

Prevalence and risk factors for eye diseases, blindness, and low vision in Lhasa, Tibet

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INTRODUCTION

The causes of blindness and visual impairment vary according to socioeconomic conditions and the availability of health and eye care services. Approximately 80% of blind people live in the developing countries, mostly in rural areas with few or underutilized eye-care facilities. With improved living standards and the pursuit of better qualities of life, the Tibetan population has greatly increased their demand for health care services. In recent years, some epidemiological surveys of common eye diseases as well as prevalence and risk factors for blindness and low vision have been carried out in China [1,2]. Increased emphasis has been put on the prevention and treatment of blindness and low vision around the world, but very little information is available on the prevalence of ocular diseases in Tibetan who live in the remote areas of the Tibetan Plateau, China. Altitude over 3 000m is well-known in the medical literature to cause biological effect on the human body. Such areas are considered to be high-altitude locations. The atmospheric conditions are hypobaric, with strong ultraviolet radiation and a high number of sunshine hours (average 3 400 hours per year). Native Tibetans live in the Himalayan Plateau, and the Tibet Autonomous Region is one of the highest altitude and harshest human habitations on earth. Vision 2020: The Right to Sight was launched in 1999 with the aim to eliminate avoidable blindness by the year 2020 [3-9]. In accordance with the World Health Organization's Global initiative for the elimination of avoidable blindness, a survey study was identified as the most appropriate method to obtain an estimation of the prevalence rates and major causes of blindness and low vision in adults aged ≥ 40 years in native Tibetan. The purpose of this survey was to assess the prevalence of ocular diseases in native Tibetan people in Qushui County, Lhasa Prefecture, Tibet Autonomous Region, China and to determine the causes of ocular diseases resulting in blindness and low vision in this population.

Abstract

• **AIM:** To determine the prevalence and risk factors for eye diseases, blindness, and low vision in Tibet, and to assist the development of eye disease prevention and treatment schemes.

• **METHODS:** We carried out a survey of eye diseases among a population living at high altitude. A total of 1 115 Tibetan permanent residents aged 40 years or older from the towns and villages of Qushui County, Lhasa Prefecture, Tibet Autonomous Region, participated in this study. All participants completed a detailed questionnaire, and underwent presenting and pinhole visual acuity tests, and a comprehensive ophthalmic examination.

• **RESULTS:** There were 187 blind eyes (8.43%), 231 eyes with low vision (10.41%). The leading cause of visual impairment was cataract of 55.0% (101/187) blindness and of 50.2% (116/231) low vision, followed by fundus lesions of 22.9% blindness and 23.8% low vision, while only a low prevalence of glaucoma of 9.6% blindness and 1.7% low vision was observed. The analysis of 2 219 eyes showed that the most common external eye disease was pterygium (27.2%) in Tibet.

• **CONCLUSION:** The high prevalence of blindness and low vision in the Tibetan population at high altitude is a serious public health issue. There is a need to establish and maintain an appropriate effective eye care program in Tibet.

• **KEYWORDS:** Tibet; eye diseases; blindness; low vision; risk factors

Table 1 Age and gender characteristics of visual acuity (eyes) in the cohort

Group	<3/60		3/60-6/18		6/15-6/10		≥6/10		Total		x ²	P
	n	%	n	%	n	%	n	%	n	%		
40-49 years	25	13.4	20	8.7	125	19.4	510	44.1	680	30.6	639.969	0.000
50-59 years	16	8.6	30	13.0	168	26.0	406	35.1	620	27.9		
60-69 years	52	27.8	78	33.8	231	35.8	195	16.9	556	25.1		
≥70 years	94	50.3	103	44.6	121	18.8	45	3.9	363	16.4		
Male	88	47.1	107	46.3	272	42.2	480	41.5	947	42.7		
Female	99	52.9	124	53.7	373	57.8	676	58.5	1272	57.3		
Total	187	100.0	231	100.0	645	100.0	1156	100.0	2219	100.0		

SUBJECTS AND METHODS

Subjects A questionnaire assessing personal and family history of ocular diseases and general medical history was completed by 1 115 Tibetan permanent residents aged 40 years or older in two districts of one county chosen by simple randomized methods. Because of diversion of the population distribution and destruction of the examination device during transport, participants were selected from one town with convenient transportation and good living conditions and two villages with stable population sizes for an age-layer survey. All participants belonged to the Zang ethnic group. Participants were divided into four age groups: 40-49 years, 50-59 years, 60-69 years, and ≥70 years. The survey took place in the towns and villages of Qushui County, Lhasa Prefecture, Tibet Autonomous Region, China, between July 2010 and November 2010.

We confirm adherence to the guidelines of the Declaration of Helsinki as well as Naval General Hospital ethics committee approval.

Methods

Visual acuity testing Presenting distance visual acuity (including corrected visual acuity) was measured using an international standard E chart, with a pinhole visual acuity examination if necessary. The visual acuity measured separately for each eye was recorded by trained medical staff and classified into four levels: <3/60, 3/60-6/18, 6/15-6/10, and ≥6/10. According to the World Health Organization classification criteria for visual impairment, blindness was defined as a best corrected visual acuity of <3/60, or a visual field constricted to <10° from fixation in the better eye. Low vision was defined as a best corrected visual acuity of 3/60-6/18, or a visual field constricted to <20° from fixation in the better eye^[10-15].

Ophthalmic examinations All comprehensive ophthalmic examinations were performed by technicians trained and employed in the General Hospital of Tibet Military Command, Lhasa. Examinations included non-contact pneumatic tonometry for intraocular pressure (AT555 Auto Non-Contact Tonometer, USA), computer refractometer optometry, and fundus photography (CR-DGi Non-Mydriatic Retinal Camera, Japan). An anterior segment examination was performed using a slit lamp biomicroscope and posterior

segment examination was performed using a direct ophthalmoscope with pupil dilation if necessary. Primary causes of low vision or blindness and eye diseases were assessed by two senior ophthalmologists based on clinical history and examination results.

Statistical Analysis Double blind data entry and the analysis of data were carried out using the Statistical Package for the Social Sciences for Windows version 16.0 (SPSS, Chicago, IL, USA), and the results were shown in Tables.

RESULTS

General Information A total of 1 115 individuals took part in the survey, including 475 males and 640 females. Participants were aged 40 years or older with a maximum age of 89 years and mean age of 57 ±11 years. Participant numbers per age group were as follows: 40-49 years, 137 males and 203 females; 50-59 years, 119 males and 192 females; 60±69 years, 137 males and 144 females; and ≥70 years, 82 males and 101 females. The disease histories of the study participants included many general diseases, which hypertension was the most common systemic disease related to eye diseases, and occurred at all age groups, with a total of 273 cases (24.5%). The prevalence of hypertension increased with age, and was 38.3% among participants aged ≥70 years. However, the prevalence of diabetes mellitus, which was also related to eye diseases, was low, affecting only 3 cases (0.3%).

Low Vision and Blindness Among the 1 115 participants (2 219 eyes), 11 eyes suffered from eyeball atrophy. The visual acuity of participants separated by age group and gender was shown in Table 1. In all age groups, blindness was found in 25 eyes (13.4%) and low vision was found in 20 eyes (8.7%) in the 40-49 years age group. In the 70 years age group or above, blindness was found in 94 eyes (50.3%) and low vision reached a prevalence of 44.6%. There were no significant differences in blindness or low vision between females and males. Overall, 187(8.43%) eyes were blind; 231 (10.41%) eyes had low vision in Table 2. The cataract was of 55.0% (101/187) blindness and of 50.2% (116/231) low vision, followed by fundus lesions, 22.9% (43/187) blindness and of 23.8% (55/231) low vision, while only a low prevalence of glaucoma of 9.6% blindness and 1.7% low vision was observed.

Table 2 Eye diseases distribution of blindness and low vision (eyes) in the cohort

Disease category	<3/60		3/60-6/18		Total	
	n	%	n	%	n	%
Cataract	101	54.0	116	50.2	217	51.9
Fundus lesion	43	22.9	55	23.8	98	23.4
Glaucoma	18	9.6	4	1.7	22	5.3
Corneal disease	7	3.7	7	3.0	14	3.3
Cataract surgery	7	3.7	19	8.2	26	6.2
Ocular trauma	8	4.3	1	0.4	9	2.2
Ametropia	0	0	26	11.3	26	6.2
Uveitis	2	1.1	2	0.9	4	0.9
Strabismus and amblyopia	1	0.5	1	0.4	2	0.5
Total	187	100.0	231	100.0	418	100.0

Table 3 Age distribution characteristics of eye diseases (eyes) in the cohort

Disease category	40-49 years		50-59 years		60-69 years		≥70 years		Total		χ^2	P
	Diseased/Total	%	Diseased/Total	%	Diseased/Total	%	Diseased/Total	%	Diseased/Total	%		
Pterygium	138/679	20.3	177/620	28.5	200/557	35.9	89/363	24.5	604/2219	27.2	39.409	0.000
Vasodilatation	56/679	8.2	73/620	11.8	83/557	14.9	31/363	8.5	243/2219	11.0	16.597	0.001
Entropion	9/679	1.3	19/620	3.1	10/557	1.8	31/363	8.5	69/2219	3.1	45.901	0.000
Corneal nebula	3/679	0.4	7/620	1.1	11/557	2.0	9/363	2.5	30/2219	1.4	9.528	0.023
Corneal macula	4/679	0.6	7/620	1.1	15/557	2.7	15/363	4.1	41/2219	1.8	20.223	0.000
Cataract	25/679	3.7	37/620	6.0	132/557	23.7	197/363	54.3	391/2219	17.6	498.948	0.000
Cataract surgery	5/679	0.7	6/620	1.0	29/557	5.2	49/363	13.5	89/2219	4.0	120.767	0.000
Glaucoma	5/679	0.7	5/620	0.8	11/557	2.0	17/363	4.7	38/2219	1.7	26.128	0.000
Suspected glaucoma	12/679	1.8	9/620	1.5	10/557	1.8	2/363	0.6	33/2219	1.5	2.902	0.407
Fundus lesion	19/679	2.8	16/620	2.6	44/557	7.9	47/363	12.9	126/2219	5.7	62.57	0.000

Ocular diseases The common eye diseases among participants were shown in Table 3. The most common external eye disease was pterygium (604 eyes, 27.2%), with a high prevalence in the 60-69 years age group (35.9%, $P < 0.01$). Bulbar conjunctival vasodilatation was the second most common, also with a high prevalence in the 60-69 years age group (14.9%, $P < 0.01$). Cataract was the most common eye disease in this study (391 eyes, 17.6%), and the major cause of blindness. The highest prevalence of cataract (54.3%) was in the ≥ 70 years age group ($P < 0.01$). In addition to cataract, fundus lesions were the second leading factors influencing visual acuity and their prevalence also increased with age. The prevalence of fundus lesions including maculopathy, retinal pigment degenerative disease, altitude retinopathy and retinal hemorrhage was 12.90% in participants aged ≥ 70 years. The glaucoma had a low prevalence in this study at 1.7%, while a further 1.5% of participants had suspected glaucoma. Of the 38 eyes with glaucoma, 8 had closed-angle glaucoma, 20 had open-angle glaucoma, 4 had secondary glaucoma, and 6 eyes had absolute glaucoma.

DISCUSSION

Living at altitude above 3 000m is known to have biological effects on the human body [16, 17]. Qushui County is located in the southwestern of Lhasa City, Tibet Autonomous Region,

China, average 3 600 meters above the sea level. Qushui County has Tibetan, Han and Hui ethnicity *etc.*, of 96.4% Tibetans. The unique environment of high altitude includes factors such as low air pressure, hypoxia, dry and cold weather, prolonged and increased exposure to sunlight, strong solar infrared light and UV radiation, and prolonged snow cover, which all have effects on the human body in general and the eyes in particular^[18, 19].

First, we learned the kinds of diseases among 1 115 Tibetan participants with detailed questionnaire including personal, family history and medication history. The most common disease found in the past medical history of participants related closely to the eye diseases was hypertension ($n=273$, 24.5%), and its prevalence increased with age. Hypertension can lead to multiple ocular diseases [20], leading to visual impairment and blindness. Diabetes mellitus, a major cause of health problems in developed countries, can also lead to visual impairment and blindness [6, 8, 9]. However, only three participants suffered from diabetes mellitus in this study. The true prevalence may be higher, as some cases may be missed diagnosis because of low levels of education and health care. The eye, like every other organ, is affected by the hypobaric hypoxia of high altitude. High altitude does expose residents to risk factors for eye problems, including excess ultraviolet light, hypoxia, and cold, dry conditions. The quantity of UV

light increases with increasing altitude, which damaged to almost all eye tissues (lids, cornea, conjunctiva, lens and retina)^[21, 22]. The most common external eye disease in all age groups was pterygium, with the highest prevalence (35.9%) in the 60-69 years age group. Pterygium frequently occurs at high altitudes with high ultraviolet radiation, and dry and dusty climates^[23, 24].

Cataract is the most common eye disease and the leading cause of reversible blindness^[25-27]. Cataracts occur in people aged 5-10 years younger in the plateau than those at low altitudes^[28]. We found a 3.7% prevalence of cataract among the 40-49 years age group. Advancing age was a leading risk factor for the development of cataract, the highest prevalence of cataract (54.3%) was observed in the age group of ≥ 70 years. The human visual system is affected by the hypobaric conditions and hypoxemia encountered at high altitude, increased damage to the optic nerve with hypoxemia^[22]. The second most frequent eye diseases were fundus diseases, including age-related macular degeneration, retinal pigment degenerative disease, hypertensive retinopathy and plateau retinopathy. Glaucoma is the second leading cause of blindness worldwide and is of major public health problem. Although it is the leading cause of irreversible blindness worldwide, the prevalence of glaucoma was relatively low in this study, at 1.7%. An additional 1.5% of participants (33 eyes) had suspected glaucoma. Because the primary glaucoma missed are as high as 50% in the developed countries at present, China and other developing countries have more than 90% of the patients with glaucoma unknown their disease, especially in remote plateau areas.

Zhao *et al*^[29] conducted an epidemiological study of primary angle-closure glaucoma in Tibet and found that the prevalence of angle-closure glaucoma in Lhasa was significantly lower than that in Beijing. We found 8 eyes with angle-closure glaucoma, and 20 eyes with open angle-glaucoma, among the 38 eyes with glaucoma. The different kinds of glaucoma in different genders, ethnicities and regions may be associated with the anatomy of the eyes^[30-32]. Early diagnosis and regular follow-up are important for the maintenance of visual acuity and prevention of blindness from glaucoma^[33, 34].

In 2002, the World Health Organization estimated that there were 37 million people with blindness and 124 million with low vision worldwide^[35, 36]. Among all participants, 187 eyes were blind and 231 eyes had low vision. The major risk factors for the prevalence of blindness and low vision were affected by many factors, including age, gender, health care, illiteracy, economic status, and rural and remote residence. Age was most significantly associated with increased prevalence of visual impairment and blindness. In the ≥ 70 years age group, 94 eyes were blind (50.3%; 94/187) and the prevalence of low vision reached 44.6%. In various studies,

the prevalence of blindness has been found to increase with age. In China, the prevalence of blindness was found to be 2% in the 50-59 years age group, and increase to 27.5% in the 60-69 years age group, and 48.8% in the 70-79 years age group^[37]. In our study we found prevalence of 8.6% in 50-59 years age group, 27.8% in the 60-69 years age group, and 50.3% in people above 70 years of age. The prevalence of low vision in rural areas was higher than that in the city, often associated with poverty, overcrowding, poor sanitation and weak health services. However, other rural risks could include physical factors, such as prolonged exposure to heat or dust. Many elderly women in rural areas suffer from visual impairment more than elderly men as a result of gender differences in the provision of medical services.

A number of epidemiological studies^[7,9,13,35,37,38] show that cataract is the leading cause of blindness and low vision and a leading global health burden, especially in developing countries. In our study, cataract, a leading cause of blindness and low vision, was of 55.0% (101/187) blindness and of 50.2% (116/231) low vision. The risk factors for cataract were not only in accordance with those found in these other studies, but also associated with the high altitude, and education degree and economic levels. In addition, the number of surveyed women (640) in this study was a little more than that of men (475), which will contribute to the high prevalence of cataract observed in this study.

This study was not without its limitations. Our sample size was small, and most participants were rural residents. However, our data estimated high prevalence of visual impairment and blindness, and of risk factors for other eye diseases among a population living in a unique environment. These findings justify of interest to the clinician treating eye diseases at high altitudes, an increasingly concerning public health problem in Tibetan plateau areas.

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