DISTANCE VISUAL ACUITY IMPAIRMENT AND SURVIVAL IN AFRICAN AMERICANS AND NON-HISPANIC WHITES

David J. Lee, PhD; Orlando Gómez-Marín, PhD; Fangchao Ma, MD; Byron L. Lam, MD

Background: Regional studies conducted in the United States have shown associations between visual impairment and shorter survival in non-Hispanic Whites.

Objective: To examine associations between visual impairment and mortality in a nationally representative sample of African Americans and non-Hispanic Whites residing in the United States.

Design: Mortality linkage with participants from the 1974–1975 National Health and Nutrition Examination Augmentation Survey was performed by the National Center for Health Statistics in 1992.

Subjects: Complete data were available on 245 African Americans and 2571 non-Hispanic Whites.

Methods: Uncorrected binocular distance visual acuity was assessed using Sloan letter charts. Usual-corrected visual acuity was then obtained with participants wearing glasses or contact lenses, if any. Analytical methods included Cox regression models with adjustment for sample weights and design effects as well as age, gender, smoking status, and self-rated health.

Results: Multivariate survival analyses found a significant interaction between race and visual impairment status; consequently, race-specific analyses were performed. There were no significant associations between uncorrected binocular visual acuity impairment (20/50 or worse) and all-cause mortality or cancer mortality. There was no significant association between impaired uncorrected acuity and cardiovascular disease mortality in African Americans (Hazard Ratio=0.67, 95% CI: 0.35–1.26), but this association was significant in non-Hispanic Whites (Hazard Ratio=1.21, 95% CI: 1.01–1.45). In multivariate models, within race groups, impaired usual-corrected visual acuity was not associated with an increased risk of all-cause mortality or mortality due to cancer or cardiovascular disease.

Conclusions: Uncorrected and usual-corrected binocular distance visual impairment is not associated with all-cause mortality or cancer mortality. Cardiovascular disease mortality risk may be slightly higher in non-Hispanic Whites with uncorrected visual acuity impairment. (*Ethn Dis.* 2003;13:485–491)

Key Words: Visual Acuity, Mortality, Neoplasms, Cardiovascular Diseases, Adult, Middle-Aged, Aged, Blacks, Non-Hispanic Whites

From the Department of Epidemiology and Public Health (DJL, OG, FM), Department of Obstetrics and Gynecology (OG), Department of Ophthalmology (BL), University of Miami School of Medicine, Miami, Florida.

Address correspondence and reprint requests to David J. Lee, PhD; Department of Epidemiology and Public Health; University of Miami School of Medicine; P.O. Box 016069 (R-699); Miami, FL 33101; 305-243-6980; 305-243-3384 (fax); dlee@med.miami.edu

INTRODUCTION

In several regional surveys conducted in the United States, associations between some eye diseases, impaired visual acuity, and an increased risk of mortality have been reported.[1–7] These regional studies were completed among patients with diabetes,[1,4,7] were comprised exclusively of non-Hispanic White participants,[1–3,5,7] or did not report analyses stratified by race or ethnicity.[6] Furthermore, an analysis of visual impairment and survival rates has never been completed in a nationally representative sample of non-Hispanic Whites and Blacks residing in the United States. The purpose of this study was to examine the association of uncorrected binocular distance visual acuity impairment and survival in adults age 25 years and older using data from the 1974–1975 National Health and Nutrition Examination Augmentation Survey I (NHANES I Augmentation Survey).

METHODS

Study Population and Design

The NHANES I Augmentation Survey was conducted by the National Center for Health Statistics in 1974–1975. A complex sample survey design was used to obtain a nationally representative sample of the civilian non-institutionalized population of the continental United States. Informed consent was obtained from all participants.[8,9]

Data collection took place in 2 phases. First, participants were administered a household interview. Next, participants who completed the household interview were scheduled to receive a comprehensive physical examination at centrally located examination trailers where visual acuity was tested. Overall rates for completing the household interview and the physical examination were 75% for African Americans and 70% for non-Hispanic Whites.

Race was classified by the interviewer as "White," "Black," or "other" and participants were asked to identify their country of origin. Those classified as "other," as well as those who self-identified as being of Hispanic origin, were excluded from the present analyses. After these exclusions, visual acuity data were available on 245 African Americans and 2571 non-Hispanic Whites

An analysis of visual impairment and survival rates has never been completed in a nationally representative sample of non-Hispanic Whites and Blacks residing in the United States.

who were 25 years of age and older at the time of the survey.

Measurement and Definition of Visual Impairment

Two Sloan letter charts, presented at a distance of 20 feet from participants, were used to assess binocular distance acuity.[10] Participants wearing corrective lenses were instructed to remove them prior to testing, and those who brought glasses or contact lenses to the examination were re-tested while wearing their corrective lenses.

Direct and background lighting was carefully controlled in the examination trailers where visual acuity testing took place. Overall, binocular impairment was defined as 20/50 or worse. Visual acuity below this level represents minimal impairment and the binocular visual acuity criteria for obtaining a passenger car driver's license is generally 20/40 or better in the United States.[11] Results from the data, for subjects tested while wearing corrective lenses, were used to categorize an individual's usual-corrected visual impairment status. Uncorrected results were used to categorize subjects who forgot to bring their eyewear to the examination or who reported that they did not wear corrective lenses.

Mortality

Participants were tracked in 1982–1984, 1986, 1987, and in 1992 using a combination of methods: 1) last known telephone number and address; 2) proxy interviews with relatives; 3) hospital and nursing home records; 4) death certificates retrieved through state vital statistics offices; 5) linkage with national telephone listings; 6) the Health Care Financing Administration enrollment file; and 7) the National Death Index.[12] Information on an individual's survival status and cause-of-death was available for 89% of the participants who underwent vision testing during 1974–1975. Underlying cause-of-death was coded using the International Classification of Diseases Ninth Revision (ICD-9).[13] Cause-specific mortality analyses were limited to cancer (ICD-9: 140–208) and cardiovascular disease (CVD, ICD-9: 390–448), since inadequate numbers of deaths due to other causes of interest (eg, diabetes, injuries) prevented classification as a cause-specific mortality.

Analysis

Due to the complex sample survey design, all analyses were completed using the Software for the Statistical Analysis of Correlated Data (SUDAAN) package to take into account sample weights and design effects.[14] Cox regression analyses were performed using the Proc Survival program in SUDAAN.

RESULTS

A total of 56 African-American and 504 non-Hispanic White deaths were noted. The corresponding numbers for CVD were 24 and 243, respectively; and deaths due to cancer were 13 and 135, respectively. Prior to multivariate modeling, interactions between visual impairment and each of the covariates were examined in hazard models for all cause mortality, cardiovascular disease mortality, and cancer mortality. These models contained visual impairment and covariates, plus an interaction term for visual impairment and the covariate of interest. Evidence of an interaction between race and uncorrected visual impairment for CVD mortality (P=.08) was observed. Figure 1 depicts the interaction between race and impaired uncorrected visual acuity. Mortality rates were similar for African Americans with and without impaired visual acuity while mortality rates for non-Hispanic Whites with impaired visual acuity were approximately twice as high relative to non-Hispanic Whites without impaired visual acuity. Because of this interaction, all analyses were conducted separately for African Americans and for non-Hispanic Whites.

Table 1 presents the race-specific distributions by survival status and availability of study participants with complete data on each of the following var-

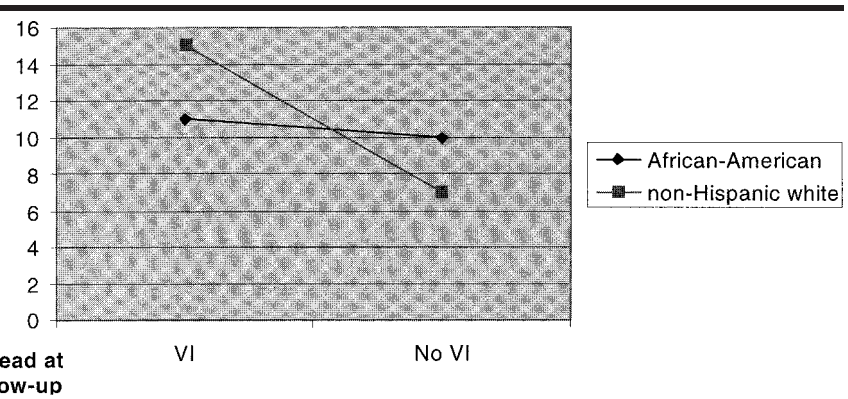

Fig 1. Race-specific cardiovascular mortality among participants with and without uncorrected visual acuity impairment

Table 1. Sociodemographic characteristics, smoking status, self-rated health, and visual acuity impairment (20/50 or worse) by follow-up status: The National Health and Nutrition Examination I Augmentation Survey

	African American			Non-Hispanic White		
	Survival Status Available (*N*=205) *N* (%)	Survival Status Unavailable (*N*=40) *N* (%)	Total (*N*=245) *N* (%)	Survival Status Available (*N*=2301) *N* (%)	Survival Status Unavailable (*N*=270) *N* (%)	Total (*N*=2571) *N* (%)
Age						
25–39	66 (32.2*)	22 (55.0)	88 (35.9)	797 (34.6*)	146 (54.1)	943 (36.7)
40–59	89 (43.3)	15 (37.5)	104 (42.5)	986 (42.9)	98 (36.3)	1084 (42.2)
60–74	50 (24.4)	3 (7.5)	53 (21.6)	518 (22.5)	26 (9.6)	544 (21.1)
Sex						
Male	88 (42.9)	21 (52.5)	109 (44.5)	1017 (44.2*)	98 (36.3)	1115 (43.4)
Female	117 (57.1)	19 (47.5)	136 (55.5)	1284 (55.8)	172 (63.7)	1456 (56.6)
Education						
≤11th grade	105 (51.2)	22 (55.0)	127 (51.8)	714 (31.0)	88 (32.6)	802 (31.2)
12th grade	60 (29.3)	12 (30.0)	72 (29.4)	856 (37.2)	104 (38.5)	960 (37.3)
>12th grade	40 (19.5)	6 (15.0)	46 (18.8)	731 (31.8)	78 (28.9)	809 (31.5)
Smoking*						
Never smoker	78 (38.1)	13 (32.5)	91 (37.1)	908 (39.5*)	90 (33.3)	998 (38.8)
Former smoker	26 (12.7)	2 (5.0)	28 (11.4)	564 (24.5)	44 (16.3)	608 (23.7)
Current smoker	101 (49.2)	25 (62.5)	126 (51.5)	829 (36.0)	136 (50.4)	965 (37.5)
Self-rated health						
Fair or better	139 (67.8)	27 (67.5)	166 (67.8)	1880 (81.7)	223 (82.6)	2103 (81.8)
Poor	66 (32.2)	13 (32.5)	79 (32.2)	420 (18.3)	47 (17.4)	467 (18.2)
Uncorrected visual impairment						
Yes	50 (24.4)	6 (15.0)	56 (22.9)	749 (32.5)	79 (29.3)	828 (32.2)
No	155 (75.6)	34 (85.0)	189 (77.1)	1552 (67.5)	191 (70.7)	1743 (67.8)
Usual corrected visual impairment						
Yes	16 (7.8)	2 (5.0)	18 (7.4)	96 (4.2)	9 (3.3)	105 (4.1)
No	189 (92.2)	38 (95.0)	227 (92.6)	2205 (95.8)	261 (96.7)	2466 (95.9)

Note: Chi-square values comparing those with available vs unavailable vital status: * $P<.05$.

iables: sociodemographic characteristics, self-rated health, smoking status, and visual impairment status. African-American and non-Hispanic White participants with unknown survival status were significantly more likely to be younger than participants with complete follow-up information. Among non-Hispanic Whites both female participants and participants who smoked were more likely to be lost during follow-up. There were no significant differences in rates of either uncorrected or usual-corrected visual impairment between those lost during follow-up and those included in the survival analyses among African Americans and non-Hispanic Whites.

Table 2 presents the race-specific distribution of age, gender, educational status, smoking status, self-rated health, and visual impairment categorized by race and survival status in 1992. Older age, male gender, lower educational attainment, poor self-rated health, uncorrected and usual-corrected visual impairment were factors associated with a decreased risk of survival among African Americans and non-Hispanic Whites. There was no association between survival status and smoking status among African Americans.

Controlling only for the complex sample survey design, hazard ratios (HRs) provided in Table 3 indicate a significant association between impaired uncorrected visual acuity and decreased survival in non-Hispanic Whites (HR: 1.83; 95% CI: [1.45, 2.31]), but not in African Americans (HR: 1.40; [0.63–3.11]). Controlling simultaneously for age, gender, smoking status and self-rated health, lowered hazard ratio estimates in both ethnic groups. After controlling for these risk factors, there was also no association between uncorrected visual impairment and risk of death due to cancer in either African Americans (1.67; [0.61–4.55]), or in non-Hispanic Whites (HR: 1.20; [0.75–1.94]). In African Americans (HR: 0.67; [0.35–1.26), there was no association between impaired uncorrected visual acuity and cardiovascular disease mortality; however, this association was significant in non-Hispanic Whites (HR: 1.21; [1.01–1.45]).

After controlling for sample design

Table 2. Sociodemographic characteristics, smoking status, self-rated health, and visual acuity impairment (20/50 or worse) by race and survival status: The National Health and Nutrition Examination I Augmentation Survey

	African American		Non-Hispanic White	
	Deceased (*N*=56) *N* (%)	Alive (*N*=149) *N* (%)	Deceased (*N*=504) *N* (%)	Alive (*N*=1797) *N* (%)
Age*				
25–39	4 (6.1)	62 (93.9)	21 (2.6)	776 (97.4)
40–59	25 (28.1)	64 (71.9)	179 (18.2)	807 (81.9)
60–74	27 (54.0)	23 (46.0)	304 (58.7)	214 (41.3)
Sex*				
Male	31 (35.2)	57 (64.8)	288 (28.3)	729 (71.7)
Female	25 (21.4)	92 (78.6)	216 (16.8)	1068 (83.2)
Education*				
≤11th grade	43 (40.9)	62 (59.1)	259 (36.3)	455 (63.7)
12th grade	7 (11.7)	53 (88.3)	137 (16.0)	719 (84.0)
Above 12th grade	6 (15.0)	34 (85.0)	108 (14.8)	623 (85.2)
Smoking†				
Never smoker	20 (26.6)	58 (74.4)	151 (16.6)	757 (83.4)
Former smoker	8 (30.8)	18 (69.2)	154 (27.3)	410 (72.7)
Current smoker	28 (27.7)	73 (72.3)	199 (24.0)	630 (76.0)
Self-rated health*				
Fair or better	24 (17.3)	115 (82.7)	318 (16.9)	1562 (83.1)
Poor	32 (48.5)	34 (51.5)	185 (44.1)	235 (55.9)
Uncorrected visual impairment*				
Yes	17 (34.0)	33 (66.0)	231 (30.8)	518 (69.2)
No	39 (25.2)	116 (74.8)	273 (17.6)	1279 (82.4)
Usual corrected visual impairment*				
Yes	8 (50.0)	8 (50.0)	35 (36.5)	61 (63.5)
No	48 (25.4)	141 (74.6)	469 (21.3)	1736 (78.7)

* Race-specific chi-square values comparing vital status are significant at the $P<.001$ level.
† Chi-square significant at the $P<.001$ level for non-Hispanic Whites only.

only, HRs provided in Table 4 indicate a significant association between usual-corrected visual acuity impairment and survival in non-Hispanic Whites (HR: 1.83; [1.32–2.55]); the estimate of the hazard ratio for African Americans was also elevated, but the corresponding 95% CI included one (HR:2.35; [0.87–6.29]). Further, controlling simultaneously for age, gender, smoking status, and self-rated health, lowered hazard ratio estimates for both non-Hispanic Whites (HR: 1.21; [0.80–1.84]) and African Americans (HR: 1.75; [0.66–4.64]). Multivariate-adjusted hazard ratios for cancer mortality were slightly elevated in non-Hispanic Whites and African Americans, but both 95% CIs included one (HR: 1.35; [0.44–4.11]; 1.43 [0.11–17.86]). Finally, estimates of adjusted hazard ratios for cardiovascular disease were slightly elevated in non-Hispanic Whites, but not in African Americans; these multivariate point estimates were not statistically significant.

DISCUSSION

In contrast to most studies conducted in the United States,[1,3,7] Europe,[15,16] and Australia,[17,18] we found little evidence to support the hypothesis that uncorrected and usual-corrected binocular distance visual acuity impairment is associated with mortality risk in African Americans or in non-Hispanic Whites. After controlling for age and gender, visually impaired non-Hispanic Whites had only a slightly higher risk of mortality relative to their counterparts without uncorrected visual impairment (HR=1.16; 95% CI [1.02–1.33]). In the Beaver Dam Eye Study, visual impairment greater than 20/40 was significantly associated with mortality (HR=1.57; 95% CI [1.18–2.08]) after controlling for the same risk factors.[3] In the Blue Mountains Eye Study, visual impairment (>20/40) remained a significant predictor of mortality after multivariate control for age, gender, self-rated health, smoking status, selected chronic conditions, body mass index, and alcohol intake (HR=1.7; 95% CI [1.2–2.3]).[18]

Comparison of findings from the Beaver Dam Eye and the Blue Mountains Eye Study with the present results is limited by differences in follow-up periods and the age distributions of the cohorts. Additionally, one important difference in visual acuity assessment between these surveys was that uncorrected and usual-corrected visual acuity was assessed in the NHANES I while the Beaver Dam Eye Study and the Blue Mountains Eye Study assessed best-corrected visual acuity. Uncorrected visual acuity captures elements of any impairment due to underlying eye disease as well as impairment due to refractive error. On the other hand, usual-corrected (ie, presenting) visual acuity captures these elements, as well as access to ophthalmic care and the willingness to wear corrective lenses. In contrast, best-corrected visual acuity assessment generally eliminates the contribution that refractive error makes toward poor visual acuity. Utilizing best-corrected visual acuity may, therefore, better capture the impact of eye diseases such as retinopathy, glaucoma, and cataract, which have been shown to be associated with reduced survival in population-based studies conducted in the United States and elsewhere.[1,2,4,6,7,18–21]

Table 3. Hazard ratios of death for participants with versus those without uncorrected visual impairment (20/50 or worse) in African Americans and non-Hispanic Whites: The National Health and Nutrition Examination I Augmentation Survey

Cause of death analysis adjusting for:	African American		Non-Hispanic White	
	Hazard Ratio	95% CI	Hazard Ratio	95% CI
All causes				
Sample study design only	1.40	0.63–3.11	1.83	1.45–2.31
Sample study design plus:				
Age & gender	0.89	0.48–1.66	1.16	1.02–1.33
Age & gender & self-rated health & smoking	0.96	0.62–1.47	1.14	0.95–1.37
Cancer (ICD: 140–208)				
Sample study design only	1.83	0.34–9.72	1.78	1.13–2.81
Sample study design plus:				
Age & gender	1.47	0.33–6.54	1.19	0.76–1.87
Age & gender & self-rated health & smoking	1.67	0.61–4.55	1.20	0.75–1.94
Cardiovascular disease (ICD: 390–448)				
Sample study design only	1.00	0.36–2.78	2.08	1.65–2.61
Sample study design plus:				
Age & gender	0.62	0.32–1.19	1.23	1.05–1.45
Age & gender & self-rated health & smoking	0.67	0.35–1.26	1.21	1.01–1.45

Table 4. Hazard ratios of death for participants with versus those without usual-corrected visual impairment (20/50 or worse) in African Americans and non-Hispanic Whites: The National Health and Nutrition Examination I Augmentation Survey

Cause of death analysis adjusting for:	African American		Non-Hispanic White	
	Hazard Ratio	95% CI	Hazard Ratio	95% CI
All causes				
Sample study design only	2.35	0.87–6.29	1.83	1.32–2.55
Sample study design plus:				
Age & gender	1.54	0.55–4.32	1.18	0.83–1.68
Age & gender & self-rated health & smoking	1.75	0.66–4.64	1.21	0.80–1.84
Cancer (ICD: 140–208)				
Sample study design only	1.67	0.21–13.45	1.87	0.68–5.12
Sample study design plus:				
Age & gender	1.10	0.12–9.80	1.26	0.45–3.51
Age & gender & self-rated health & smoking	1.43	0.11–17.86	1.35	0.44–4.11
Cardiovascular disease (ICD: 390–448)				
Sample study design only	1.28	0.23–7.22	2.08	1.33–3.27
Sample study design plus:				
Age & gender	0.86	0.12–5.97	1.28	0.75–2.20
Age & gender & self-rated health & smoking	0.84	0.17–4.02	1.32	0.74–2.38

. . . we found little evidence to support the hypothesis that uncorrected and usual-corrected binocular distance visual acuity impairment is associated with mortality risk in African Americans or in non-Hispanic Whites.

Results from the Blue Mountains Eye Study provide only limited support for the notion that the use of best-corrected distance visual acuity impairment leads to results in stronger associations with survival status than the use of usual-corrected impairment measures. As indicated above, best-corrected visual impairment was significantly associated with mortality (HR=1.7; 95% CI: [1.2–2.3]); however, analysis using usual-corrected visual acuity resulted in a slightly lower, but statistically significant mortality risk estimate (HR=1.5; 95% CI: [1.2–1.9]). Since this is the only mortality study to present risk estimates using both visual impairment assessment approaches, it is recommended that future investigators also complete mortality analyses using both methods. Having additional information on the predictive value of usual-corrected visual acuity will be useful for gerontologists and other investigators who wish to use a visual assessment protocol, but cannot bring participants into a clinic for testing.

We repeated our analyses using a definition of impairment of 20/80 or worse to determine if a more severe form of impairment would be a stronger predictor of mortality. These results are not reported since associations between visual impairment and survival did not change appreciably from those reported

in Tables 3 and 4. The relatively few NHANES I Augmentation Survey participants with more severe visual impairment limited this latter analysis. For example, only 7% of African-American participants and 14% of non-Hispanic White participants had an uncorrected visual acuity of 20/100 or worse.[22] Other studies reported increased mortality risk when examining more severe vs less severe levels of impairment.[1,3,7]

It is unclear if eye disease and visual impairment are independent predictors of reduced survival or if these conditions serve as a proxy for poor health.[19] Self-rated health, which is itself a predictor of reduced survival,[23] was included in the present multivariate statistical models to address this concern. The addition of self-rated health, including smoking status, did little to reduce associations between visual impairment and mortality beyond adjustment for age and gender (Tables 3 and 4).

This is the first population-based report examining associations between visual impairment and mortality in African Americans. Assessment of potential interactions identified a significant interaction between race and uncorrected visual impairment when examining cardiovascular disease mortality. This interaction is evident upon inspection of Table 3. After control for all co-variates, there was a slight, but significant increased risk of CVD mortality in non-Hispanic Whites, while for African Americans there was a lower, but statistically non-significant reduction in CVD risk among African Americans. The reasons for this finding are unclear. Notably, African Americans are at increased risk of CVD relative to non-Hispanic Whites. Additionally, the prevalence of risk factors for CVD differs between African Americans and non-Hispanic Whites.[24] Responses to the treatment of CVD and CVD risk factors also vary in these 2 groups.[25,26] Finally, the macro-level influences of racism[27,28] and race-specific variations in cardiovascular care[29,30] may also explain, perhaps in part, this CVD mortality differential. Given these factors it is reasonable to hypothesize that visual impairment is not an important risk factor for CVD mortality in African Americans.

Additional research into the association between visual impairment and mortality in African Americans is needed, given the small number of African Americans included in the present analysis and the resulting low statistical power. For example, for all-cause mortality, at the 5% level, the statistical power is only 24% for uncorrected visual impairment and 56% for usual corrected visual impairment. There was some evidence of an increased risk of cancer mortality among visually impaired African Americans but not among non-Hispanic Whites; however, these analyses for African Americans were based on only 13 cancer deaths and all 95% CI included one.

In the Framingham Eye study, after controlling for age and gender, participants with diabetes who had lens changes indicative of cataracts (eg, opacities, aphakia) were 4 times more likely to die of cancer compared to participants with diabetes who did not have similar lens changes.[5] However, no association between lens changes and cancer mortality risk was reported for participants without diabetes in the study. In the Salisbury Eye Evaluation Project,[6] the presence of mixed nuclear opacities was also associated with cancer mortality, even after controlling for age, gender, smoking status, body mass index, and comorbid conditions (OR 2.85; 95% CI [1.14–7.01]). It is unclear what biological mechanism could explain a possible association between eye disease, visual impairment, and cancer mortality risk. Nevertheless, additional studies with sufficient statistical power are needed to determine if there is a relationship between eye conditions and cancer mortality risk and whether the strength of this association is stronger in African Americans than in non-Hispanic Whites.

Finally, results could be biased due to loss during follow-up. Participants with unavailable survival status were significantly more likely to be younger, female and to report being a smoker at baseline relative to participants with available survival status. The percentage of participants with visual impairment, however, did not differ significantly between those with vs those without available information on survival status. In addition the percentage of participants who were lost during follow-up was modest for African Americans (16.3%) and for non-Hispanic Whites (10.5%). Nevertheless we conducted a sensitivity analysis by calculating HRs for African Americans and non-Hispanic Whites assuming first that all those lost during follow-up were deceased and then assuming all those lost during follow-up were alive. These HRs were similar to the HRs for survival presented in Table 4. For example, the HR for African Americans controlling for all covariates was 0.96 (0.62–1.47); assuming that participants lost during follow-up were deceased and then assuming participants were living led to HRs of 0.88 (0.45–1.76) and 0.90 (0.40–2.01), respectively.

To summarize, after controlling for survey design effects plus age, gender, smoking status, and self-rated health, there was no association between uncorrected and usual-corrected binocular distance visual acuity impairment and survival in African Americans and non-Hispanic Whites. There is a slight, statistically significant, increased risk of CVD mortality in visually impaired vs non-impaired non-Hispanic Whites.

ACKNOWLEDGMENTS

Supported by grant 1 R29 AG12444 from the National Institute on Aging.

REFERENCES

1. Klein R, Klein BE, Moss SE, Cruickshanks KJ. Association of ocular disease and mortality in a diabetic population. *Arch Ophthalmol.* 1999;117:1487–1495.
2. Hiller R, Podgor MJ, Sperduto RD, et al.

High intraocular pressure and survival: The Framingham Studies. *Am J Ophthalmol.* 1999;128:440–445.
3. Klein R, Klein BE, Moss SE. Age-related eye disease and survival: The Beaver Dam Eye Study. *Arch Ophthalmol.* 1995;113:333–339.
4. Hanis CL, Chu H, Lawson K, et al. Mortality of Mexican Americans with NIDDM. *Diabetes Care.* 1993;16:82–89.
5. Podgor MY, Cassel GH, Kannel WB. Lens changes and survival in a population-based study. *N Engl J Med.* 1985;313:1438–1444.
6. West SK, Muñoz B, Istre J, et al. Mixed lens opacities and subsequent mortality. *Arch Ophthalmol.* 2000;118:393–397.
7. Klein R, Moss SE, Klein BEK, DeMets DL. Relation of ocular and systemic factors to survival in diabetes. *Arch Intern Med.* 1989;149: 266–272.
8. National Center for Health Statistics. Plan and operation of the NHANES I Augmentation Survey of Adults 25–74 Years: United States, 1974–1975. *Vital Health Stat 1.* 1978; 14. DHEW Publication No. (PHS) 78-1314.
9. Plan and operation of the NHANES I Epidemiologic Followup Study 1986. *Vital Health Stat 1.* 1987;22. DHHS Publication No. (PHS) 87-1324.
10. National Center for Health Statistics. *Instruction Manual, Part 15c: Examination Staff Procedures Manual for the Health Examination Survey, 1974–1975.* Washington, DC: Public Health Service.
11. American Academy of Ophthalmology. Eye Net issue briefs—driver's license requirements. Available at: http://www.eyenet.org/member/comm/issue_briefs/license.html. Accessed October 17, 2000.
12. Cox CS, Mussolino ME, Rothwell ST, et al. Plan and operation of the NHANES I Epidemiologic Followup Study 1992. National Center for Health Statistics. *Vital Health Stat.* 1997;1(35):1–231.
13. World Health Organization. *International Classification of Diseases.* 9th rev. Geneva: World Health Organization; 1978.
14. Research Triangle Institute. *Software for Survey Data Analysis (SUDAAN) Version 5.30.* Research Triangle Park, NC: Research Triangle Institute; 1991.
15. Thompson JR, Gibson JM, Jagger C. The association between visual impairment and mortality in elderly people. *Age Aging.* 1989; 18:83–89.
16. Appollonio I, Carabellese C, Magni E, Frattola L, Trabucchi M. Sensory impairments and mortality in an elderly community population. A six year follow-up study. *Age Aging.* 1995;24:30–36.
17. McCarty CA, Nanjan MB, Taylor HR. Vision impairment predicts 5 year mortality. *Br J Ophthalmol.* 2001;85:322–326.
18. Wang JJ, Mitchell P, Simpson JM, Cumming RG, Smith W. Visual impairment, age-related cataract, and mortality. *Arch Ophthalmol.* 2001;119:1186–1190.
19. Thompson JR, Sparrow JM, Gibson JM, Rosenthal AR. Cataract and survival in an elderly nondiabetic population. *Arch Ophthalmol.* 1993;111:675–679.
20. Cohen DL, Neil HAW, Sparrow J, Thorogood M, Mann JI. Lens opacity and mortality in diabetes. *Diabet Med.* 1997;7:615–617.
21. Schouten EG, Vandenbroucke JP, Van Der Heide-Wessel C, Van Der Heide RM. Retinopathy as an independent indicator of all-cause mortality. *Int J Epidemiol.* 1986;15: 234–236.
22. Lee DJ, Gomez-Marin O, Lam BL. Prevalence of uncorrected binocular distance visual acuity in Hispanic and non-Hispanic adults: results from the HHANES and the NHANES I. *Ophthalmology.* 1998;105:552–560.
23. Idler EL, Benyamini Y. Self-rated health and mortality: a review of twenty-seven community studies. *J Health Soc Behav.* 1997;38:21–37.
24. James SA. Primordial prevention of cardiovascular disease among African Americans: a social epidemiological perspective. *Prev Med.* 1999;29:S84–S89.
25. Cushman WC, Reda DJ, Perry HM, et al. Regional and racial differences in response to antihypertensive medication use in a randomized controlled trial of men with hypertension in the United States. *Arch Intern Med.* 2000; 160:825–831.
26. Cubeddu LX, Aranda J, Singh B, et al. A Comparison of verapamil and propranolol for the initial treatment of hypertension. Racial differences in response. *JAMA.* 1986;256: 2214–2221.
27. Clark VR. The perilous effect of racism of Blacks. *Ethn Dis.* 2001;11:769–772.
28. Williams DR. Race, socioeconomic status, and health. The added effects of racism and discrimination. *Ann N Y Acad Sci.* 1999;896: 173–188.
29. Ayanian JZ, Udvarhelyi IS, Gatsonis CA, Pashos CL, Epstein AM. Racial differences in the use of revascularization procedures after coronary angiography. *JAMA.* 1993;269: 2642–2646.
30. Weitzman S, Cooper L, Chambless L, et al. Gender, racial, and geographic differences in the performance of cardiac diagnostic and therapeutic procedures for hospitalized acute myocardial infarction in four states. *Am J Cardiol.* 1997;79:722–726.

AUTHOR CONTRIBUTIONS

Design and concept of study: Lee, Gomez-Marin, Ma, Lam

Data analysis and interpretation: Gomez-Marin, Lee, Lam, Ma

Manuscript draft: Lee, Gomez-Marin, Ma, Lam

Statistical expertise: Gomez-Marin

Acquisition of funding: Lee, Gomez-Marin, Lam