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ORIGINAL ARTICLE

The prevalence and risk factors of visual impairment among the elderly in Eastern Taiwan

Wen-Li Wang [a,b], Nancy Chen [c], Min-Muh Sheu [d,e,f], Jen-Hung Wang [g], Wen-Lin Hsu [a,h,i], Yih-Jin Hu [b,*]

[a] *Department of Community Medicine, Buddhist Tzu Chi General Hospital, Hualien, Taiwan*
[b] *Department of Health Promotion and Health Education, National Taiwan Normal University, Taipei, Taiwan*
[c] *Department of Ophthalmology, Buddhist Tzu Chi General Hospital, Hualien, Taiwan*
[d] *Eye Care and Blindness Prevention Center of Eastern Taiwan, Mennonite Christian Hospital, Hualien, Taiwan*
[e] *Department of Ophthalmology and Visual Science, Tzu Chi University, Hualien, Taiwan*
[f] *Department of Ophthalmology, Mennonite Christian Hospital, Hualien, Taiwan*
[g] *Department of Medical Research, Buddhist Tzu Chi General Hospital, Hualien, Taiwan*
[h] *Department of Radiation Oncology, Buddhist Tzu Chi General Hospital, Hualien, Taiwan*
[i] *School of Medicine, College of Medicine, Buddhist Tzu Chi University, Hualien, Taiwan*

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Abstract Visual impairment is associated with disability and poor quality of life. This study aimed to investigate the prevalence and associated risk factors of visual impairment among the suburban elderly in Eastern Taiwan. The cross-sectional research was conducted from April 2012 to August 2012. The ocular condition examination took place in suburban areas of Hualien County. Medical records from local infirmaries and questionnaires were utilized to collect demographic data and systemic disease status. Logistic regression models were used for the simultaneous analysis of the association between the prevalence of visual impairment and risk factors. Six hundred and eighty-one residents participated in this project. The mean age of the participants was 71.4 ± 7.3 years. The prevalence of vision impairment (better eye $< 6/18$) was 11.0%. Refractive error and cataract were the main causes of vision impairment. Logistic regression analysis showed that people aged 65—75 years had a 3.8 times higher risk of developing visual impairment ($p = 0.021$), while the odds ratio of people aged > 75 years was 10.0 ($p < 0.001$). In addition, patients with diabetic retinopathy had a 3.7 times higher risk of developing visual impairment ($p = 0.002$), while the odds ratio of refractive error was 0.36 ($p < 0.001$). The prevalence of visual impairment was relatively high compared with previous

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* Corresponding author. Department of Health Promotion and Health Education, National Taiwan Normal University, Number 162, He-ping East Road, Section 1, Taipei 10610, Taiwan.
E-mail address: t09026@ntnu.edu.tw (Y.-J. Hu).

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studies. Diabetic retinopathy was an important risk factor of visual impairment; by contrast, refractive error was beneficial to resist visual impairment. Therefore, regular screening of ocular condition and early intervention might aid in the prevention of avoidable vision loss.
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Introduction

Visual function included visual acuity (VA), visual field, and contrast sensitivity, all coordinate together to perform daily tasks [1]. The vision domain affects activities of daily life independent of the effects of age, general health, educational level, and depression [2]. Hence, visual impairment in elderly was associated with disability [3] and lower quality of life [4]. Vision, along with systemic disease, psychological status, and interpersonal relationships, could also affect mortality and morbidity in the elderly people [5]. However, most elderly people believed that deterioration of vision is a natural process of aging and therefore usually do not seek appropriate medical attention, although many of the conditions might be treatable [6,7].

Metabolic syndrome is characterized by obesity, glucose intolerance, elevated blood pressure, and dyslipidemia. Each component of metabolic syndrome predisposes people to atherosclerosis, and when clustered together, these components promote cardiovascular diseases prominently [8]. Owing to urbanization, a more sedentary life style, and increasing life longevity, metabolic syndrome has become more prevalent [9]. Ocular complications of diabetes mellitus due to microvasculopathy as well as macrovasculopathy, such as cardiovascular disease, have distinct associations; therefore, adequate blood glucose control has been advocated to prevent diabetic retinopathy and the subsequent visual impairment. However, the role of dyslipidemia and blood pressure control in ocular disease prevention remains controversial [10].

The eastern shoreline of Taiwan is steep with the East Coast Mountain Range extending down the east coast of the island and the narrow Huatung Valley separating it from the high Central Mountain Range. There are indigenous tribes and rural villages scattered throughout the mountainous area. Although the National Health Insurance, initiated in 1995, had almost 99% coverage of the 23-million strong Taiwanese population, to most elderly residents the accessibility of medical services remained scarce due to the inconvenience caused by this geographic feature. The project was funded by the Health Promotion Administration to screen the eye conditions of the residents who had been followed-up at local infirmaries for systemic diseases such as diabetes, hypertension, or dyslipidemia. We aimed to investigate the prevalence and associated risk factors of visual impairment of the suburban elderly in Eastern Taiwan via analyzing this data directly.

Methods

The Research Ethics Committee of the Buddhist Tzu Chi General Hospital, Hualien, Taiwan, approved this study. This is a cross-sectional research, in which the visual screening program was conducted from April 2012 to August 2012, with the cooperation between one hospital and 10 local infirmaries, located mostly in suburban areas of Hualien County. Our study only enrolled the suburban elderly older than 55 years from those participants in the project funded by Health Promotion Administration. The systemic disease status was collected from medical records of local infirmaries and by questionnaires.

Ocular examinations

The standardized ophthalmic examinations were conducted, included presenting VA, automatic refractometry, noncontact tonometry, slit-lamp biomicroscopic examination, retinoscopy, and fundus examination.

The VA was measured using the Snellen chart (distributed by the Taiwna Optical) at a distance of 20 ft (~6 m). The uncorrected VA or VA with present distance spectacles of each eye was measured initially. We defined visual impairment as presenting VA worse than 6/18 in the better eye according to the criteria set forth by the World Health Organization [11]. The mean spherical equivalent refractive error was used for calculation. Myopia was defined as spherical equivalent < -0.5 diopters (D). Hyperopia was defined as a spherical equivalent $> +0.5$ D [12].The definition of ocular diseases and the details of ocular examinations are described in our previous study [13].

Determination of causes of visual impairment

The major causes of visual impairment were identified in the participants who were categorized as visually impaired. If the better-seeing eye had more than one ocular disease, the senior ophthalmologist would designate the major vision-dampening pathological condition as the cause of the visual impairment. Vision impairment was attributed to refractive error when VA improved to $>$ 6/18 with either the pinhole test or after refraction.

Age-related macular degeneration grades were assigned in accordance with the Wisconsin age-related maculopathy grading system. Cataracts were classified by use of Lens Opacities Classification System III. If the final diagnosis could not be made at the mobile medical unit, the patient

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was referred and scheduled for further examinations as described. Whenever glaucoma was either suspected or diagnosed, and optic neuropathy or a disproportional decrease in VA, the patients were referred to our medical center for further examinations including visual field test, optical coherence tomography, or further brain imaging whenever brain lesions were suspected. Patients with retinal diseases were also referred for further ophthalmic investigations including fluorescein angiogram, optical coherence tomography, and electroretinography. Most cases with cataract-causing visual impairment were referred and treated with cataract surgery and the patient's data were modified after the operation according to the final diagnosis. For instance, if the patient had macular degeneration or glaucoma, the entry relating to the disease etiology would be modified accordingly postsurgery. Therefore, the possibility of underestimating retinal or optic nerve diseases was low.

Statistical analysis

The data were expressed as frequencies, proportions, or mean ± standard deviations, depending on the characteristics of each item. Chi-square test was used to evaluate the association between two categorical variables. Logistic regression models were used for the simultaneous analysis of the association between the prevalence of visual impairment and risk factors. The crude and adjusted odds ratios and 95% confidence intervals were calculated. Statistically significant differences were defined as $p < 0.05$. All of the statistical analyses were performed using SPSS software version 17.0 (SPSS Inc., Chicago, IL, USA).

Results

The demographic data are summarized in Table 1. Of the 681 residents who participated in this project, 62.3% were women ($n = 424$) and 75.0% lived in suburban areas ($n = 511$). The mean age of the participants was 71.4 ± 7.3 years. The prevalence of vision impairment (better eye < 6/18) was 11.0% (95% confidence interval: 8.7–13.4%). Among the participants, 72.8% had diabetes mellitus ($n = 496$), 64.3% of them had hypertension ($n = 438$), and 29.1% had hyperlipidemia ($n = 198$). The age-specific prevalence of visual impairment increased from 3.0% in the 55–65 years age group to 19.1% for those aged 75 years or older. Visual impairment increased significantly with advancing age, but there was no difference regarding sex or location of residence.

The leading diagnosis among the participants was cataract (89.3%) and refractive error (83.4%), followed by hypertensive retinopathy (37.3%), pterygium (28.0%), and diabetic retinopathy (6.5%). Participants with visual impairment had a significantly higher prevalence of diabetic retinopathy (16.0% vs. 5.3%) and lower prevalence of refractive error (66.7% vs. 85.5%) compared with participants without visual impairment (Table 2). Refractive error and cataract were, respectively, the main causes of presenting vision impairment, followed by others, age-related macular degeneration, diabetic retinopathy, optic neuropathy, and cornel opacity (Figure 1).

Table 1 Demographics ($N = 681$).

Item	Normal	Visual impairment	Total	p
N	606	75	681	
Age (y)	70.9 ± 7.3	75.5 ± 6.4	71.4 ± 7.3	<0.001*
Age group (y)				<0.001*
55–65	129 (21.3)	4 (5.3)	133 (19.5)	
65–75	299 (49.3)	29 (38.7%	328 (48.2)	
>75	178 (29.4%	42 (56.0)	220 (32.3)	
Sex				0.615
Male	231 (38.1)	26 (34.7)	257 (37.7)	
Female	375 (61.9)	49 (65.3)	424 (62.3)	
Urbanization				0.257
Urban	147 (24.3)	23 (30.7)	170 (25.0%	
Suburban	459 (75.7)	52 (69.3%	511 (75.0)	
Hypertension	382 (63.0)	56 (74.7)	438 (64.3)	0.047*
HTN history				0.074
None	224 (37.0)	19 (25.3)	243 (35.7)	
0–10 y	239 (39.4)	31 (41.3)	270 (39.6)	
10–20 y	143 (23.6)	25 (33.3)	168 (24.7)	
Hyperlipidemia	179 (29.5)	19 (25.3)	198 (29.1)	0.502
Hyperlipidemia history				0.745
None	427 (70.5)	55 (73.3)	482 (70.8)	
0–10 y	152 (25.1)	18 (24.0)	170 (25.0)	
10–20 y	27 (4.5)	2 (2.7)	29 (4.3)	
DM	436 (71.9)	60 (80.0)	496 (72.8)	0.169
DM history				0.116
None	169(27.9)	15(20.0)	184(27.0)	
0–10 y	289(47.7)	34(45.3)	323(47.4)	
10–20 y	148(24.4)	26(34.7)	174(25.6)	
Cataract & surgery				0.382
No cataract	67 (11.1)	6 (8.0)	73 (10.7)	
Cataract w/o surgery	394 (65.0)	46 (61.3)	440 (64.6)	
Cataract w/i surgery	145 (23.9)	23 (30.7)	168 (24.7)	

Data are presented as n (%) or mean ± standard deviation.
* A p value < 0.05 was considered statistically significant after test.
DM = diabetes mellitus; HTN = hypertension; w/i = with; w/o = without.

Of the 75 participants with visual impairment, significant lens opacity was present in 34 (45.3%). One hundred and sixty-eight participants had undergone cataract surgery in the past. Thus, the coverage of the existing cataract surgery service was 83.17%.

Among those 168 participants who had cataract surgery, 23 participants had a presenting VA of < 6/18 in the better-seeing eye attributed to refractive error (8), posterior capsular opacity (2), optic neuropathy (3), age-related macular degeneration (3), corneal opacity (2), diabetic retinopathy (1), diabetic macula edema (1), macula pucker (1), and myopic retinal degeneration (1).

We conducted a logistic regression analysis to evaluate the effects of different factors associated with visual

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Table 2 Percentage of ocular diseases of the study participants ($N = 681$).

Item	Normal	Visual impairment	Total	p
N	606	75	681	
Ocular disease				
Refractive error	518 (85.5)	50 (66.7)	568 (83.4)	<0.001*
Cornea opacity	24 (4.0)	7 (9.3)	31 (4.6)	0.069
Pterygium	170 (28.1)	21 (28.0)	191 (28.0)	0.992
Cataract	539 (88.9)	69 (92.0)	608 (89.3)	0.444
Glaucoma	15 (2.5)	0 (0.0)	15(2.2)	0.393
Optic neuropathy	23 (3.8)	3 (4.0)	26 (3.8)	0.930
Vascular retinopathy	233 (38.4)	21 (28.0)	254 (37.3)	0.078
Diabetic retinopathy	32 (5.3)	12 (16.0)	44 (6.5)	0.002*
Maculopathy	13 (2.1)	4 (5.3)	17 (2.5)	0.106
Phthisis	3 (0.5)	2 (2.7)	5 (0.7)	0.096
Other	20 (3.3)	3 (4.0)	23 (3.4)	0.732

Data are presented as *n* (%).
* A p value < 0.05 was considered statistically significant after the test.

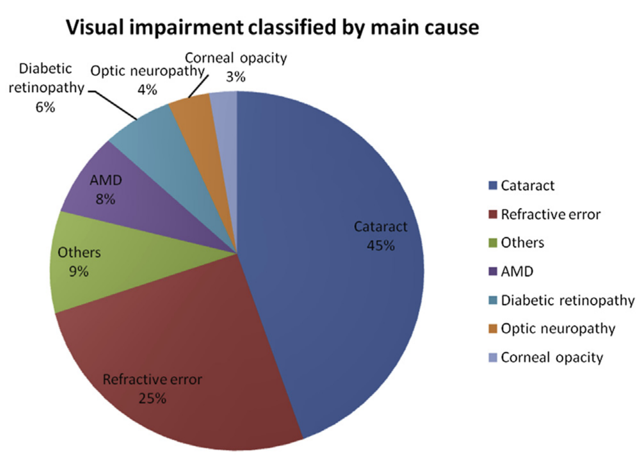

Figure 1. Main causes of visual impairment (best corrected visual acuity < 6/18). AMD = age-related macular degeneration.

impairment. The results of the crude and adjusted analyses showed that there were significant differences in the prevalence of presenting visual impairment with respect to different ages and being with or without diabetic retinopathy and refractive error. People aged 65–75 years had a 3.8 times higher risk of developing visual impairment ($p = 0.021$), while the odds ratio of people aged > 75 years was 10.0 ($p < 0.001$) compared with those aged 55–65 years. The elderly with diabetic retinopathy had a 3.7 times higher risk of developing visual impairment compared with those without diabetic retinopathy ($p = 0.002$). The adjusted odds ratio of a patient with refractive error to have visual impairment was 0.36 compared with those without refractive error ($p < 0.001$) (see Table 3).

Discussion

This study is the first to elucidate the potential ocular diseases and prevalence of visual impairment in the elderly population with hypertension, diabetes, or hyperlipidemia in Eastern Taiwan.

In the current study, there was a higher prevalent trend of visual impairment among patients with a longer duration of hypertension or diabetics for > 10 years, and that the patients with diabetic retinopathy had a 3.7 times increased risk of visual impairment. Huang et al. [14] reviewed the National Health Insurance data and found an increasing prevalence of diabetes-related end-stage renal diseases, eye diseases, and peripheral vascular diseases in the Taiwan population during 2000–2009. Meanwhile, the study of Tseng et al. [15] showed that the prevalence of hypertension and dyslipidemia in diabetic patients with eye diseases increased in the same period of time. In a crude analysis, the history of diabetic and hypertension for > 10 years had shown significant association with visual impairment; however, the significance was masked after being adjusted for other covariates. This might be due to the frequent comorbidity of hypertension, dyslipidemia, and diabetes in the elderly population. Hypertension and dyslipidemia are the modifiable risk factors for cardiovascular diseases; therefore, it might be justifiable to control blood pressure in order to improve ocular conditions [16], while the benefit of lipid profile monitoring needs further evidence.

Visual impairment (presenting acuity of better seeing eye < 6/18) was found in 11.0% of the participants in our survey. Comparable to other previous studies, refractive error, and cataract [17] were the main causes of vision impairment. As VISION 2020, a program launched by World Health Organization to eliminate global avoidable blindness, stated, four out of five cases of vision impairment were preventable [18]. And the data regarding the main preventable causes of visual impairment was crucial for initiating the action plan [19].

Cataract, mostly characterized as age-related nuclear sclerosis [20], had a major influence on the visually impaired elderly population [13,21]. Although the prevalence of cataract is variable among different ethnicity, socioeconomic status [22], and sex [23], the incidence of cataract increased with age [23,24]. Senile cataract is a major avoidable cause of blindness in many developing countries [25], and cataract surgery was proven to be associated with a significantly better long-term survival of elderly patients in the Blue Mountain study [26]. The prevalence of cataract surgery was 24.7% (95% confidence interval: 21.4–27.9%) among our participants, which was higher than the 6.5% surgery rate (95% confidence interval: 5.5–7.5%) in the survey of Indigenous Eye Health of Australia [27]. Cataract surgical coverage (CSC)—the proportion of visually impairing cataract and cataract surgery numbers—was regarded as an indicator to assess the degree to which cataract surgical services met the needs of the population [19]. In our survey, which defined visually disabling lens opacity as VA < 6/18, the CSC was 83.17%. It was relatively good compared to the CSC of other areas [27]. As to the result of cataract surgery, those 23 (13.7%)

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Table 3 Factors associated with visual impairment ($N = 681$).

	Univariate		Multivariate	
	Odds ratio (95% CI)	*p*	Odds ratio (95% CI)	*p*
Age (y)	—	—	—	—
55–65	References	NA	References	NA
65–75	3.13 (1.08–9.08)	0.036*	3.78 (1.23–11.68)	0.021*
>75	7.61 (2.66–21.75)	<0.001*	9.96 (3.16–31.34)	<0.001*
Sex	—	—	—	—
Male	References	NA	References	NA
Female	1.16 (0.70–1.92)	0.561	1.37 (0.79–2.35)	0.262
Urbanization	—	—	—	—
Urban	References	NA	References	NA
Suburban	0.72 (0.43–1.22)	0.228	0.57 (0.32–1.01)	0.053
HTN history	—	—	—	—
None	References	NA	References	NA
0–10 y	1.53 (0.84–2.79)	0.165	1.28 (0.67–2.45)	0.460
>10 y	2.06 (1.10–3.88)	0.025*	1.74 (0.87–3.51)	0.120
DM history	—	—	—	—
None	References	NA	References	NA
0–10 y	1.33 (0.70–2.51)	0.386	1.33 (0.67–2.64)	0.419
>10 y	1.98 (1.01–3.88)	0.047*	1.25 (0.57–2.76)	0.582
Corneal disease	—	—	—	—
No	References	NA	References	NA
Yes	2.50 (1.04–6.01)	0.041*	2.05 (0.79–5.33)	0.140
Cataract & surgery	—	—	—	—
No cataract	References	NA	References	NA
Cataract w/o surgery	1.30 (0.54–3.17)	0.559	0.71 (0.26–1.91)	0.494
Cataract w/i surgery	1.77 (0.69–4.55)	0.235	0.56 (0.19–1.65)	0.294
Diabetic retinopathy	—	—	—	—
No	References	NA	References	NA
Yes	3.42 (1.68–6.97)	0.001*	3.71 (1.60–8.61)	0.002*
Pterygium	—	—	—	—
No	References	NA	References	NA
Yes	1.00 (0.59–1.70)	0.992	0.85 (0.47–1.52)	0.578
Refraction	—	—	—	—
No	References	NA	References	NA
Yes	0.34 (0.20–0.58)	<0.001*	0.36 (0.20–0.63)	<0.001*

Data are presented as *n* (%) or odds ratio (95% CI).
* A p value < 0.05 was considered statistically significant after the test.
CI = confidence interval; DM = diabetes mellitus; HTN = hypertension; NA = not applicable; w/i = with; w/o = without.

patients that remained visually impaired after cataract surgeries, the main reasons were refractive error, optic atrophy, and macular degeneration.

The adjusted odds ratio of a patient with refractive error to have presenting visual impairment was 0.36 compared with those without refractive error in this study; in other words, refractive error was beneficial to resist visual impairment. The most common cause of bilateral low vision (VA < 6/12 to > 6/60) was uncorrected refractive error in the Indigenous Eye Heath Study [28]. In this study, people who had poor presenting VA were considered vision impaired regardless of their actual best-corrected VA; therefore, refractive error was a major visually disabling cause, and that represented the actual status of vision in their daily life. In our previous study, many patients with an uncorrected VA less than 6/18 were able to gain useful vision with spectacles; however, in certain remote areas there were neither optician shops nor medical services to address the issue of uncorrected VA [29,30].

Although refractive error was still the second leading cause in the current study, people with refractive error were more prone to seek optometry service or medical attention; therefore, many ocular diseases could have been intervened in their earlier stage.

In our study, patients with diabetic retinopathy had a 3.7 times higher risk of developing visual impairment compared with those without ($p = 0.002$). Diabetes resulted in damage and dysfunction of multiple organ systems. Both microvascular and macrovascular complications contributed to the high morbidity and mortality rate. Microangiopathy due to hyperglycemia causes vascular leakage and capillary occlusion, and subsequently caused retinal ischemia and increased levels of vascular endothelial growth factor which are responsible for the development of neovascularization and the proliferative stage of diabetic retinopathy [31]. The legacy effect of intensive blood sugar control was well known to reduce the risk of diabetic retinopathy in diabetic patients [32].

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The current study is the only survey regarding visual impairment among the elderly of Eastern Taiwan to date. The methodology using the Mobile Vision Van Unit for outreach service could bring instruments to remote areas and screen more elderly patients in the villages and tribes.

The purposive sampling of the current study might not represent the characteristics of the general elderly population in Eastern Taiwan. However, it could reveal the possible causes of visual impairment in suburban elderly. Although the cross-sectional design of the current survey readily showed the association of the probable risk factors, it did not outline the cause-and-effect relationship clearly.

Conclusion

The prevalence of visual impairment was relatively high compared with other previous studies. Age and diabetic retinopathy were important risk factors of visual impairment; by contraat, refractive error was beneficial to resist impaired vision. Therefore, regular screening of ocular conditions and early intervention might aid in the prevention of avoidable vision loss in the suburban elderly.

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