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Original Article

The association of visual impairment and 3-year mortality among the elderly in Taiwan: The Shihpai Eye Study

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Abstract

Background: The association between visual impairment and mortality has been controversial. Moreover, literature on the relationship was very limited in the Asian population. The purpose of this study was to investigate whether visual impairment increases the 3-year risk of mortality in a cohort of urban Chinese elderly individuals.

Methods: Participants in the Shihpai Eye Study, who were aged ≥65 years, with a baseline examination conducted between July 1, 1999 and December 31, 2000, were recruited for the current study. The total number of possible participants identified was 4750. Of those, 3746 persons were eligible, and 2045 persons were randomly selected to be invited to participate in the study. Of those 2045 individuals, 1361 (66.6%) participated in both the questionnaire and eye examination. A follow-up of a fixed cohort was also conducted after 3 years. The death of any participants was confirmed through the household registration system.

Results: Of the 1361 participants included at baseline, 54 (3.97%) died before the 3-year follow-up. Multiple logistic regression analysis showed that mortality was significantly associated with a fall history [relative risk (RR): 2.12; 95% confidence intervals (CI): 1.08–3.98] and a history of diabetes (RR: 2.06; 95% CI: 1.03–3.95). Visual impairment was not a significant predictor of mortality after adjustment for confounders.

Conclusion: After adjustments were made for age, sex, education, marital status, lifestyle factors, depression symptoms, fall history, and history of systemic diseases, visual impairment was not a significant predictor of 3-year mortality in elderly persons.

Keywords: Chinese; mortality; urban; visual impairment

1. Introduction

The prevalence of visual impairment has been shown to increase with age[1] and has become a public health concern. According to the literature, visual impairment is the third most prevalent physical impairment among older adults.[1,2] Visual impairment often limits people's ability to perform daily tasks[2,3] and affects their quality of life.[4–6] In addition to causing morbidity, visual impairment has also been suggested as a predictor of mortality.[7–13] In the Beaver Dam Eye Study,[12] people with visual acuity <6/12 were 1.57 times as likely to die in the following 5 years. In addition, the Blue Mountains Eye Study[11] reported that visual impairment was independently associated with an increased 7-year mortality

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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rate, with a relative risk (RR) of 1.7. Although visual impairment has been proposed to be an independent predictor of mortality, it should be noted that confounding factors, such as age, depression, etc., were not adjusted for in some studies. Other studies did not find a correlation between visual impairment and mortality.[14–16] For example, the Blue Mountains Eye Study,[14] which included an 11-year follow-up, did not find a correlation between visual impairment and mortality. A population-based study of elderly people aged ≥75 years in the United Kingdom had similar results.[15] The Beijing Eye Study[16] also noted that mortality was not significantly associated with presenting and best-corrected visual acuity.

Thus, the association between visual impairment and mortality is controversial. Moreover, most of the studies evaluating the association between visual impairment and mortality have been limited to Caucasians. Literature on the relationship between visual impairment and mortality among Asians has been limited to only three citations, namely, the Tanjong Pagar Study,[17] the Southern Harbin Eye Study,[18] and the Beijing Eye Study.[16] The first two studies noted a positive relationship between visual impairment and mortality, whereas the results of the Beijing Eye Study contradicted that finding. This study aimed to investigate whether visual impairment increases the 3-year risk of mortality in a cohort of urban Chinese elderly individuals.

2. Methods

The Shihpai Eye Study[19–21] was a community-based, cross-sectional survey of vision and eye diseases among noninstitutionalized participants aged ≥65 years in Shihpai, Taipei, Taiwan. The details of the sample selection and methods for the Shihpai Eye Study have been described previously.[19] In summary, residents aged ≥65 years were identified using the national household registration system. This system officially registers personal information, such as date of birth, sex, home address, family members, and relations. It was also designed to collate and supply demographic information and to officially recognize the personal status and relations of the ethnic Chinese public. This provides a reference for the government to develop effective administrative and socioeconomic development programs and assists scholars in academic research. The baseline examinations were conducted between July 1, 1999 and December 31, 2000. According to the official household registration conducted in 1999, the total number of residents aged ≥65 years in Shihpai was 4750. Of those, 3746 were eligible for this study, and 2045 were randomly selected to be invited to participate. Of the 2045 individuals invited to participate, 1361 (66.6%) participated in both the questionnaire and eye examination. All of the participants recruited in the baseline examination were considered eligible for a continuing fixed cohort study in 2003. After careful follow-up, 927 individuals participated (83%) in the follow-up survey, 54 individuals died, 167 individuals moved to a new household, 20 individuals were inpatients or were paralyzed or disabled, and 193 individuals refused to complete the survey. Informed consent was obtained from each participant after providing a thorough explanation of the survey and prior to enrollment in the study. The study was approved by the Institutional Review Board of the Taipei Veterans General Hospital, Taipei, Taiwan. The survey followed the tenets of the Declaration of Helsinki.

2.1. Definitions

Visual acuity was assessed using a Snellen E chart at a distance of 6 m. It was recorded separately for each eye and was defined as the lowest line for which the majority of E letters were positioned correctly. Visual acuity was measured initially without refractive correction (using the participant's glasses if worn). A sequential testing approach, including counting fingers, detecting hand motions, target fixation, and light perception, was used for all participants when visual acuity could not be assessed using a Snellen E chart. If visual acuity was <6/6, the examination was repeated with subjective refraction. If the refraction measurement could not be appropriately obtained, a pinhole-corrected acuity test was performed.

In this study, visual impairment was defined as a presenting visual acuity of <6/12 in the participant's better eye, as this reflects the visual acuity a person experiences in everyday living. The cut-off of 6/12 was used, because it is representative of the visual needs of modern life,[22–24] such as driving. In many countries and in most of the states in the US, visual acuity of ≥6/12 in the better eye is required for an unrestricted license.

The mortality status of the participants was traced through relatives or friends to provide final death status and also rechecked by research assistants using the household registration system.

The Geriatric Depression Scale-Short Form (GDS-S) was administered, and a score of ≥5 was considered to indicate depression symptoms.

A fall history was considered significant if one or more falls had occurred in the previous 12 months.

Histories of hypertension, diabetes, cardiovascular disease, and stroke were obtained by a checklist and defined as positive if one had previously been diagnosed by a physician as having the disease.

2.2. Statistical analysis

The dependent outcome in this study was all-cause 3-year mortality. The baseline profiles for the surviving participants and deceased participants in 2003 were compared using Student's t test for continuous variables and Chi-square analysis for categorical variables. The independent variables tested were age, sex, education, marital status, smoking history, alcohol intake, GDS-S scores, fall history, hypertension, stroke, diabetes, cardiovascular disease, arthritis, visual impairment, and whether one had contact eye service prior to the study examination. Independent variables associated with 3-year mortality with $p \leq 0.20$ in the univariate analysis were considered in the multivariate modelling for 3-year mortality.

RR was calculated for each independent variable in the models, and 95% confidence intervals (CIs) were calculated using maximum likelihood methods. A p value <0.05 was considered statistically significant in the multiple regression model. All analyses were performed using SAS version 6.12 (SAS Institute, Cary, NC, USA) software.

3. Results

3.1. Three-year cumulative mortality rate among community-dwelling elderly

During the 3-year period, 54 residents died before they completed a second interview in 2003. Therefore, the 3-year cumulative mortality rate for the population was 3.97% (54/1361). Although no significant difference in mortality rate was found between sexes, mortality rate did significantly increase with age (Chi-square test for trend; Chi-square = 4.392; $p = 0.001$). Visual impairment was detected in 222 (16.3%) participants, 15 (27.7%) participants in the mortality group and 207 (15.8%) participants in the surviving group. The age-specific 3-year cumulative mortality rates are shown in Table 1.

3.2. Demographics and predictors of 3-year mortality in univariate analysis

The univariate analysis showed that deceased participants were significantly older (mean age: 75.9 years vs. 72.6 years; RR: 1.12; 95% CI: 1.07−1.17) and were more likely to be current smokers (RR: 1.02; 95% CI: 1.01−1.05) compared to surviving participants. The risk of visual impairment (RR: 2.01; 95% CI: 1.13−3.61) was significantly higher in participants with reduced survival. As shown in Table 2, deceased individuals were also more likely to have a GDS-S score of ≥5 (RR: 1.05; 95% CI: 1.01−1.11), to have experienced at least one fall (RR: 1.04; 95% CI: 1.01−1.08), and to have a history of stroke (RR: 1.09; 95% CI: 1.01−1.21) and diabetes (RR: 1.04; 95% CI: 1.01−1.08).

3.3. Demographics, clinical factors, and predictors of 3-year mortality in multivariate analysis

A multivariate log-binomial regression model was performed to adjust for confounding factors. In the final model, a history of falls (RR: 2.12; 95% CI: 1.08−3.98) and diabetes (RR: 2.06; 95% CI: 1.03−3.95) were significant predictors of 3-year mortality (Table 3). Visual impairment and depression was not significantly related to 3-year mortality in multivariate regression analysis.

Table 1
Three-year cumulative mortality rate by sex and age among residents ≥65 years of age in Shihpai, 2000−2003.

Age	3-y cumulative mortality (%)			χ^2 test	
	Male	Female	Total	Sex difference	Age difference
	N (%)	*N* (%)	*N* (%)		
65−69	5 (1.98)	3 (1.68)	8 (1.85)	$p = 0.336$	χ^2 (trend) = 4.392
70−74	10 (3.12)	3 (1.66)	13 (2.59)		$p = 0.001$
75−79	14 (8.81)	8 (6.35)	22 (7.72)		
80+	7 (7.87)	4 (7.55)	11 (7.75)		
Total	**36 (4.38)**	**18 (3.34)**	**54 (3.97)**		

4. Discussion

In this community-based cohort of Chinese elderly, although visual impairment was more prevalent in deceased participants, the association between visual impairment and mortality became insignificant after adjusting for other covariates. Presenting visual acuity was used in this study because it reflects the visual acuity present when a person is doing everyday tasks and affects the psychological status of persons more than best-corrected visual acuity. The association between visual impairment and mortality presented in the literature has been inconsistent. Although visual impairment has been suggested as an independent marker for mortality by some studies,[7−13,17,18] other studies have arrived at contradicting conclusions.[14−16] The results of our study agreed with those of the Beijing Eye Study[16] but contrasted sharply with those of the Tanjong Pagar Study[17] and the Southern Harbin Eye Study.[18] Environmental factors and differing lifestyles may explain these discordant findings and deserve further evaluation. Moreover, it should be noted that different definitions of visual impairment, follow-up period, accessibility of health care resources, etc. may also explain these discrepancies.

For example, in the Tanjong Pagar Study,[17] a multivariate analysis after follow-up for a median of 6.8 years found that participants with presenting visual acuity in the better eye worse than logMAR 0.3 had a hazard ratio of 2.9 (95% CI: 1.4−6.3) compared to participants with logMAR 0.0. Although medical history and income were adjusted for in their analysis, depression symptoms, fall history, and history of contact with eye services, which are potential confounding factors, were not investigated. Moreover, the targeted age group was 40−79 years of age, as opposed to our elderly population of ≥65 years of age at baseline. Our study also contrasted sharply with the 4-year follow-up of the Southern Harbin Eye Study.[18] This may be due to environmental differences between the studies: our survey was conducted in an urban area, whereas their survey was conducted on residents of a rural area who were aged ≥50 years. Moreover, they used a different definition of visual impairment: moderate visual impairment was defined as a presenting visual acuity worse than 20/60 but equal to or better than 20/400. Confounding factors, such as education level, lifestyle, and prior contact with eye services were not adjusted for in their study.

The Salisbury Eye Evaluation[13] was another population-based cohort study targeted at an age group similar to our study of 65−84 years of age. That study found that lower baseline visual acuity was associated with the risk of mortality in their 8-year cohort. The study further evaluated whether depression symptoms mediate the relationship between mortality and visual impairment and did not find any correlation. While our study results did not support a positive relationship

Table 2
Baseline characteristics among surviving participants and deceased participants ≥65 years of age in Shihpai, Taipei, Taiwan, 2000−2003.

Status at baseline	Participants (n = 1361)		p	Crude relative risk (95% CI)
	Deceased (n = 54)	Survived (n = 1307)		
Age, mean (SD)	75.9 (5.7)	72.6 (5.0)	<0.001	1.12 (1.07−1.17)
Sex: female	33.3	39.8	0.338	NS
Educational level: illiterate or primary school	50.0	47.3	0.695	NS
Married status	68.5	73.9	0.378	NS
Current smoking	25.9	17.3	0.037	1.02 (1.01−1.05)
Alcohol intake	9.3	11.7	0.574	NS
GDS-S scores ≥ 5 (depression symptoms)[a]	18.5	8.4	0.011	2.35 (1.12−4.55)
Fall history	29.6	15.7	0.007	2.26 (1.22−3.80)
Hypertension history	55.5	44.3	0.105	NS
Stroke history	14.8	4.4	<0.001	3.46 (1.70−7.04)
Diabetes history	27.8	14.6	0.009	2.15 (1.21−3.83)
Cardiovascular disease history	27.8	24.9	0.637	NS
Arthritis history	12.9	14.2	0.793	NS
Visual impairment	27.8	15.8	0.047	1.03 (1.01−1.07)
Without eye services prior to the study examination	31.5	29.2	0.652	NS

Data are presented as %.
CI = confidence intervals; NS = nonsignificant; SD = standard deviation.
[a] The Geriatric Depression Scale-Short Form (GDS-S) was administered, and a score of ≥5 was considered to indicate depression symptoms.

between visual impairment and mortality, our results did confirm that depressive symptoms were not predictive of mortality. Although depression symptoms and visual impairment were significantly associated with mortality by the crude RR evaluation, both became substantially attenuated after adjusting for confounders. This was in concordance with Thiagarajan and colleagues'[15] findings in the United Kingdom. Their study concluded that associations that have been reported for visual impairment and mortality or for specific causes of visual impairment are confounded by comorbidities, risk factors, and other factors related to susceptibility to death. This was further strengthened by our findings: although fall history and visual impairment were highly correlated, that correlation was insignificant after adjusting for other covariates.

Table 3
Baseline characteristics associated with 3-year mortality in multivariate log-binomial regression model among the cohort of elderly persons in Shihpai, Taipei, Taiwan, 2000−2003.

Variables	Age and sex adjusted relative risk (95% CI)	Adjusted relative risk[a](95% CI)
Demographics		
Marital status (married vs. single/divorced/widowed)	NS	NS
Education (illiterate or primary vs. secondary or above)	NS	NS
Lifestyle, depression symptoms, and fall		
Current smoking	NS	NS
Alcohol intake (yes vs. no)	NS	NS
GDS-S scores ≥ 5 (depression symptoms) (yes vs. no)	2.31 (1.14−4.65)	NS
Fall	2.02 (1.11−3.70)	1.89 (1.03−3.50)
Medical history		
Hypertension (yes vs. no)	NS	NS
Stroke (yes vs. no)	2.73 (1.23−6.07)	NS
Diabetes (yes vs. no)	2.14 (1.18−3.90)	1.89 (1.02−3.49)
Cardiovascular disease (yes vs. no)	NS	NS
Arthritis (yes vs. no)	NS	NS
Ocular conditions		
Visual impairment (yes vs. no)		NS
Without eye services prior to the study examination	NS	NS

CI = confidence intervals; GDS-S = Geriatric Depression Scale-Short Form; NS = nonsignificant.
[a] Adjusted variables include age, sex, current smoking, depression symptoms, fall, stroke, diabetes, and visual impairment.

In the Blue Mountains Eye Study,[11] after a 7-year follow-up, the authors suggested that visual impairment after best-correction (presenting visual impairment was not significant) was an independent risk factor for mortality in older persons. However, after 4 more years of follow-up,[14] visual impairment (best-corrected VA (visual acuity) <20/40 in the better eye) was not a risk factor for all-cause mortality. Although a significant finding was noted in a subgroup of participants aged ≤75 years, the hazard ratio was greatly attenuated in the multivariate models.

The findings of this study are strengthened by its prospective design, large population, and comprehensive set of other risk variables considered for risk adjustment. Moreover, our survey was conducted in a medical center by professionally trained ophthalmologists according to a standardized protocol.

There were some limitations in our study. First, the nonparticipating individuals in the baseline survey were older and more likely to be female or illiterate; a selection bias due to nonresponse was unavoidable. Secondly, our study populations were noninstitutionalized survivors, excluding those who were inpatients or who had paralysis or disability in the baseline survey. This probably removed a disproportionate number of potential participants with functional or physical impairment and/or declining health-related quality of life and

may have biased the results of the study. Third, the assessment of comorbidities using a dichotomized classification was simplistic. This study demonstrated that visual impairment has a nonsignificant ability to predict short-term mortality among community-dwelling elderly.

In conclusion, while visual impairment is more prevalent among mortality individuals, the relationship no longer exists after adjustment for other covariates.

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