Ophthalmic Epidemiology, 18(2), 54–60, 2011

ISSN: 0928-6586 print/ 1744-5086 online
DOI: 10.3109/09286586.2010.545503

informa
healthcare

ORIGINAL ARTICLE

Visual Impairment and Mortality in a Rural Adult Population (The Southern Harbin Eye Study)

Zhijian Li[1,2], Dianjun Sun[2], Ping Liu[1], Liqiong Zhang[1], Jie Bai[1], and Hao Cui[1]

[1]*Department of Ophthalmology, First Affiliated Hospital, Harbin Medical University, Harbin, China*

[2]*The Center for Endemic Disease Control, Chinese Center for Disease Control and Prevention, Harbin Medical University, Harbin,China*

ABSTRACT

Purpose: To evaluate the association between visual acuity (VA) and 4-year mortality in an older population-based cohort.

Methods: Five thousand and fifty-seven persons aged 50 to 96 years (91.0% of the eligible population) residents of the Southern Harbin, Heilongjiang Provence, China participated in the study. At baseline (2006), the main ocular diseases were diagnosed from a basic ocular examination including presenting and best-corrected VA. Of the 5,057 participants in the baseline survey, those who died after the study were identified and the death certificate was checked. The physicians in charge of the health of the village population were asked for the presumed cause of death. The rate of death was determined in the follow-up survey in 2010. We evaluated the association of visual impairment (VI) and mortality using multiple logistic regression.

Results: Between the baseline examination and the censoring cutpoint study, a total of 214 subjects (4.2%) were dead. Females with VI were less likely to have died relative to male gender with VI ($P < 0.05$). Compared with participants who reported better presenting VA (VA ≥ 20/60), the risk of mortality was significantly higher for those reporting moderate VI (20/400 ≤ VA < 20/60) (Odds Ratio [OR], 2.1; 95% confidence interval [CI],1–4.1) and those reporting severe VI (VA < 20/400) (OR,3.6; 95% CI, 2.0–6.6). Similar associations were obtained for best-corrected VA in the better eye (OR, 3.1; 95% CI: 1.5–6.4 and 3.9; 95%CI: 2.1–7.2, respectively).

Conclusion: In this Chinese population-based cohort we found that visual impairment predicted a significantly elevated mortality.

KEYWORDS: Visual acuity;Visual impairment; Mortality; Population-based; Follow-up

INTRODUCTION

Previous studies have consistently shown an association between visual acuity (VA) and increased mortality in older population.[1–4] Because higher age is the major risk factor for mortality, the major age-related ocular diseases such as cataract, glaucoma, and macular degeneration, also are related to increased mortality if, in a univariate analysis, age and other confounding factors are not taken into account.[5–10] In the Beijing Eye Study, a population-based cohort survey showed that subcapsular posterior cataract predicted a significantly elevated mortality.[11] Data collected in the National Health Interview Survey from 1986 through 1994 documented an approximate 50% increased risk of all-cause and cardiovascular mortality among patients with glaucoma.[12] In contrast, more recent population-based studies did not find

Received 09 July 2010; revised 07 September 2010; accepted 26 October 2010

Correspondence: Hao Cui, Department of Ophthalmology, First Affiliated Hospital, Harbin Medical University, Harbin, China. E-mail: hydcuihao@126.com

any association between glaucoma and mortality after follow-up periods of either 5 or 10 years.[13,14] Retinal vein occlusions, and visual impairment (VI) may have increased mortality.[15–17]

Nevertheless, most of the studies were focused only on an individual disease. We aimed to assess the multivariate relationships between mortality and the visual impairment in a population-based investigation of adults aged 50 to 96 years at baseline residing in China. The study was conducted in rural population where the lifestyle and environment may be different. This area was selected for study to represent the typical environmental region. This area is characterized by a cold weather (average 4.5°C yearly), lower elevation (around 200 meters), farming communities, and plains. This study provides vital epidemiological data on the relationship between visual impairment and mortality in this environment.

PATIENTS AND METHODS

The Southern Harbin Eye Study (SHES) surveyed vision and eye disease in population aged 50 to 96 years from a rural area south of Harbin, China. Sampling design and participant eligibility criteria and methods used to conduct the study have been previously described.[10,18,19] Briefly, a county was selected to be the survey location, with approximately 640,000 people living in rural areas in 2005. The investigation followed the tenets of the Declaration of Helsinki and the approval of the Health Department, Heilongjiang Province, China, was obtained. Verbal consent from subjects was obtained before examination with the nature of the examination and participant rights explained by the registrars. People with an eye complaint were referred to the county hospital for treatment.

Baseline survey methods

The designated ophthalmologists provided training to the epidemic prevention doctors at individual Xiang clinics. Upon training, these Xiang doctors went to every household in the selected village, recording everyone 50 years old and over, obtaining basic information, including age, gender, home ownership, and self-rated health. Participants were asked whether they had hypertension, diabetes, a heart attack, angina, stroke, or cancer history. Hypertension was defined as a self-reported history of physician diagnosis or subjects who were receiving drug treatment for hypertension. Diabetes was diagnosed from history or from an elevated fasting venous blood glucose of 7.0mmol/L (140mg%) or more. Detailed histories of current smoking and alcohol consumption also were recorded.

Baseline eye examination and diagnosis of the main ocular diseases

At the time of the first survey in 2006, 21 clusters were randomly selected units. The selected clusters ranged in population from 756 to 1,452, with an estimated 2005 census population of 23,025. Within the 21 clusters selected for this study, a total of 5,057 individuals aged 50 years and above underwent VA testing and a basic eye examination out of 5,559 enumerated people resulting in an overall response rate of 91.0%. We could not examine 502 of the enumerated people, including 325 people who were temporarily unavailable despite repeated visits on the day of examination and 177 people who refused to participate. Non-participation and participation did not differ with regard to age ($P > 0.05$) or education ($P > 0.05$),but a greater proportion of females (52.9%) among participants compared with non-participants (33.6%) ($P < 0.001$).

The clinical eye examinations were conducted by two different teams, consisting of seven ophthalmologists each. Those physically unable to attend the examination site were offered the ocular examination at home.

A logarithmic visual acuity chart (Precision Vision, LaSalle, IL, USA) was used to measure VA. Visual acuity was measured for each eye. The smallest line read with one or no errors at 4 m using 5 tumbling-E letters in each row was recorded. If no letters from the chart could be identified, VA was determined by counting fingers, hand movements, light perception, or no light perception. Refraction error was measured using an auto refractometer (Topcon Corporation, Model RM-8000B, Tokyo, Japan), and the appropriate spectacle correction used in determining VA. All subjects received a basic ocular examination including external appearance of the eye, examination of the anterior chamber and lens with a slit-lamp biomicroscope, and examination of the fundus by direct ophthalmoscopy.

Blindness (severe VI) was defined as presenting VA worse than 20/400. Moderate visual impairment was defined as presenting VA worse than 20/60 but equal to or better than 20/400. Unilateral visual impairment was defined as visual impairment in one eye but 20/60 or better in the other eye.

Cataract blindness was defined as the sum of both unoperated and operated cataract blind individuals. Because it is not possible to retrospectively determine the preoperative status of a patient with cataract, the following guideline was obeyed: For those operated

on in both eyes, it was assumed that the individual was an abilaterally cataract blind patient, whereas unilaterally operated on patients were assumed to have been bilaterally blind at the time of surgery only if the unoperated on fellow eye was currently blind. VA < 20/400 was used as the definition of blindness in the cataract blindness burden analyses.

In the baseline survey, cataract was the dominant cause of bilateral visual impairment (55.4%), blindness (70.4%) and unilateral blindness (46.7%). Corneal opacity was another leading cause of unilateral (16.4%) and bilateral (8.2%) blindness. Refractive error and cataract were the main causes of unilateral (35.9%, 35.7%) visual impairment, followed by AMD (8.4%); While glaucoma was an important cause of unilateral (5.7%) and bilateral (5.1%) blindness, but not visual impairment.

Assessment of mortality and causes of death

Of the 5,057 participants in the baseline survey, those who died after the population-based study were identified and the death certificate was checked. The cause of death was determined by the physicians in charge of health of the village population. Those who had moved to the other area after the population-based study were assessed about the health status and death for 135 of the 228 participants (59.2%) by direct telephone contact with the former participants or their relatives.

Statistical analyses

We used the presenting and best-corrected VA from better-seeing eye to define visual impairment. To evaluate the association of VA and mortality, we estimated ORs and 95% Cls for all-cause mortality and sex- specific all-cause mortality using Multiple logistic regression for stratified presenting VA groups (VA < 20/400, 20/400 ≤ VA < 20/60, VA ≥ 20/60). Plots of all-cause mortality curve stratified by group were generated by the SigmaPlot 11 method. The data were analyzed by the SPSS 15 software for Windows (Statistical Package for the Social Sciences, Chicago, IL, USA).

RESULTS

Demographic and socioeconomic characteristics of the examined subjects are displayed in Table 1. The subjects age 50 years and older in the selected clusters made up 27.3% of the population, and the mean age was 60.5 ± 17.5 (range 50–96) years. The average age of female was 60.4 years versus 60.7 years among males. Females were less educated than males. Subjects

TABLE 1 Demographic characteristics of examined subjects by sex, age, education, housing, and visual status [a].

	Baseline Survey			Follow up Survey[e]		
	Male No(%)	Female No(%)	Total No(%)	Male No(%)	Female No(%)	Total No(%)
Age(yrs)						
50–59	1275(45.5)	1530(54.6)	2805(55.5)	1241(45.4)	1494(54.6)	2735(55.1)
60–69	707(49.9)	710(50.1)	1417(28.0)	697(49.6)	707(50.4)	1404(28.3)
70–96	401(48.0)	434(52.0)	835(16.5)	397(48.1)	428(51.9)	825(16.6)
Eucation(yrs)						
7–13	953(54.1)	808(55.9)	1761(34.8)	927(54.1)	787(45.9)	1714(34.5)
1–6	1258(45.0)	1538(55.0)	2796(55.3)	1238(44.8)	1523(45.2)	2761(55.6)
0	172(34.4)	328(65.6)	500(9.9)	171(35.0)	318(65.0)	489(9.9)
Housing type [b]						
Public	109(4.6)	86(3.2)	195(3.9)	101(57.1)	76(44.9)	177(3.6)
Private	1985(83.3)	2213(86.5)	4198(83.0)	1953(47.2)	2183(52.8)	4136(83.3)
Home ownership [c]	289(12.1)	375(10.3)	664(13.1)	284(43.6)	367(54.4)	651(13.1)
visual status[d]						
VA <20/400	32(31.2)	74(69.8)	106(2.1)	32 (30.2)	74(69.8)	106(21.5)
20/400≤VA<20/6	243(37.3)	408 (62.7)	651(12.9)	231(36.6)	400(63.4)	631(12.7)
VA≥20/60	2169(49.1)	2191(50.9)	4300(85.0)	2138(50.1)	2149(49.9)	4227(95.2)
Total (%)	2383(47.1)	2674(52.9)	5057(100)	2401(48.4)	2623(51.6)	4964(100)

[a]Data are given as number(%) of participants
[b] Public =government-owned housing.
[c]Home ownership =government subsidized, self-purchased housing.
[d]paticipants presenting visual acuity in the better eye.
[e]Difference in numbers between baseline and follow up survey because of the lack of data due to moving away.

age 50–59 were more likely to be examined (n = 2,805, 55.5%). In the follow-up visit, 4,964 individuals (98.2%) were enumerated and 93 individuals were not checked due to moving away.

During an average 4-year period, cerebrovascular (CVA) events were the most common cause of death (n = 75; 35.0%), followed by heart disorders (n = 63; 29.4%), malignancies (n = 41; 19.2%), and other causes (n = 16; 7.5%) such as nonmalignant lung diseases (n = 2), diabetes (n = 3), injury (n = 2), liver (n = 4), and kidney (n = 3) problems. Data on mortality or cause of death were missing for 5 participants (2.3%). The most frequent causes of presenting VI in the dead subjects were cataract (40.9%), refractive error (33.3%), and macular degeneration (16.7%). The percentile of diabetic retinopathy was only 3.0% in the dead cases.

Between the baseline examination and the censoring cutpoint study, a total of 214 subjects (4.2%) were dead. One hundred sixty one deaths among the 4,300 subjects (3.7%) with VA ≥ 20/60 were recorded. Forty deaths among the 651 subjects (6.1%) with 20/400 ≤ VA < 20/60, and 13 deaths among 106 subjects (12.3%) with VA < 20/400 were recorded.

All-cause mortality by better-eye presenting VA is shown in Table 2. Poorer presenting VA categories were associated strongly with mortality. Persons with moderate (20/400 ≤ VA < 20/60) and severe (VA < 20/400) reduction in presenting VA had poorer survival compared with persons with better vision (VA ≥ 20/60; $P < 0.05$, OR: 3.6 [95%CI: 2.0–6.6]).

Table 2 also shows results for all-cause mortality by better-eye best-corrected VA. As compared with participants with best- corrected VA of ≥ 20/60, participants with moderate and severe reduction had a OR of 3.1 (95%CI: 1.5–6.4) and 3.9 (95%CI:2.1–7.2), respectively ($P < 0.001$).

An examination of interactions between covariates and visual status revealed sex-specific differences in mortality across categories of presenting VA. Females with better acuity were more likely to have died relative to male gender with no VI (3.9% vs. 3.6%) (Figure 1); however, females with presenting VI were less likely to have died relative to males with VI. There is a significant ($P < 0.05$) interaction between sex and categories of presenting VA. Because of this interaction, all mortality analyses were completed separately among male and female participants.

Sex-specific data of ORs and corresponding 95% CIs for death from all-causes mortality are shown in Table 3. Compared with participants who reported better presenting VA (VA ≥ 20/60), the risk of mortality was significantly higher for those reporting moderate VI (20/400 ≤ VA < 20/60) and those reporting severe VI (VA < 20/400), although, in both cases, these associations were stronger among men than women. The prevalence of all-cause mortality in

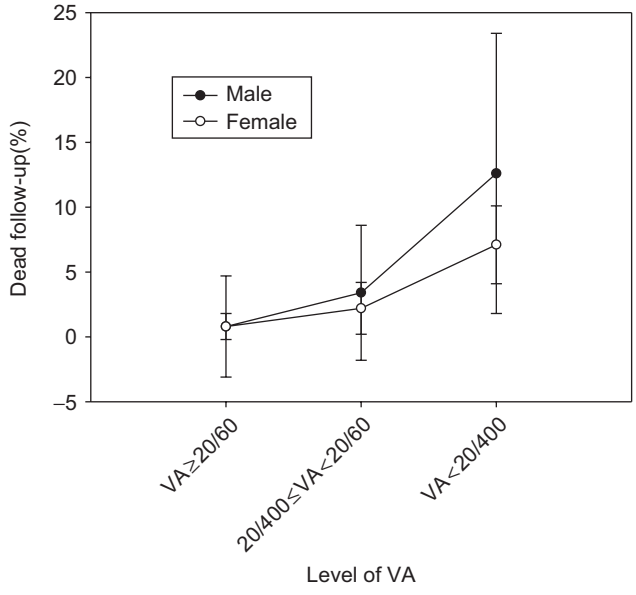

FIGURE 1 Prevalence for all-cause mortality

TABLE 2 Proportional hazards models of all-cause mortality by better-eye visual acuity.

Visual Acuity (VA)	Subject No	Mortality No	Ratio % (95%CI)	Adjust OR (95%CI)§
Presenting VA				
VA≥20/60	4227	161	3.8(3.1–4.3)	1
20/400≤VA<20/60	631	40	6.3(4.4–8.2)	2.1(1.1–4.1)
VA <20/400	106	13	12.3 (6.0–18.6)	3.6(2.0–6.6)[a]
Best-Corrected VA				
VA≥20/60	4452	169	3.8(3.2–4.4)	1
20/400≤VA<20/60	418	32	7.7(5.1–10.3)	3.1(1.5–6.4)[b]
VA <20/400	94	13	13.8(6.8–20.8)	3.9(2.1–7.2)[b]

VA= visual acuity
$P<0.05$[a]
$P<0.001$[b]
§Adjusted for age and gender

male (15.6%) was higher than that in female gender (10.8%) ($P < 0.05$).

DISCUSSION

Results of our analyses showed that presenting visual impairment significantly predicted higher all-cause mortality in this population- based study of older adults, among individuals 50 years and older. We showed that subjects with presenting VA worse than 20/400 had a 3.6-fold higher risk of death as compared with subjects with better vision (VA ≥ 20/60), independent of other predictors of mortality. Several mechanisms account for the associations between VI and mortality. These mechanisms include the following: (1) adverse treatment effects for eye diseases, (2) exposure to factors known to increase the risk of these conditions and major cause-specific deaths, (3) aging, and (4) impaired psychological functioning.[20] Visual impairment is related to functional disability.[21,22] Loss of independence, need for community support, and reduced social interaction and depression.[23] Depression has been reported to predict cardiovascular mortality.[24] All the results are similar to findings from other population-based studies that have been documented (Table 4).

In agreement with previous study,[28] relationships between categories of VA and mortality were stronger in men in our study. In this study, the prevalence of all-cause mortality in male (15.6%) was higher than that in female gender (10.8%) ($P < 0.05$). The exact mechanism is unclear. Basically, women live longer and have a better chance of development of eye and other age-related comorbid conditions, whereas men die earlier in life and are more likely to have fewer comorbid conditions. Therefore, it is possible that other variables are more likely to confound a relationship between eye disease and mortality in women than in men. However, other eye studies,[29,30] have reported larger mortality risk estimates in female compared with male gender. A recent study from Atherosclerosis Risk in Communities showed that retinal arteriolar narrowing is related to risk of coronary heart disease in women.[31] Further research is needed to identify the associations between VI and mortality in male and female gender.

We chose to use presenting VA because we hypothesized that a person's actual acuity would affect mortality through intervening factors such as accidents,[32] psychological health,[33] and quality of life,[34] which may be responsible in part for poor survival among persons with visual impairment.[35] It is possible that presenting VA reflects a person's daily level of visual comfort. In our study, only 29 participants (2.2%) presented spectacle.[36] The predictive value of presenting VA for mortality was somewhat

TABLE 3 Sex-specific all-cause mortality date.

	All-cause mortality			
Visual acuity status by sex	No. of subject	No. of death	Prevalence (95%CI)	OR (95%CI)
Male				
VA ≥ 20/60	2066	76	3.7(2.8–4.5)	1
20/400 ≤ VA < 20/60	245	19	7.8(4.4–11.2)	2.2(0.8–6.3)
VA < 20/400	32	5	15.6(3.0–28.2)	4.6(1.7–12.4)
Female				
VA ≥ 20/60	2141	85	3.9(3.1–4.7)	1
20/400 ≤ VA <20/60	406	21	5.2(3.0–7.4)	2.2(1.0–5.3)
VA < 20/400	74	8	10.8(3.7–17.9)	3.1(1.4–6.6)
Total	4964	214	4.2(3.6–4.8)	

$P < 0.05$
No., Number; VA, Visual acuity;

TABLE 4 Studies of association between visual acuity and mortality in population-based surveys[a].

Year	Study	Population	Sample Size(No.)	Follow-up(yrs)	VA association Mortality	Harzad Ratio (95%CI)	Multivariate Controls
2005	Medical Research Council Study, UK[26]	White persons	13569	6	VA worse than 20/60	1.17(1.07–1.27)	age, gender, lifestyle, smoking, etc.
2005	Salisbury Eye Evaluation, US [27]	white and black persons	1991	8	per 1 line decrease	1.05(1.01–1.09)	age, gender, race, body, Mass index, etc.
2006	Tanjong Pagar Study, Singapore[28]	Chinese	1225	7	VA worse than 20/40	2.8(1.4–1.48)	Age,gender, Hypertension, diabetes,
2010	The Southern Harbin Eye Study, China	Chinese	5057	4	VA worse than 20/60	3.6(2.0–6.6)	age, gender, cerebrovascular, events, etc

stronger than for best-corrected VA.[27] However, our results were similar when we used best-corrected VA and the best-corrected VA was statistically significant related to mortality.

Although the findings are similar to other studies, this does not indicate the association between VI and mortality is independent of urban/rural lifestyle. It has been proved that diabetes would correlate with a higher rate of cardiovascular disease and CVA.[37,38] With respect to the ocular parameter of diabetic retinopathy, the present survey is different from previous population-based studies such as the Tanjong Pagar Study, the Beaver Dam Study, and the Beijing Study in which this disease was correlated with an increased risk of mortality.[15,16,27,39] There are only three subjects who died from diabetes in our study and the percentile of diabetic retinopathy was only 3.0% in the dead cases. Maybe the rural lifestyle and/or ethnic groups account for the results.

The Southern Harbin Eye Study has many strengths for investigating the relationship of VA and mortality including its population-based sample with high participation, long-term follow-up, and use of standardized procedures. Limitations include the likelihood that some important confounding factors may not have been controlled for and some associations may be due to a chance finding. We cannot exclude the possibility that some of the associations may be false. To the best of our knowledge, no data show an association between VA and mortality in China. In this study, we examined the relationship between VA and mortality in a population-based cohort of rural Chinese adults aged 50 to 96 years at baseline residing in China. Based on the observation, we hypothesize that visual impairment may be an important marker for mortality in the study. If the hypothesis is confirmed, a longer duration of follow-up for this population may provide more precise estimates of these associations.

ACKNOWLEDGMENTS

We would like to acknowledge the significant contributions of the Heilongjiang Health Bureau for organizational support, the Wuchang Town Hospital (Juan Huang) for logistical support.

This work is supported by Nature Science Foundation of Heilongjiang Province, China (D2007-51) and Hospital Research Foundation of the First Affiliated Hospital, Harbin Medical University, Harbin, China (grant no. 2009B04).

***Declaration of interest*:** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES

1. McCarty, CA, Nanjan, MB, Taylor, HR. Vision impairment predicts 5 year mortality. Br J Ophthalmol 2001; 85(3): 322–326.
2. Clemons, TE, Kurinij, N, Sperduto, RD. Associations of mortality with ocular disorders and an intervention of high-dose antioxidants and zinc in the Age-Related Eye Disease Study: AREDS Report No.13. Arch Ophthalmol 2004;122 (5):716–726.
3. Thiagarajan, M, Evans, JR, Smeeth, L, Wormald, RP, Fletcher, AE. Cause-specific visual impairment and mortality: results from a population-based study of older people in the United Kingdom. Arch Ophthalmol 2005;123(10):1397–1403.
4. Knudtson, MD, Klein, BE, Klein, R. Age-related eye disease, visual impairment, and survival: the Beaver Dam Eye Study. Arch Ophthalmol 2006;124(2):243–249.
5. Leske, MC, Connell, AM, Wu, SY, Hyman, L, Schachal, A. Prevalence of lens opacities in the Barbados Eye Study. Arch Ophthalmol 1997; 115:105–111.
6. Varma, R, Torres, M, Los Angeles Latino Eye Study Group. Prevalence of lens opacities in Latinos: the Los Angeles Latino Eye Study. Ophthalmology 2004;111:1449–1456.
7. Foster, PJ, Wong, TY, Machin, D, Johnson, GJ, Seah, SK. Risk factors for nuclear, cortical and posterior subcapsular cataracts in the Chinese population of Singapore: the Tanjong Pagar Survey. Br J Ophthalmol 2003;87:1112–1120.
8. Foster, PJ, Oen, FT, Machin, D, Ng, TP, Devereux, JG, Johnson, GJ, et al. The prevalence of glaucoma in Chinese residents of Singapore: across-sectional population survey of the Tanjong Pagar district. Arch Ophthalmol 2000;118: 1105–1111.
9. Vingerling, JR, Dielemans, I, Hofmanm A, Grobbee, DE, Hijmering, M, Kramer, CF, et al. The prevalence of age-related maculopathy in the Rotterdam Study. Ophthalmology 1995;102:205–210.
10. Li, ZJ, Cui, H, Zhang, L, Liu, P, Yang, H. Cataract blindness and surgery among the elderly in rural Southern Harbin, China. Ophthalmic Epidemiology 2009;16:78–78.
11. Xu, L, Cui, TT, Wang, YX, Jonas, JB. Cataract and mortality. The Beijing eye study. Graefes Arch Clin Exp Ophthalmol. 2008;246:615–617.
12. Lee, DJ, Gomez-Marin, O, Lam, BL, Zheng, DD. Glaucoma and survival: the National Health Interview Survey.1986–1994. Ophthalmology. 2003;110:1476–1483.
13. Klein, R, Klein, BE, Moss, SE. Age-related eye disease and survival: the Beaver Dam Eye Study. Arch Ophthalmol 1995;113:333–339.
14. Borger, PH, Van Leeuwen, R, Hulsman, CA, Wolfs, RC, van der Kuip, DA, Hofman, A, et al. Is there a direct association between age-related eye diseases and mortality? The Rotterdam Study. Ophthalmology 2003;110: 1292–1296.
15. Cugati, S, Wang, JJ, Knudtson, MD, Rochtchina, E, Klein, R, Klein, BE, et al. Retinal vein occlusion and vascular mortality: pooled data analysis of population-based cohorts. Ophthalmology 2007;114:520–524.
16. Xu, L, Liu, WW, Wang, YX, Yang, H, Johna, JB. Retinal vein occlusions and mortality: the Beijing Eye Study. Am J Ophthalmol. 2007;144:972–973.
17. Wang, JJ, Mitchell, P, Simpson, JM, et al. Visual impairment, opacities in the Barbados Eye Study. Arch Ophthalmol 1997;119:1186–1190.
18. Li, ZJ, Cui, H, Liu, P, Zhang, L, Yang, H, Zhang, L. Prevalence and causes of blindness and visual impairment among

the elderly in rural Southern Harbin, China. Ophthalmic Epidemiology 2008;15:334–338.
19. Li, ZJ, Cui, H, Zhang, L, Liu, P, Bai, J. Prevalence of and associated factors for corneal blindness in a rural adult population (The Southern Harbin Eye Study). Current Eye Research 2009;34(8):646–651.
20. Lee, DJ, Gomez-Maran, O, Lam, BL, Zheng, DD. Visual acuity impairment and mortality in US adults. Arch Ophthalmol. 2002;120:1544–1550.
21. West, SK, Munoz, B, Rubin, GS, Schein, OD, Bandeen-Roche, K, Zeger, S. Function and visual impairment in a population-based study of older adults: the SEE project: Salisbury Eye Evaluation. Invest Ophthalmol Vis Sci.. 1997;38:72–82.
22. Lee, P, Smith, JP, Kington, R. The relationship of self-rated vision and hearing to functional status and well-being among seniors 70 years and older. Am J Ophthalmol. 1999;127:447–452.
23. Horowitz, A, Reinhardt, JP, Boerner, K. The effect of rehabilitation on depression among visually disabled older adults. Aging Ment Health. 2005;9:563–570.
24. Rumsfeld, JS, Jones, PG, Whooley, MA, Sullivan, MD, Pitt, B, Weintraub, WS, et al. Depression predicts mortality and hospitalization in patients with myocardial infarction complicated by heart failure. Am Heart J.2005;150: 961–967.
25. Thiagarajan, M, Evans, JR, Smeeth, L, Wormald, RP, Fletcher, AE. Cause-specific visual impairment and mortality: results from a population-based study of older people in the United Kingdom. Arch Ophthalmol 2005;123: 1397–1403.
26. Freeman, EE, Egleston, BL, West, SK, Bandeen-Roche, K, Rubin, G. Visual acuity change and mortality in older adults. Invest Ophthal Mol Vis Sci. 2005;46:4040–4045.
27. Foong, AWP, Fong, CW, Wong, TY, Saw, SM, Heng, D, Foster, PJ. Visual acuity and mortality in a Chinese population: The Tanjong Pagar Study. Ophthalmology 2008;115:802–807.
28. Knudtson, MD, Klein, BEK, Klein, R. Age-related eye disease, visual impairment and survival: The Beaver Dam Eye Study. Arch Ophthalmol 2006;124:243–249.
29. Reidy, A, Minassian, DC, Desai, P, Vafidis, G, Joseph, J, Farrow, S. Increased mortality in women with cataract: a population based follow up of the North London Eye Study. Br J Ophthalmol 2002; 86: 424–428.
30. Egge, K, Zahl, PH. Survival of glaucoma patients. Acta Ophthalmol Scand 1999;77:397–401.
31. Wong, TY, Klein, R, Sharrett, AR, Duncan, BB, Couper, DJ, Tielsch, JM, et al. Retinal arteriolar narrowing and risk of coronary heart disease in men and women: the Atherosclerosis Risk in Communities Study. JAMA. 2002; 287: 1153–1159.
32. Ivers, RQ, Mitchell, P, Cumming, RG. Sensory impairment and driving: the Blue Mountain Eye Study. Am J Public Health 1999; 89:85–87.
33. Freeman, EE, Egleston, BL, West, SK, Bandeen-Roche, K, Rubin, G. Visual acuity change and mortality in older adults. Invest Ophthalmol Vis Sci 2005; 46: 4040–4045.
34. Carabellese, C, Appollonio, I, Rozzini, R, Bianchetti, A, Frisoni, GB, Frattola, L. Sensory impairment and quality of life in a community elderly population. J Am Geriatr Soc 1993;41:401–407
35. Ramrattan, RS, Wolfs, RCW, Panda-Jonas, S, Jonas, JB, Bakker, D, Polis, HA, et al. Prevalence and causes of visual field loss in the elderly and associations with impairment in daily life functioning. The Rotterdam Study. Arch Ophthalmol 119: 1788–1794.
36. Li, ZJ, Sun, D, Cui, H, Zhang, L, Liu, P, Yang, H, et al. Refractive error among the elderly in rural Southern Harbin, China. Ophthalmic Epidemiology 2009; 16(6):388–394.
37. Lesobre, B. Cardiovascular risk factors in type 2 diabetes. Diabete Metab 1994;20(3pt2):351–356.
38. Ducluzeau, PH, Berlie, P, Leftheriotis, G, de Bray, JM, Fortrat, JO. A truncated ultrasound screening procedure for atheroma of the cervical arteries in asymptomatic diabetic patients: evidence from a retrospective study. Diabetes Metab 2008; 34 (4 Pt 1): 370–374.