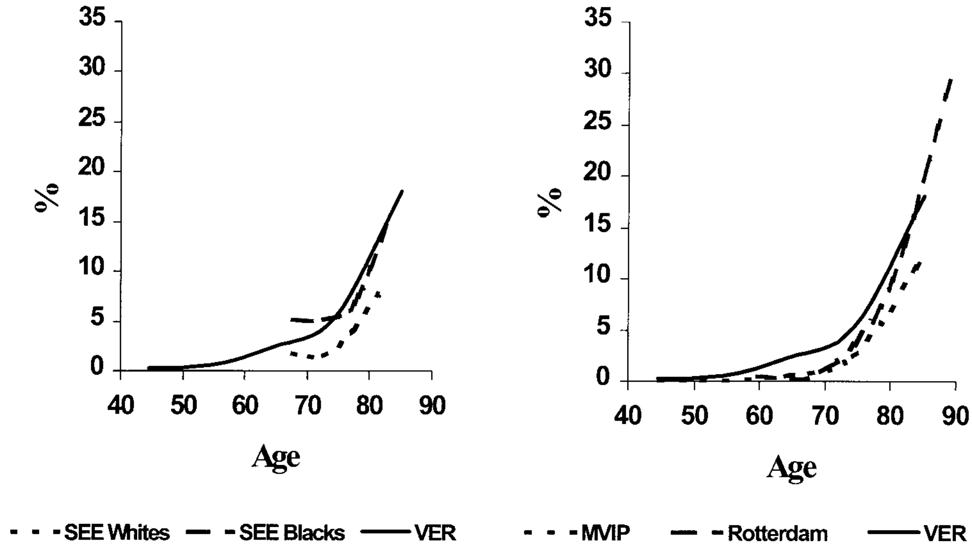

FIGURE 4. Prevalence of best corrected visual acuity of less than 20/40 in the SEE (left), MVIP (right), and Rotterdam (right) studies, compared with prevalence in Proyecto VER.

higher than rates reported in whites and similar to rates found in African Americans. Compared with the Salisbury Eye Evaluation (SEE),[17] a recent population-based study of elderly Americans, the prevalence in elderly Mexican Americans is higher than the prevalence in whites but comparable to the prevalence in African Americans (Fig. 4). Compared with white populations in the Melbourne Visual Impairment Survey (MVIP)[5] and the Rotterdam study,[22] blindness and impairment prevalences are higher in the Mexican-American population of Proyecto VER.

As found in other population-based studies of vision, the primary social factor associated with visual impairment was low income.[23,24] A spectrum of social risk factors are probably involved in this association. First, low-income populations are known to have lower rates of health insurance coverage, of visits to health-care providers, and, in general, lower quality of medical care.[25,26] Second, low-income Hispanic Americans are more likely to underuse available health services than other ethnic groups because, in addition to financial constraints, they face other types of barriers, including lack of knowledge of available services, poor use of preventive care, and inability to communicate in English.[27] Routine eye examinations are essential to identify persons with treatable vision loss from cataract, or persons with early eye disease, in whom treatment can prevent vision deterioration, such as occurs in glaucoma or diabetic retinopathy.[28–31]

A major finding in our study was the magnitude of the problem of uncorrected refractive error in this Mexican-American population. This observation confirms the results of several studies in the United States and abroad, in that a high proportion of the general population may have improved visual acuity with proper refraction.[1,2,4,5] Uncorrected refractive error was responsible for the majority of presenting visual impairment (acuity worse than 20/40), with almost three quarters of the individuals with presenting acuity worse than 20/40 improving to 20/40 or better with refraction. Presenting acuity worse than 20/40 has functional consequences, including limiting the ability to drive. Seventy-seven percent improved a significant amount, two or more lines on the acuity chart, and almost half of the improvements occurred in people with presenting acuities worse than 20/60. In our study, people with uncorrected refractive error had significantly lower scores in the near vision, distance vision, and driving subscales and report more problems with role functions, dependency, and mental health. These differences indicate that in fact, uncorrected refractive error has a negative impact on vision-related function.

This finding alone suggests the potential for major improvements in visual function in the Mexican-American community with interventions primarily focused on providing efficient refractive services. The predictive factors for uncorrected refractive error point to limitations in the ability to seek health care because of language problems, lack of monetary resources, and/or lack of information on available services.

In conclusion, the prevalence of visual impairment in this Mexican-American population was higher than that reported in other recent population-based studies of whites and similar to the prevalence reported in African Americans. In spite of ophthalmic services being readily available, uncorrected refractive error was the leading cause of reduced acuity. A comprehensive approach that, in addition to affordable ophthalmic care, includes educational and promotional components targeted to the Mexican-American community may substantially improve vision and visual function of this segment of the U.S. population.

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