SPECIAL ARTICLE

THE PREVALENCE OF BLINDNESS AND VISUAL IMPAIRMENT AMONG NURSING HOME RESIDENTS IN BALTIMORE

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Abstract *Background.* Although the prevalence of blindness and visual impairment increases with age, most surveys of ocular disease do not include nursing home residents.

Methods. We conducted a population-based prevalence survey of persons 40 years of age or older residing in nursing homes in the Baltimore area. Of 738 eligible subjects in 30 nursing homes, 499 (67.6 percent) participated in the study. They had their eyes examined and their visual acuity tested and were interviewed in detail. The nonparticipants were more likely to be older, to be white, and to have lower scores on the Mini–Mental State Examination.

Results. The prevalence of bilateral blindness (visual acuity ≤20/200) was 17.0 percent. The prevalence of visual impairment (<20/40 but >20/200) was 18.8 percent. The frequency of blindness increased from 15.2 percent among those under 60 years of age to 28.6 percent among those 90 or older. The age-adjusted prevalence of blindness was 50 percent higher among blacks than among whites ($P<0.01$). As compared with the noninstitutionalized population from the same communities, the rate of blindness among nursing home residents was 13.1 times higher for blacks and 15.6 times higher for whites. Cataract was the leading cause of blindness, followed by corneal opacity, macular degeneration, and glaucoma. We judged that 20 percent of the functional blindness and 37 percent of the visual impairment could be remedied by adequate refractive correction.

Conclusions. Blindness and visual impairment are highly prevalent among nursing home residents. Much of this loss of vision could be treated or prevented with appropriate ophthalmologic care. (N Engl J Med 1995;332: 1205-9.)

THE frequency of blindness and visual impairment increases among older persons,[1-4] but little work has been done to document the magnitude and severity of this problem among the oldest old people, many of whom reside in nursing homes or extended-care facilities. Most previous studies have been limited to single nursing homes[5,6] or non–population-based samples of such facilities,[7] or have relied on questionnaires or nursing-staff reports of visual performance rather than direct measurements.[8,9] Although they are major contributors to disability,[10-12] blindness and ocular disease are rarely listed as the conditions responsible for admission to a nursing home. As part of a comprehensive assessment of the prevalence and causes of vision loss in a multiracial community, we assessed the status of nursing home residents with respect to vision and ocular disease.

METHODS

The Baltimore Nursing Home Eye Survey is a population-based prevalence survey of ocular disease and visual impairment among nursing home residents who had previously lived in the communities of East Baltimore. It was designed to complement the sample of noninstitutionalized East Baltimore residents studied in the original Baltimore Eye Survey.[1] In the current study we estimated the prevalence of ocular disease among persons who would have been eligible for the Baltimore Eye Survey had they been living at home. These estimates could then be combined with the results from the community-based sample to provide a total picture of the magnitude of vision loss in a community. Data were collected from February 1988 through September 1989.

The sampling plan identified residents of nursing homes who had been admitted from an address within the sampling frame of the Baltimore Eye Survey. The admitting offices of all nursing homes in the Baltimore area were contacted to identify residents admitted from the eastern and southeastern health districts of Baltimore. People admitted to a nursing home directly from a hospital were assigned the address of the residence from which they were admitted to the hospital.

Thirty-four of the 36 nursing homes identified as having potentially eligible subjects (94.4 percent) agreed to participate. In the second stage of the study, eligible subjects were defined as those 40 years of age or older who were admitted from a residence in eastern or southeastern Baltimore. Four participating nursing homes (11.8 percent) had no patients who had been admitted from an address in the target area. The number of eligible subjects in each nursing home ranged from 1 to 89, with a total of 748.

A short version of the Mini–Mental State Examination[13] was administered to all eligible subjects to determine their competence to provide informed consent. It is scored on a scale ranging from 0 to 32 points, with a score of 0 representing poor cognitive function, and a score of 32 excellent cognitive function. We conferred with the professional staff at each facility regarding the ability to provide informed consent of all subjects who scored less than 15 on the examination. In a small minority of cases, the medical staff recommended that such persons be approached directly. In all other cases, the next of kin or the legal guardian, including a state agency if necessary, was asked to provide permission for the subject to participate. All procedures were approved by the Joint Committee on Clinical Investigation of the Johns Hopkins Medical Institutions.

We interviewed each participating subject or, if necessary, a proxy respondent. The interview included demographic characteristics, medical and ophthalmic history, the use of eye-care and general medical services, self-perceived problems with vision, and a variety of other variables. An ophthalmologic screening examination was conducted in the nursing home and included measurements of height, weight, blood pressure, pulse, ocular refraction, visual acuity, visual fields, and intraocular pressure, as well as stereo-fundus color photographs of the optic disk and maculae. For refraction and visual-acuity testing, subjects' eyes were first refracted with the AO Reichert SR-IV Programmed Subjective Refractor (AO Reichert Scientific Instruments, Buffalo, N.Y.). This result was refined as neces-

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sary with the use of standard subjective-refraction techniques. Retinoscopy and trial lenses were used to refract the eyes of subjects who could not use the SR-IV. Visual acuity was measured at 4 m with the use of the charts and light box described by Ferris et al.[14,15] Visual acuity was measured separately for each eye and was defined according to the lowest line on the chart for which the majority of letters were read correctly. Visual acuity was measured twice, first with the subject's typical distance correction (that is, eyeglasses or contact lenses, if any) and again with the full required distance correction as determined by the study refraction data. Best corrected visual acuity was defined as the visual acuity in the better eye with full distance correction.

Because definitions of blindness and visual impairment vary widely around the world,[16] we have used two alternative sets of criteria in this report. The first set is the criteria most commonly applied in the United States — a best corrected visual acuity in the better eye of ≤20/200 for blindness and between 20/40 and 20/200 for visual impairment. This definition of blindness is used by the Social Security Administration to define eligibility for disability due to severe loss of vision. The cutoff for visual impairment conforms to requirements for obtaining a driver's license in most states.[17] The second set of criteria is that established by the World Health Organization and used in the *International Classification of Diseases* — a best corrected visual acuity in the better eye of less than 20/400 for blindness and less than 20/60 but no less than 20/400 for visual impairment.[18]

The statistical analysis consisted of an estimation of prevalence, with 95 percent confidence intervals based on the normal approximation. The adjusted prevalence was calculated with multiple linear-regression models.

RESULTS

A total of 748 potentially eligible subjects were identified during recruitment — 455 whites, 283 blacks, and 10 persons of other races. Because of their small number, subjects in the "other" race category were excluded from further analysis, leaving a total of 738 subjects. Five hundred fourteen (69.6 percent) of these subjects underwent at least part of the ocular examination. Of the 224 subjects whose eyes were not examined, 12 (5.4 percent) died before an examination could be scheduled, 71 (31.7 percent) declined to provide consent for any contact, 123 (54.9 percent) consented initially but ultimately declined permission when it came time for the eye examination, and 18 (8.0 percent) did not participate for a variety of other reasons, most commonly because of hospitalization.

The rate of participation in the ocular examination declined from an average of 74.6 percent among those under the age of 80 to 64.5 percent among those 80 or older (Table 1). There was no indication of a linear decline in participation with increasing age. Black subjects participated significantly more frequently than did whites (77.7 percent vs. 64.6 percent, $P<0.001$), mirroring the participation in the noninstitutionalized sample drawn from the same communities.[1] There was no difference in the rate of participation according to sex. Nonparticipants had significantly lower scores on the Mini–Mental State Examination than participants; over 80 percent scored less than 12, as compared with approximately 60 percent of the participants.

Of the 514 subjects who underwent eye examinations, distance visual acuity was measured according to the study protocol in 443 (86.2 percent). The vast majority of the 71 subjects whose visual acuity was not measured were medically incapable of responding to testing (n = 63; 88.7 percent). Their scores on the Mini–Mental State Examination were extremely low, with a mean of 1.3, as compared with 10.6 for those with data on visual acuity ($P<0.001$). Among these 71 subjects, 56 (78.9 percent) were sufficiently cooperative that a clinical judgment could be made about their probable visual acuity on the basis of responses to light, the avoidance of threat, and the clinical status of their eyes. Visual acuity for these 56 subjects was classified according to the categories 20/40 or better, 20/50 to better than 20/100, 20/100 to better than 20/200, 20/200 to 20/400, and worse than 20/400. When these groups were combined, data on visual acuity were available for 499, or 97.1 percent, of those who had undergone an eye examination. The inclusion of the 56 subjects who could not be fully tested made little difference in the observed prevalence.

Table 1. Distribution of Participants and Nonparticipants in the Eye Examination According to Age, Sex, Race, and Score on the Mini–Mental State Examination.

VARIABLE	PARTICIPANTS	NON-PARTICIPANTS*	TOTAL
Age — no. (%)†			
40–59 yr	46 (73.0)	17 (27.0)	63
60–69 yr	64 (73.6)	23 (26.4)	87
70–79 yr	181 (75.4)	59 (24.6)	240
80–89 yr	170 (64.9)	92 (35.1)	262
≥90 yr	53 (63.1)	31 (36.9)	84
Total	514 (69.8)	222 (30.2)	736
Race — no. (%)‡			
White	294 (64.6)	161 (35.4)	455
Black	220 (77.7)	63 (22.3)	283
Total	514 (69.6)	224 (30.4)	738
Sex — no. (%)§			
Male	182 (70.0)	78 (30.0)	260
Female	332 (69.5)	146 (30.5)	478
Total	514 (69.6)	224 (30.4)	738
Mini–Mental State Examination			
Mean (±SE) score	9.3±0.50	4.7±0.61	
Percentage with a score less than 12¶	59.9	81.7	

*Data on age were missing for two nonparticipants.
†Chi-square with 4 degrees of freedom = 9.28, P = 0.05.
‡Chi-square with 1 degree of freedom = 14.21, P<0.001.
§Chi-square with 1 degree of freedom = 0.02, P = 0.88.
¶Chi-square with 1 degree of freedom = 33.22, P<0.001.

Age was strongly associated with visual impairment and blindness. There was a small peak in the prevalence of blindness among subjects 40 to 59 years of age, which was followed by an increasing prevalence with older ages to a high of 28.6 percent among those 90 years of age or older — more than double the rate among those in their 60s (Table 2, Fig. 1). Bilateral visual impairment was also common in this population, with rates rising from 10.9 percent in the youngest age group to 26.5 percent among those 90 years of age or older. Overall, the total prevalence of poor vision (visual impairment or blindness) was 35.8 percent according to the U.S. definition and 30.5 percent according to the criteria of the World Health Organization.

For the black residents of nursing homes, the rates of blindness were 50 percent higher than for the whites (crude rates according to the U.S. definition: 21.0 percent, as compared with 14.0 percent for the whites) (Table 2). Adjusting for age and sex only increased this

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Table 2. Prevalence of Blindness and Visual Impairment as Determined by U.S. and WHO Criteria According to Age, Race, and Sex.*

VARIABLE	TOTAL NO.	VISUAL IMPAIRMENT†		BLINDNESS‡	
		U.S.	WHO	U.S.	WHO
		no. of subjects (% prevalence; 95% confidence interval)			
Age (yr)					
40–59	46	5 (10.9; 1.9–19.9)	5 (10.9; 1.9–19.9)	7 (15.2; 4.8–25.6)	5 (10.9; 1.9–19.9)
60–69	62	12 (19.4; 9.5–29.2)	13 (21.0; 10.8–31.1)	8 (12.9; 4.6–21.3)	4 (6.5; 0.3–12.6)
70–79	175	26 (14.9; 9.6–20.1)	35 (20.0; 14.1–25.9)	25 (14.3; 9.1–19.5)	9 (5.1; 1.9–8.4)
80–89	167	38 (22.8; 16.4–29.1)	48 (28.7; 21.9–35.6)	31 (18.6; 12.7–24.5)	11 (6.6; 2.8–10.4)
≥90	49	13 (26.5; 14.2–38.9)	14 (28.6; 15.9–41.2)	14 (28.6; 15.9–41.2)	8 (16.3; 6.0–26.7)
Total	499	94 (18.8; 15.4–22.3)	115 (23.0; 19.4–26.7)	85 (17.0; 13.7–20.3)	37 (7.4; 5.1–9.7)
χ^2_4		7.31	8.81	6.68	8.03
P value		0.12	0.07	0.15	0.09
Race					
White	285	55 (19.3; 14.7–23.9)	66 (23.2; 18.3–28.1)	40 (14.0; 10.0–18.1)	12 (4.2; 1.9–6.5)
Black	214	39 (18.2; 13.1–23.4)	49 (22.9; 17.3–28.5)	45 (21.0; 15.6–26.5)	25 (11.7; 7.4–16.0)
Total	499	94 (18.8; 15.4–22.3)	115 (23.0; 19.4–26.7)	85 (17.0; 13.7–20.3)	37 (7.4; 5.1–9.7)
Relative prevalence (black:white)		0.94	0.99	1.50	2.79
χ^2		0.09	0.00	4.23	9.94
P value		0.76	0.97	0.04	0.002
Sex					
Male	181	29 (16.0; 10.7–21.4)	37 (20.4; 14.6–26.3)	25 (13.8; 8.8–18.8)	11 (6.1; 2.6–9.6)
Female	318	65 (20.4; 16.0–24.9)	78 (24.5; 19.8–29.3)	60 (18.9; 14.6–23.2)	26 (8.2; 5.2–11.2)
Total	499	94 (18.8; 15.4–22.3)	115 (23.0; 19.4–26.7)	85 (17.0; 13.7–20.3)	37 (7.4; 5.1–9.7)
χ^2		1.47	1.09	2.09	0.74
P value		0.22	0.30	0.15	0.39

*Visual acuity was measured directly in the majority of subjects, and indirectly in the others (see the Results section).

†The U.S. criterion for visual impairment is a visual acuity between 20/40 and 20/200. The World Health Organization (WHO) criterion is a visual acuity of less than 20/60 but not less than 20/400.

‡The U.S. criterion for blindness is a visual acuity of 20/200 or less. The WHO criterion for blindness is a visual acuity of less than 20/400.

difference, from 7.0 to 8.8 percentage points ($P<0.01$). Although blindness was strongly associated with race, there was no significant difference according to race in the prevalence of visual impairment (Table 2).

Women had higher rates of both blindness and visual impairment than did men, although these differences were not statistically significant (Table 2). The prevalence of blindness was 1.37 times greater for women. Similar differences were found for visual impairment.

As compared with community-dwelling persons of the same age from the same base population, nursing home residents had a dramatically higher prevalence of blindness (Table 3). Overall, prevalence rates for the nursing home residents were 15.6 times higher for whites and 13.1 times higher for blacks. For both racial groups, the difference in prevalence between nursing home residents and community residents was greatest in the younger groups, with a continuous decline with increasing age. This decline in relative prevalence was probably due to a ceiling effect, given the high rates in the older groups. Even among people 80 years of age and older, however, the prevalence of blindness was 2.4 to 3.7 times higher in the nursing home population than among those living in the community.

As in our previous study of a community sample,[1] the prevalence of uncorrected refractive error was high. We judged that 20 percent of the functional blindness and 37 percent of the functional visual impairment could be remedied by adequate refractive correction.

Cataract was the leading cause of blindness, accounting for blindness in 46 of the 170 eyes (27.1 percent) among bilaterally blind persons (Table 4). Cataract also occurred in combination with macular degeneration or glaucoma in another five eyes, bringing the total proportion of blind eyes with cataract as a contributory cause to 30 percent. The importance of cataract was not limited to subjects with poor cognitive function. Whereas cataract alone accounted for 58.2 percent (39 of 67) of blind eyes among persons with scores of 10 or lower on the Mini–Mental State Examination, it accounted for 20 percent (2 of 10) and 62.5 percent (5 of 8) of blind eyes for those with scores of 11 to 20 and 21 or higher, respectively. Other leading causes of blindness included corneal opacity or phthisis

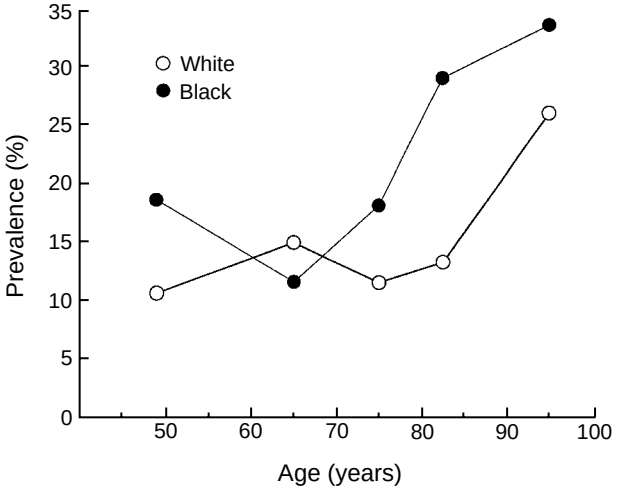

Figure 1. Prevalence of Blindness (Visual Acuity, 20/200 or Worse) According to Age and Race among Nursing Home Residents in the Baltimore Area.

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bulbi (shrinkage and disorganization of the eyeball) in 21 eyes (12.4 percent), glaucoma in 17 (10.0 percent), age-related macular degeneration in 20 (11.8 percent), diabetic retinopathy in 11 (6.4 percent), and cortical damage associated with stroke in 10 (5.9 percent).

There were differences in the distribution of causes of blindness and in the cause-specific prevalence of blindness according to race (Table 4). Cataract was the leading cause of blindness for both blacks and whites on the basis of prevalence and the proportion of the total number of blind eyes. Glaucoma, corneal opacity, diabetic retinopathy, optic atrophy, and presumed occipital-cortex infarction as a result of stroke were more prevalent among blacks, although none of these differences were statistically significant. Macular degeneration was a more frequent cause of blindness among whites.

Table 4. Distribution of Causes of Blindness among Persons Blind in Both Eyes, According to Race.

Cause	White		Black		Total	
	eyes	prevalence*	eyes	prevalence*	eyes	prevalence*
	no. (%)	*%*	*no. (%)*	*%*	*no. (%)*	*%*
Cataract	28 (35.0)	5.6	18 (20.0)	5.6	46 (27.1)	5.6
Cataract in combination with another cause†	4 (5.0)	1.1	1 (1.1)	0.5	5 (2.9)	0.8
Corneal opacity or phthisis	8 (10.0)	2.1	13 (14.4)	3.7	21 (12.4)	2.6
Glaucoma	4 (5.0)	0.7	13 (14.4)	3.3	17 (10.0)	1.8
Age-related macular degeneration	16 (20.0)	2.8	4 (4.4)	0.9	20 (11.8)	2.0
Diabetic retinopathy	2 (2.5)	0.4	9 (10.0)	2.3	11 (6.5)	1.2
Other retinal damage	2 (2.5)	0.4	4 (4.4)	1.4	6 (3.5)	0.8
Optic atrophy	0 (0)	0	6 (6.7)	1.9	6 (3.5)	0.8
Removal of the eyeball	2 (2.5)	0.7	1 (1.1)	0.5	3 (1.8)	0.6
Cortical damage after stroke	2 (2.5)	0.4	8 (8.9)	1.9	10 (5.9)	1.0
Other or unknown	12 (15.0)	2.5	13 (14.4)	3.3	25 (14.7)	2.8
Total	80 (100)		90 (100)		170 (100)	

*Prevalence denotes the proportion of nursing home residents for whom the indicated cause was a cause of blindness in one or both eyes.

†Two eyes had concurrent cataract and age-related macular degeneration, and three eyes had cataract in combination with glaucoma.

There was a strong association of cognitive function with visual acuity. The mean Mini–Mental State score was 11.4 among those with good vision (20/40 or better), as compared with 7.8 for those with visual impairment ($P<0.01$) and 4.8 for those who were bilaterally blind ($P<0.01$). Adjusting for age, sex, and race did not materially affect this association.

Discussion

Our results show that one in six nursing home residents in whom visual acuity could be measured or estimated was bilaterally blind. This rate was 13 to 15 times higher than among a community-dwelling sample of similar age from the same locale. The differences between the study participants and nonparticipants in age and in cognitive-function scores suggest that the prevalence rates we observed are biased and that the true rates were even higher. When these results are combined with population-based estimates from other studies, it is clear that nursing home residents have significantly higher rates of blindness than people living in the community and that these excess rates are not explained solely by their advanced age.

Table 3. Prevalence of Blindness among Nursing Home and Community-Dwelling Populations of East Baltimore According to Age.*

Age (yr)	White			Black		
	nursing home	community†	relative prevalence‡	nursing home	community†	relative prevalence‡
	percent			*percent*		
40–59	10.5	0.5	21.0	18.5	0.7	26.4
60–69	14.8	0.2	74.0	11.4	1.6	7.1
70–79	11.3	0.6	18.8	18.0	2.9	6.2
≥80	17.6	7.3	2.4	29.7	8.0	3.7
Total	14.0	0.9	15.6	21.0	1.6	13.1

*Blindness was defined according to the U.S. criteria.

†Community rates of blindness are from Tielsch et al.[1]

‡All comparisons between prevalence rates for community and nursing home residents were significant at the 1 percent level.

In the Beaver Dam Eye Study, a small sample of 45 nursing home residents had a blindness rate of 8.3 percent based on examination methods comparable to those used in our survey.[2] The researchers involved in the Established Populations for the Epidemiologic Studies of the Elderly used a questionnaire and measured distance visual acuity among the survivors of population-based cohorts from three communities.[19] Among the 242 subjects who resided in nursing homes at the time of the six-year follow-up, 17 percent were functionally blind, and residence in a nursing home was associated with a sixfold increase in the prevalence of blindness.[19] Woodruff and Pack reported a blindness rate of 9.7 percent from a survey of 43 nursing homes in three counties of Ontario, Canada.[20] The variation in prevalence reported in these studies is relatively small considering the potentially large differences in definitions of blindness, the techniques used to measure visual function, and the different population characteristics.

As expected, even within a group of institutionalized elderly people, the prevalence of blindness and visual impairment was strongly associated with age. The rate of blindness was more than twice as high among those 90 years of age or older as among those in their 60s. This is consistent with rates reported by other studies of nursing home populations and by studies of community-dwelling elderly subjects.[1-4,19-21] The high prevalence among members of the youngest age group (40 to 59 years of age) may reflect a greater importance of visual loss as a cause for admission to a nursing home in that age group.

Black participants were 50 percent more likely to be blind than white participants. This difference was greater after adjustment for age and sex. In spite of the well-documented difference in the amount of nursing home use between blacks and whites,[21,22] it seems un-

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likely that the observed difference in the prevalence of blindness was due to differential selection according to race for admission to nursing homes. There was a similar relative difference in the prevalence of blindness according to race in the sample of community residents from the same neighborhoods.[1,23] There was some evidence that women had higher rates of blindness than men, which is consistent with data from other studies.[19-21]

As in our previous report on the community-based sample from East Baltimore,[1] uncorrected refractive error was an important source of visual impairment in this institutionalized group. Adequate refractive correction reduced the prevalence of blindness by 20 percent and of visual impairment by 37 percent. These results may underestimate the degree of functional loss caused by refractive error because they are based on distance acuity. Adequate near vision is important for many of the activities of elderly people, and almost all people over the age of 60 need near-vision correction.

In our previous report on the causes of blindness in a community-based sample from the same population, over 40 percent of the blindness was treatable or preventable.[23] Among blacks in East Baltimore, cataract was the leading cause of blindness, indicating an inappropriately low use of cataract surgery. Our current results suggest that inadequate eye-care services may be a problem in nursing homes as well. Cataract was the leading cause of blindness for both blacks and whites, with corneal blindness second for blacks and third for whites. Even among those who had better cognitive-function scores, cataract remained the leading cause of blindness. As expected, blacks had higher rates of blindness due to glaucoma, whereas blindness caused by age-related macular degeneration was more common among whites. Although a substantial proportion of blind eyes in this population were not treatable (e.g., because of cortical blindness due to stroke), over 40 percent were treatable or preventable with appropriate intervention, the most important intervention being cataract surgery.

During the recruitment phase of this study, we interviewed all nursing home medical and nursing directors regarding the frequency of patient admission to their facilities due to serious visual impairment. None thought that patients were admitted because of a vision-related inability to care for themselves at home. Incontinence and dementia were consistently identified as the precipitating conditions associated with admission. Severe vision loss may be an unrecognized contributor to the decline in patients' cognitive function and in their ability to care for themselves, which increases the likelihood of admission to a nursing home. There was also wide variation among nursing homes in their awareness of the visual status of their patients. The high prevalence of treatable disorders suggests that policies for the testing and referral of patients need to be implemented more uniformly in these facilities.

Finally, it is clear from these data that poorer cognitive function is strongly associated with poorer visual acuity. Although we attempted to minimize the effect of subjects' cognitive status on the measurement of their visual acuity, it was impossible to eliminate this factor completely. Whether persons who have both a treatable loss of vision and cognitive impairment should receive ophthalmologic intervention will depend on the cause and severity of the cognitive deficit. Few data are available in the literature to guide a physician's choice of clinical management strategies in this situation. For patients with mild-to-moderate dementia, restoration of vision may improve their quality of life and reduce the intensity of nursing care required. The relative risks and benefits of such interventions need to be evaluated objectively.

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