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The prevalence and causes of visual impairment among ethnic Tujia adults in a rural community in China

Xiaojing Xiong, MD, Danning Liu, PhD, Shenchun Liu, PhD, Mingxing Wu, PhD, Bainwen Zhan, MD, Hao Wang, MD, Xiyuan Zhou, MD*

Abstract

We aimed to investigate the prevalence and causes of visual impairment (VI) in an elderly Tujia ethnic rural population in Southwest China.

From June 1 to December 31, 2018, a random cluster sampling survey was conducted among Tujia individuals aged 50 years or older in the rural areas of Qianjiang District County in Chongqing. The sampling design used village-based clusters of approximately equal size (1000 people). The sampling frame was composed of 110 clusters including 26,527 adults aged 50 years or older; 10 clusters (2556 adults) were randomly selected, and 2122 subjects were examined. Ophthalmologic examinations and questionnaires were administered to all the participants. Low vision and blindness were defined using best-corrected visual acuity (BCVA) and presenting visual acuity, according to The World Health Organization standard. The prevalence of VI was estimated, and causes of VI were identified.

The participation rate was 83.0%. The prevalence of VI was 15.2% (BCVA 8.0%). In the study population, the prevalence of low vision and blindness increased with age ($P < .05$) and was higher among those with a low education level ($P < .01$). The majority of VI was attributed to cataracts (50.0%) and uncorrected refractive error (35.7%). With BCVA, cataract (79.3%) was the most common cause of VI, followed by age-related macular degeneration (10.7%).

The main causes of VI in Tujia ethnic were cataracts and refractive errors. Both cataracts and refractive errors are curable eye diseases; thus, local health institutions need to adopt a more active eye care project as a strategy to prevent blindness.

Abbreviations: AMD = age-related macular degeneration, BCVA = best-corrected visual acuity, IOP = intraocular pressure, PVA = presenting visual acuity, VA = visual acuity, VCDR = vertical cup-to-disc ratio, VI = visual impairment, WHO = The World Health Organization.

Keywords: causes, prevalence, rural, Tujia ethnic, visual impairment

1. Introduction

Visual impairment (VI) and blindness are important global health issues that exert significant influence not only on an individual's quality of life but also on society due to negative economic and social impact. The estimated health burden of VI is greater than that of hypertension, diabetes, obesity, or hyperlipidemia.[1] The World Health Organization (WHO) estimated that 285 million people have impaired vision, worldwide of whom 246 million are low vision and blindness in 39 million people.[2] With the increase in life expectancy, it is expected that the number of people with age-related eye diseases and impaired vision will increase considerably in the near future. China is the most populous country in the world;[3] thus, an understanding of the epidemiology of VI in China may have considerable public health implications.

China has a total of 56 recognized ethnic groups living in different areas and environments. In recent years, increasing research has been conducted in different regions of China to estimate specific areas of low vision and blindness. Most of these studies are aimed at the Han ethnicity of China.[4–7] Fewer studies have been carried out on the prevalence of VI in minority areas of China. However compared with Han people (the ethnic majority in China), minority residents have shorter life expectancies and utilize medical services less frequently. According to the sixth national Census in China in 2010, the Tujia ethnicity, with a

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Xiyuan Zhou orcid: 0000-0023-6369-3589 s.

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The Second Affiliated Hospital of Chongqing Medical University, Chongqing, China.

* *Correspondence: Xiyuan Zhou, the Second Affiliated Hospital of Chongqing Medical University, No. 76 Linjiang Road, Yuzhong District, Chongqing, China (e-mail: zhouxiyuan2002@aliyun.com).*

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population of about 8,353,912, accounted for 7.34% of the entire Chinese population.[8] The Tujia people mainly reside in the Wuling Mountains, which occupy the border zone of Chongqing, Hunan, Hubei, and Guizhou. Living on land with fertile soil, most of them make a living out of farming, fishing, mining, and of course tourism.[9] Qianjiang district, located in southeastern Chongqing, has several ethnical minorities, where the Tujia ethnicity accounts for 57.6% of the local population. The Tujia ethnicity is also the largest minority population in Chongqing with a population of about 1.398 million.[9] The history of Tujia can be traced back to the ancient Ba dynasty which occupied this region around 2500 years ago. Most of Tujia people in remote areas have insufficient health infrastructure and notable cultural diversity. It is well known that the prevalence of blindness and low vision and the cause of disease varies between different region and culture. Therefore, the formulation and implementation of antiblindness policies must be tied to the times and local conditions. There has been no published report on the prevalence and causes of VI in Tujia ethnic living in rural China to date. The purpose of the present study was to determine the prevalence of VI in this area and to identify its major causes.

2. Materials and methods

2.1. Sampling and enumeration

This study was carried out in Qianjiang, Southwest China, one of the most important areas for Tujia ethnic. The population of this area is 445,000. Qianjiang has 11 rural Tujia towns. Each rural town comprises many small administrative villages. Tujia ethnic live separately from people of other ethnic groups.

The study population was selected by random sampling the rural population of Tujia ethnicity. The sampling design used village-based clusters of approximately equal size (1000 people). Villages larger than 1500 in population were subdivided into clusters. Meanwhile, where geographically practical, villages smaller than 750 were combined. The target population was composed of 110 clusters including 26,527 adults aged 50 years or older, and 10 clusters (2556 adults aged 50 years or older) were randomly selected. Ultimately, 2122 ethnic Tujia adults participated in this study, with a response rate of 83.0%.

Four ophthalmologists with more than 5 years of practice performed the survey from June 1 to December 31, 2018. The investigation team arrived at the village 1 to 2 days in advance and had support from the government. All adults of Tujia ethnic aged 50 years or older living in the selected clusters were invited to participate in a detailed eye examination and a face-to-face questionnaire-based interview. First, the local government informed the eligible subjects, identified using local population database. Then the eligibility of the participants was further confirmed using door-to-door survey, by the study team. A person was considered ineligible if he had moved out of the village, had not lived there in the past 6 months, was deceased, or was terminally ill and had an estimated life expectancy of less than 3 months. Study participants were examined at a prescheduled date established at the time of enumeration. Residents who refused to participate in the survey 3 times were excluded. The survey sites were usually located close to the selected clusters, mostly in health centers, schools, village halls, etc. For cluster living in a remote and inaccessible area, the investigation team visited the village for the investigation. If participants were unable to attend the interview because of age, mobility, or systemic illness, the team conducted the interviews at the participant's home. All participants were informed of the purpose and procedure of the investigation. The investigation was approved by the ethics committee of the Second Affiliated Hospital of Chongqing Medical University, Chongqing (Grant No. 2016-101) review board, and the conduct of the studies adhered to the Declaration of Helsinki. The study methods were carried out in accordance with the approved guidelines. All participants were informed of the purpose and procedure of the investigation. Before investigation, each subject signed a letter of informed consent. Data masking was used to protect participants' privacy information, such as ID card, mobile number, etc.

2.2. Eye examination

A trained health worker (local doctors) administered a standard questionnaire. The questionnaire collected demographic, lifestyle, income, and education information; general medical history; and ophthalmic history. Blood pressure, blood glucose measurement. And detailed ophthalmic examinations were performed for all subjects by the 4 ophthalmologists.

Visual acuity (VA) was measured using the Snellen E chart at a distance of 5 m. The presenting visual acuity (PVA) with habitual refractive correction was recorded first. Automatic refractometry (Auto Refractometer AR-610, Nidek Ltd, Tokyo, Japan) was performed if the uncorrected VA was lower than 0.5. For some people, especially elderly participants who were examined in their homes, the best-corrected visual acuity (BCVA) was assumed to be the same as pinhole vision.[10] Intraocular pressure (IOP) was measured by an ophthalmologist using a handheld tonometer (ICare tonometer model: TA03, GS1-128). After 3 consecutive measurements, the average value was obtained. A detailed examination of conjunctiva, cornea, anterior chamber depth, iris, and lens was performed using hand slit lamp microscope. A nonmydriatic digital camera was used to take color photographs of the fundus, and a concrete analysis of each photograph was performed for the diagnosis of oculopathy. Primary causes of low vision or blindness were assessed by 2 senior ophthalmologists based on the clinical history and examination.

2.3. Definitions of visual impairment

According to the WHO, VI is defined as a BCVA worse than 0.5 (including low vision and blindness) in the better eye. The classification criteria for VI are defined as follows: blindness was present if VA was worse than 0.05 in the better eye, and low vision was present if VA was 0.3 or worse but better than 0.05.[2] In addition, this study reported binocular VI and described data for unilateral VI.

2.4. Cause of visual impairment

If a VA$\leq$0.5 could be improved to $>$0.5 with correction, refractive error was considered the cause of VI.[11] If there was no evidence of corneal or retinal abnormalities and simultaneous lens opacity, cataracts were considered the main cause of VI. Myopic maculopathy was considered if the spherical equivalent was greater than -6.0 diopters and 1 or more of the following ophthalmologic findings was present: tessellated fundus with yellowish-white diffuse or grayish-white patchy chorioretinal atrophy, macular hemorrhage, or posterior staphyloma.[12] Glaucoma was defined according to the International Society

for Geographical and Epidemiological Ophthalmology Grading System.[13] Glaucoma was suspected based on the following observations: vertical cup-to-disc ratio (VCDR) ≥0.7 in either eye, VCDR asymmetry ≥0.2, neuroretinal rim width reduced to <0.1 cup-to-disc ratio (between 11 and 1 o'clock or 5 and 7 o'clock), IOP >21 mm Hg, optic disc hemorrhage, notch or nerve fiber layer defect.[12] Age-related macular degeneration (AMD) was determined as a cause of VI if significant damage was observed on the macula, such as soft drusen of the retinal pigment epithelium, subfoveal hemorrhage, subretinal, and intraretinal edema with no retinal cause detected, or a subfoveal disciform scar. For participants who were diagnosed with diabetes, the examination showed microaneurysms along with cystoid macular edema, hard exudates, and intraretinal hemorrhages, which were considered evidence of diabetic retinopathy. Other causes of VI were determined according to routine clinical diagnosis.

If there were 2 or more causes of VI, we regarded the causes that had the presumed greatest impact on VI as the primary diagnosis. If cataracts coexisted with posterior segment damage of the optic nerve or retina and cataract extraction could not restore vision, posterior segment damage was considered the cause of VI. If dense cataract, corneal haze or other diseases blocked any field of vision in the posterior segment and there was no sign of any other cause of vision loss, the cause of VI was considered to be cataract, corneal haze, or other diseases. If 2 eyes of the subject showed VI due to 2 different causes, the ophthalmologist team selected the main cause of VI in the eye with better vision as the cause of VI for the subject. When there was doubt regarding the main cause of VI, a second experienced ophthalmologist examined the subject again, and then the 2 ophthalmologists determined the diagnosis by consensus.

2.5. Statistics

Data were entered by using EpiData 3.02 software for Windows (The EpiData Association, Odense M, Denmark) and were checked by other data operators after the examination of each cluster was completed. Statistical analysis was performed using the statistical software SPSS version 20.0 (SPSS, Chicago, IL). Data are presented as prevalence and odds ratios with 95% confidence intervals (CI). Multiple logistic regression analysis was used to investigate the association of VI with age, sex, and education. Odds ratios and 95% confidence intervals are reported. $P < .05$ was defined as statistically significant.

Table 1

Study population by age, gender, and education.

	No. enumerated (%)	No. examined (%)	Examination response rate (%)
Age (yr)			
50–59	771 (30.2)	455 (21.4)	59.0
60–69	1027 (40.2)	956 (45.1)	93.1
70–79	642 (25.1)	605 (28.5)	94.2
≥80	116 (4.5)	106 (5.0)	91.4
Gender			
Male	954 (37.3)	739 (37.3)	77.5
Female	1602 (62.7)	1383 (65.2)	86.3
Education			
Illiteracy	993 (38.8)	787 (37.1)	79.3
Primary school or higher	1563 (61.2)	1335 (62.9)	85.4
All	2556 (100)	2122 (100)	83.0

3. Results

A total of 2556 ethnic Tujia ethnic aged 50 years or older were considered eligible for this study, and 2122 were examined (response rate 83.02%). In general, those who did not respond were more likely to be relatively younger. For example, the participation rate of people aged 50 to 59 years is 59.0%, which was lower than other group (Table 1). Reasons for not attending the eye examinations were categorized as follows: temporarily left the surveyed area (133), severe illness (35), refused the survey because of a busy schedule (156), not interested in participating (21), and could not be contacted (78). A few people were unable to complete VA testing successfully (11)

We identified 85 people with blindness and 237 with low vision (Table 2). The prevalence of blindness was 4.0% (95% CI, 3.2%–4.9%), while the prevalence of low vision was 11.2% (95% CI, 9.85%–12.4%). When the BCVA was considered, the incidence of blindness and low vision were decreased significantly. The rate of unilateral blindness (<0.1 in 1 eye) was 5.2% (n = 110; 95% CI, 4.3%–6.2%) based on PVA, and when BCVA was considered, the prevalence was 5.4% (n = 114; 95% CI, 4.45%–6.4%). Approximately 78.8% of the participants (n = 1672) were categorized as having normal or near-normal vision (0.3 or better in both eyes). This percentage increased to 84.3% (n = 1788) when BCVA was considered.

Table 2

Prevalence of vision impairment based on presenting and best-corrected visual acuity.

	VA definition		Prevalence with PVA		Prevalence with BCVA	
	Better eye	Worse eye	NO. (%)	(95% CI)	NO. (%)	(95% CI)
NN	≥0.3	≥0.3	1672 (78.8%)		1788 (84.3%)	
VI	≥0.1	<0.3 to ≥0.01	237 (11.2%)	(9.8–12.4)	166 (7.8%)	(6.7–9.0)
UL	≥0.1	<0.1	110 (5.2%)	(4.3–6.2)	114 (5.4%)	(4.4–6.4)
MB	<0.1 to ≥0.05	<0.1	18 (0.8%)	(0.5–1.3)	16 (0.8%)	(0.4–1.1)
SB*	<0.05	<0.05	85 (4.0%)	(3.2–4.9)	38 (1.8%)	(1.2–2.4)
WHO low vision	<0.3 to ≥0.05	–	237 (11.2%)	(9.8–12.4)	131 (6.2%)	(5.2–7.2)
US blindness	≤0.1	–	103 (4.9%)	(4.0–5.8)	54 (2.5%)	(1.9–3.2)
US low vision	<0.5 to >0.01	–	541 (25.5%)	(23.6–27.4)	213 (10.0%)	(8.8–11.3)
Total			2122		2122	

MB = moderate bilateral blindness, NN = normal/near normal, SB = severe bilateral blindness, UL = unilateral blindness, VA = visual acuity, US = the United States, WHO = World Health Organization.
* Equivalent to WHO blindness definition (VA < 0.05 in better eye).

Table 3

Presenting and best-corrected visual acuity less than 0.3 by age, gender, and education.

		PVA < 0.3≥0.05		PVA < 0.05		BCVA < 0.3 ≥0.05		BCVA < 0.05	
		Prevalence	OR	Prevalence	OR	Prevalence	OR	Prevalence	OR
	NO.	No. (%)	(95% CI)	NO. (%)	(95% CI)	NO. (%)	(95% CI)	NO. (%)	(95% CI)
Age									
50–59	455	26 (5.7%)		8 (1.8%)		15 (3.3%)		2 (0.4%)	
60–69	956	85 (8.9%)	1.61 (1.02–2.54)†	42 (4.4%)	2.57 (1.20–5.52)†	56 (5.9%)	1.83 (1.02–3.26)†	19 (2.0%)	4.59 (1.07–19.80)†
70–79	605	98 (16.2%)	3.19 (2.03–5.01)†	28 (4.6%)	2.71 (1.22–6.01)†	44 (7.3%)	2.30 (1.26–4.19)†	12 (2.0%)	4.58 (1.02–20.58)†
≥80	106	28 (26.4%)	5.92 (3.30–10.64)†	7 (6.6%)	3.95 (1.40–11.15)†	16 (15.1%)	5.22 (2.49–10.93)†	5 (4.7%)	11.21 (2.15–58.62)†
Gender									
Male	739	74 (10.0%)		42 (5.7%)		33 (4.5%)		21 (2.8%)	
Female	1383	163 (11.8%)	1.20 (0.90–1.61)*	43 (3.1%)	0.53 (0.35–0.82)*	98 (7.1%)	1.63 (1.09–2.45)*	17 (1.2%)	0.43 (0.22–0.81)†
Education									
Illiterate	787	206 (26.2%)		48 (6.1%)		125 (15.9%)		36 (4.6%)	
Primary or higher	1335	31 (2.3%)	0.07 (0.05–0.10)†	37 (2.8%)	0.44 (0.28–0.68)†	6 (0.4%)	0.02 (0.01–0.06)†	2 (0.1%)	0.31 (0.01–0.13)†

* $P \geq .05$.
† $P < .05$.

For PVA, gender was not significantly associated with the presence of low vision and blindness (Table 3). However, when BCVA was considered, males were more likely to be affected by blindness. Participants with a low education level were more likely to suffer from low vision and blindness. The principal causes of VI by PVA and BCVA categories and age are summarized.

Among 772 eyes with a VA less than 0.3, when BCVA was considered, the number of VA less than 0.3 was reduced (Table 4). Cataracts are generally the most common cause of VI.

Table 4

Principal cause of vision impairment in eyes with presenting and best-corrected visual acuity less than 0.3.

NO. (%)

Eyes by visual acuity				Eyes by age (yr)				
Principal cause	<0.3–≥0.1	<0.1–≥0.05	<0.05	50–59	60–69	70–79	≥80	Total
Cataract	287 (62.9)	26 (66.7)	162 (58.5)	45 (56.3)	184 (61.5)	192 (62.3)	54 (63.5)	454 (61.5)
	237 (84.3)	26 (68.6)	136 (73.9)	34 (75.6)	163 (78.4))	151 (80.3)	51 (82.3)	399 (79.3)
Undercorrected refractive error	124 (27.2)	1 (2.6)	44 (15.9)	21 (26.3)	58 (19.4)	71 (23.1)	19 (22.4)	169 (21.9)
	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AMD	18 (3.9)	10 (25.6)	10 (3.6)	6 (7.5)	9 (3.0)	14 (4.5)	9 (10.6)	38 (4.9)
	18 (6.4)	10 (26.3)	9 (4.9)	6 (13.3)	9 (4.3)	14 (7.4)	8 (12.9)	37 (7.4)
Myopic maculopathy	0 (0)	0 (0)	19 (6.9)	2 (2.5)	10 (3.3)	7 (2.3)	0 (0)	19 (2.5)
	1 (0.4)	0 (0)	1 (0.5)	0 (0)	1 (0.5)	1 (0.5)	0 (0)	2 (0.4)
Corneal disorder	10 (2.2)	1 (2.6)	9 (3.2)	2 (2.5)	11 (3.7)	5 (1.6)	2 (2.4)	20 (2.6)
	10 (3.6)	1 (2.6)	9 (4.9)	2 (4.4)	11 (5.3)	5 (2.7)	2 (3.2)	20 (4.0)
posterior capsular opacification	13 (2.9)	1 (2.6)	2 (0,7)	0 (0)	8 (2.7)	8 (2.6)	0 (0)	16 (2.1)
	10 (3.6)	0 (0)	2 (1.1)	0 (0)	7 (3.4)	6 (3.2)	0 (0)	13 (2.6)
Glaucoma	1 (0.2)	0 (0)	3 (1.1)	0 (0)	4 (1.3)	0 (0)	0 (0)	4 (0.5)
	1 (0.4)	0 (0)	3 (1.6)	0 (0)	4 (1.9)	0 (0)	0 (0)	4 (0.8)
Pterygium	1 (0.2)	0 (0)	3 (1.1)	0 (0)	2 (0.7)	2 (0.6)	0 (0)	4 (0.5)
	2 (0,7)	0 (0)	2 (1.1)	0 (0)	2 (1.0)	2 (1.1)	0 (0)	4 (0.8)
Optic atrophy	0 (0)	0 (0)	4 (1.4)	1 (1.3)	0 (0)	3 (1.0)	0 (0)	4 (0.5)
	0 (0)	0 (0)	4 (2.2)	1 (2.2)	0 (0)	3 (1.6)	0 (0)	4 (0.8)
DR	1 (0.2)	0 (0)	1 (0.4)	0 (0)	2 (0.7)	0 (0)	0 (0)	2 (0.3)
	1 (0.4)	0 (0)	1 (0.5)	0 (0)	2 (1.0)	0 (0)	0 (0)	2 (0.4)
Vitreous hemorrhages	0 (0)	0 (0)	1 (0.4)	0 (0)	0 (0)	0 (0)	1 (1.2)	1 (0.3)
	0 (0)	0 (0)	1 (0.5)	0 (0)	0 (0)	0 (0)	1 (1.6)	1 (0.2)
eyeball atrophy	0 (0)	0 (0)	10 (3.6)	2 (2.5)	5 (1.7)	3 (1.0)	0 (0)	10 (1.3)
	0 (0)	0 (0)	10 (5.4)	2 (4.4)	5 (2.4)	3 (1.6)	0 (0)	10 (2.0)
Others	1 (0.2)	0 (0)	4 (1.4)	1 (1.3)	3 (1.0)	1 (0.3)	0 (0)	5 (0.6)
	1 (0.4)	0 (0)	2 (1.1)	0 (0)	2 (1.0)	1 (0.5)	0 (0)	3 (0.6)
Indetermination	0 (0)	0 (0)	5 (1.8)	0 (0)	3 (1.0)	2 (0.7)	0 (0)	5 (0.6)
	0 (0)	0 (0)	4 (2.2)	0 (0)	2 (1.0)	2 (1.1)	0 (0)	4 (0.8)
Total	456 (100)	39 (100)	277 (100)	80 (100)	299 (100)	308 (100)	85 (100)	772 (100)
	281 (100)	38 (100)	184 (100)	45 (100)	208 (100)	188100)	62 (100)	503 (100)

For each principal cause, the first row represents the result based on presenting visual acuity while the second row represents the result based on best-corrected visual acuity.
AMD = age-related macular degeneration, DR = diabetic retinopathy.

Table 5

Principal causes of low vision and blindness according to presenting and best-corrected visual acuity.

Causes	Based on PVA						Based on BCVA					
	Low vision† (n = 237)		Blindness* (n = 85)		Visual impairment‡ (n = 322)		Low vision† (n = 131)		Blindness* (n = 38)		Visual impairment‡ (n = 169)	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Cataract	131	56.5%	30	35.3%	161	50.0%	106	80.9%	28	73.7%	134	79.3%
Refractive error	79	34.1%	36	42.4%	115	35.7%	0	0.0%	0	0.0%	0	0.0%
AMD	12	5.2%	6	7.1%	18	5.6%	12	9.2%	6	15.8%	18	10.7%
Myopic maculopathy	0	0.0%	9	10.6%	9	2.8%	0	0.0%	0	0.0%	0	0.0%
Corneal opacity	5	2.2%	2	2.4%	7	2.2%	5	3.8%	2	5.3%	7	4.1%
Posterior capsular opacification	8	3.4%	0	0.0%	8	2.5%	6	4.6%	0	0.0%	6	3.6%
Glaucoma	0	0.0%	1	1.2%	1	0.3%	0	0.0%	1	2.6%	1	0.6%
Pterygium	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Optic atrophy	0	0.0%	1	1.2%	1	0.3%	0	0.0%	1	2.6%	1	0.6%
DR	1	0.4%	0	0.0%	1	0.3%	1	0.8%	0	0.0%	1	0.6%
Others	1	0.4%	0	0.0%	1	0.3%	1	0.8%	0	0.0%	1	0.6%

PVA = presenting visual acuity, BCVA = best-corrected visual acuity, AMD = age-related macular degeneration, DR = diabetic retinopathy.

* Defined as visual acuity <0.05.

† Defined as visual acuity <0.3 and ≥0.05.

‡ Blindness plus low vision, defined as visual acuity <0.3.

Cataract and refractive error together accounted for approximately 83.4% of the eyes with a PVA less than 0.3. When the BCVA was considered, refractive error was no longer a cause of VI, and cataract was assigned as the major cause of VI across all levels of severity.

We further explored the causes of VI based on individual data. Cataract were still the main cause of low vision. However, in the blindness group, refractive error was more common. When defined by BCVA, cataracts remained the leading cause of VI, The prevalence of AMD and corneal opacity ranked third and fourth, respectively (Table 5).

4. Discussion

It is an important public health issue that low vision and blindness caused serious psychological and mental harm to the affected individuals and their families. The WHO, other international organizations and governments have made efforts to reduce the global burden of blindness. The goal is to eliminate avoidable cases of blindness by 2020.[14] This study described in detail the current prevalence and causes of low vision and blindness in ethnic Tujia adults in a rural community in china, which paved the way for a sound prevention and treatment system of VI.

In the study, we found the prevalence of blindness was 1.8%, and the prevalence of low vision was 6.2% in the studied population. The prevalence of VI in the present study which was higher than that in Sichuan (1.4%),[15] Guangzhou (3.6%), [16] and Taiwan (4.9%).[17] As most of those regions include developed cities, we consider the high prevalence in our study to be partly associated with poor economic status, which would have limited the population's access to eye healthcare services. But the response rate of the younger group (50–59 years old) is relatively low in the study, which was the source of potential bias. Because the incidence of visual impairment is increased with age, it may lead to overestimation of the true incidence of visual impairment.

Our research has many similarities with the studies of the ethnic Bai and Dai that were conducted by The Yunnan Minority Eye Studies,[18,19] such as the sampling strategies used, the definitions of the outcomes and the age ranges of the study subjects. Therefore, the results for the 3 ethnic groups can be directly compared. The prevalence of presenting VI was lower among the Tujia ethnic population than among the Bai and Dai ethnic groups.[18,19] Studies have pointed out that due to the lack of medical and health services (lack of cataract surgery), the prevalence of visual impairment in rural areas is higher.[20] Based on our study, cataract surgery is an important factor when estimating the prevalence of VI. The proportion of VI caused by cataracts was 15.17%, which was higher than that of the Bai (4.6%) [18] and Dai (8.9%) [19] populations possibly due to the Health Express Project which is a free cataract surgery program to solve the vision problem in rural China.[20]

Cataracts are the leading cause of blindness in developing areas, including India [21] and China,[4] as well as in some developed areas, including Hong Kong,[22] Singapore,[23,24] Japan,[25,26] and Los Angeles.[27] In our study, cataracts contributed to more than half of cases of low vision and blindness. Additionally, this rate increased with age, from 56.3% in people aged 50 to 59 years to 61.5% in those aged 60 to 69 years, 62.3% in those aged 70 to 79 years, and 63.5% in those aged 80 years or over. The high altitude in the sampling areas may account in part for the higher prevalence of VI that was observed in the current study, probably because of limited accessibility to eye care services and a lack of awareness of eye diseases among the studied population.

When PVA was considered, refractive error was the second most common cause of VI. Refractive error is also the main cause of VI based on PVA in other cities in China, such as Sichuan,[15] Guangzhou,[16] Dali,[18] Xishuangbanna,[19] Hongkong,[23] Harbin,[29] and Shunyi.[30] When BCVA was considered, refractive error was no longer a cause of VI. Surprisingly, VI caused by myopic maculopathy is rare among Tujia ethnic, while it has become the main cause of incurable vision loss in some areas of China.[31] Researches showed that prolonging time for outdoor activities could reduce the incidence of high myopia.[32] In the study, participants were from remote rural areas, most of whom work outdoors to make a living, therefore, they have enough time for outdoor activities. Myopia could also be defined

as having an axial length greater than 24 mm, and high myopia defined as greater than 26 mm,[33] so, high myopia may be related to the eye development. We hypothesized whether there were protective genes for high myopia in Tujia ethnic, which would be our next research plan.

In most Western countries, the major cause of VI in the elderly population is AMD.[34,35] In our study, AMD was the second most common cause of VI by BCVA (10.7%) and the third most common cause of VI by PVA (5.6%). The rate of VI caused by AMD was markedly higher than most related Han Chinese population surveys. These discrepancies between our study and other studies could be explained with 2 possible reasons. First, long-term outdoor labor among Tujia ethnic increases their exposure to ultraviolet light, leading to a higher prevalence of AMD. Second, lower levels of education and the preponderance of female and elderly participants in this study, combined with relatively poor access to eye care services in the Tujia area, may contribute to these observed differences.

Corneal opacity was the third most common cause of VI in our study on BCVA, accounting for 4.1% of all cases. Among these cases, 5 were the consequence of trauma, and 2 resulted from infections. Our study participants were farmers and fishers who spent most of their working hours outdoors. Most participants were poorly educated and had a low socioeconomic status. The participants also had limited knowledge regarding eye health care; therefore, the likelihood of eye infection and injury was greatly increased.

Glaucoma is the second leading cause of blindness globally.[36] These results are close to those observed in Harbin and Guangzhou. However, in our study, glaucoma was not the main cause of blindness. The reason is unclear, but we hypothesize that this low prevalence was observed because we did not take loss of visual field criteria into consideration. The current survey contained a large number of samples, large scale, high response rate, using standardized protocol. This study first revealed the incidence of low vision and blindness of the elderly Tujia ethnic in rural areas.

The strengths of our study include the population-based study sample, good response rate, and standardized protocols for data collection. Our results were comparable with other population-based studies. Our study was also one of the few studies which added knowledge on the epidemiology of VI among ethnic minorities in China. Meanwhile, our study had several limitations. Firstly, the relatively low response rate in the youngest group (aged 50–59 years, 59.0%) could be a source of potential bias. Because the rates of visual impairment increase with age, low response rate in younger group might result in overestimating the prevalence of visual impairment. Also, lots of male Tujia people go out to work for living, causing imbalanced male-to-female ratio in these areas, which might lead to a bias. In addition, our study did not include the nonocular causes of blindness. Besides, we did not use VEP/ERG or other technology, which might underestimate the prevalence of macular diseases and optic neuropathy. Finally, ultrasonography for corneal opacity cases and associated cataract were not used in this study.

5. Conclusion

Our study suggests that low vision and blindness are now a significant public health concern among elderly adults of Tujia ethnic in rural areas of China. The prevalence of low vision and blindness in rural Tujia ethnic is higher than that in the Han population, and the causes are largely treatable. Further estimation of the national burden of VI in China should include the results for ethnic minorities to obtain a more accurate estimation and better guide clinical management and health resource allocation. The social, psychological, and economic barriers that prevent members of ethnic minorities from accessing eye care should be further explored.

Author contributions

Conceptualization: Xiyuan Zhou.
Data curation: Xiaojing Xiong and Danning Liu.
Formal analysis: Xiaojing Xiong.
Investigation: Xiaojing Xiong, Shenchun Liu, Hao Wang, Bianwen Zhang.
Methodology: Xiaojing Xiong and Hao wang.
Validation: Hao Wang and Bianwen Zhang.
Software: Bianwen Zhang and Mingxing WuW.
Supervision: Danning Liu.
Validation: Hao Wang and Bianwen Zhang.
Visualization: Xiyuan Zhou.
Writing – original draft: Xiaojing Xiong.
Writing – review & editing: Xiaojing Xiong and Hao Wang.

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