

# Prevalence of and Risk Factors for Pterygium in Rural Adult Chinese Populations of the Bai Nationality in Dali: The Yunnan Minority Eye Study

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**PURPOSE.** The purpose of the study was to describe the prevalence, severity, and associated risk factors for pterygium in a population-based sample of rural residents of the Bai minority population in rural Dali, China.

**METHODS.** A population-based survey of Chinese Bai Nationality aged  $\geq 50$  years from randomly selected block groups in southwestern China was conducted. A clinical examination by experienced ophthalmologists was carried out, and the presence of pterygium was diagnosed at the examination. Pterygium was graded clinically by slit lamp examination. Questionnaires were conducted on risk factors.

**RESULTS.** From a total of 2742 eligible subjects, 2133 (77.8%) were examined. The prevalence of pterygium was high (overall 39.0% [95% confidence interval (CI) 37.0–41.0]). Women had a higher rate than men (27.3% vs. 11.7%, respectively). In multivariate analysis, pterygium was independently associated with increasing age (odds ratio [OR] 1.55 [95% CI 1.24–1.93], 1.47 [95% CI 1.13–1.91], and 1.79 [95% CI 1.17–2.73], respectively, for persons 60–69 years, 70–79 years, and 80 years and older compared with 50–59 years), female sex (OR 1.42 [95% CI 1.08–1.88]), lack of formal education (OR 1.26 [95% CI 1.03–1.56]), and presence of outdoor work (OR 1.51 [95% CI 1.10–1.92]). Height, weight, hypertension, diabetes, smoking, and alcohol use history were not associated with pterygium.

**CONCLUSIONS.** The prevalence of pterygium in Dali is 39.0% among Chinese Bai aged 50 years and older. Independent

associations with increasing age ( $>59$  years), female sex, lack of education, and occupations linked to outdoor work suggest a multifactorial cause of this condition. (*Invest Ophthalmol Vis Sci.* 2012;53:6617–6621) DOI:10.1167/iops.11-8947

Pterygium is a wedge-shaped abnormal fibrovascular growth of conjunctiva that extends onto the cornea. This is a proliferative disorder of the ocular surface, caused by connective tissue remodeling and angiogenesis leading to fibrovascular proliferation.<sup>1</sup> The prevalence of pterygium reported in different studies varies widely with age, sex, race, and geography.<sup>2–6</sup> In the Barbados eye study, pterygia were found among 23.4% of black, 23.7% of mixed (black and white), and 10.2% of white participants.<sup>7</sup> The prevalence of pterygium in Chinese differed in various studies and areas, ranging from 2.9% in north Chinese to 14.49% in Tibetans and 33.01% in rural Chinese in southern China.<sup>8–10</sup> In Singapore, 6.9% of adult ethnic Chinese were found to have pterygium in either eye.<sup>5</sup> The Meiktila Eye Study reported a high prevalence of pterygium (19.6%) in central Myanmar, which has ethnically similar populations to China.<sup>11</sup> Pterygium has been associated with environmental factors<sup>1,12,13</sup> such as ultraviolet radiation, geography, heat, dust, and a dry atmosphere. The pathogenesis and mechanisms, however, are not known.

The Yunnan Minority Eye Study (YMES) is a population-based epidemiologic study on ocular diseases conducted in Yunnan, China, and carried out in three counties with mainly minority populations, including Bai, Yi, and Dai minority nationalities, respectively. The prevalence of pterygium in members of the Bai Nationality was examined as part of YMES in rural Dali Chinese aged 50 years or older. The Bai are one of the 56 ethnic groups officially recognized by People's Republic of China; they live mostly in Dali Bai Autonomous Prefecture in Yunnan Province. To our best knowledge, no such study has ever been conducted among the adult Bai Nationality.

Dali is located in Yunnan-Guizhou Plateau and is known for high winds. Pterygium in Chinese minority nationalities and in such plateau peoples who have high exposure to sunlight and wind has not been well studied. The purpose of our study was to determine the prevalence and risk factors for pterygium in a population of Bai Nationality adults residing in rural southwestern China.

## METHODS

### Study Population

Dali is a 1815 km<sup>2</sup> city (county level) located in the southwestern part of China (eastern longitude 99°58' and northern latitude 25°25') and has a population of approximately 520,000 (National Census 2000;

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<http://www.stats.gov.cn/tjsj/nds/jrenkoupuocha/2000jiedao/html/J53.htm>), most of whom are Bai Nationality. Dali has a temperate climate, with average daily temperatures of 14.9°C and yearly total rainfall of 1056 mm.

The study was conducted in accordance with the tenets of the World Medical Association's Declaration of Helsinki. Study subjects were enrolled in a randomly selected sample of individuals in Dali. Details of the study have been reported previously.<sup>14</sup> The sampling frame was constructed using geographically defined clusters based on village register data. Cluster boundaries were defined such that each cluster would have a population of approximately 1000 individuals (all ages). Villages larger than 1500 in total population were subdivided, and where geographically practical, villages smaller than 750 were grouped. In this way, cluster sampling was used to divide Dali County into 259 areas. Field work was carried out over a 4-month period beginning in January 2010. Listing of households with the names of residents  $\geq 50$  years of age was obtained from the village registers, followed by door-to-door household visits conducted by enumeration teams. Residents  $\geq 50$  years of age were enumerated by name, sex, age, education (using graduation levels), and spectacle usage. Individuals temporarily absent at the time of the household visit were included in the enumeration. Unregistered adults  $\geq 50$  years of age were enumerated and included in the study sample if they had been living in the household for 6 months.

An examination site was set up in the local community facilities within 15 minutes' walking distance for most subjects. Study participants were examined according to a prescheduled date established at the time of enumeration. Identity of the subjects was verified using the subjects' official photo identity cards. Those who did not appear at the examination site were revisited, repeatedly if necessary, by a member of the enumeration team to encourage participation. Home visits and examinations were performed for inpatient, paralyzed, and disabled residents.

Two optometrists used an auto refractometer (RM-8000; Topcon Corp., Tokyo, Japan) to measure the noncycloplegic refraction. Distance visual acuity was measured using a retro-illuminated logarithm of the minimum angle of resolution tumbling E chart at a distance of 4 m, and at 1 m for those failing to read the top line (20/200). Visual acuity was recorded as the smallest line read with one or no errors. Testing for counting fingers, hand movement, or light perception was performed on those unable to read the top line at 1 m. Each eye was measured separately, with glasses if worn for distance correction. The presenting visual acuity with habitual correction was recorded. In those presenting with visual acuity  $< 20/25$  in either eye, best corrected visual acuity (BCVA) was assessed using the results of autorefractometry and subjective refinement.

Each participant then received a comprehensive eye examination including slit lamp (model SL-1E; Topcon Corp.) examinations of ocular surface, anterior segment, and lens, as well as stereoscopic fundus examination.

## Grade of Pterygium

The examination of the anterior segment of the eye was performed by two experienced ophthalmologists using a slit lamp. Participants were examined one by one, and the pupils were not dilated during the examination. Pterygium was defined as a raised fleshy triangular fibrovascular tissue growth of the conjunctiva encroaching onto the clear cornea. The severity of pterygium, if present, was graded under standard lighting conditions based on the location of the pterygium head encroachment on cornea as follows<sup>15,16</sup>:

- Grade 0: no pterygium
- Grade 1: head of pterygium at the limbus
- Grade 2: head of pterygium between the limbus and the undilated pupil margin
- Grade 3: head of pterygium within the pupil margin
- Grade 4: head of pterygium crossing the pupil

If the participant had bilateral pterygium, he or she was classified according to the higher-grade pterygium (worse eye).

## Demographic and Lifestyle Data

Data on demographic and lifestyle factors were collected by a trained interviewer using a standard questionnaire. The risk factors were evaluated as follows: (1) Personal characteristics included age, sex, years of education, occupation, income, smoking status, and alcohol use; (2) environmental variables included job location (outdoors or at sea versus indoors), hat or umbrella use, and the use of sunglasses; (3) medical factors included general medical history, and ocular factors included the presence of any eye disease or history of eye surgery.

## Statistical Analysis

Statistical analysis was performed using a commercially available statistical software package (SPSS for Windows, version 16.0; SPSS, Chicago, IL). The prevalence rates of pterygium for subjects were calculated. For independent samples, Student's *t*-tests were used to compare means, and  $\chi^2$  tests were used to compare proportions. Logistic regression was used to investigate associations of pterygium and risk factors, such as age, sex, education, smoking history, and outdoor work history. Confidence intervals (95%) are presented. All *P* values are two-sided and considered to be statistically significant when less than 0.05.

## RESULTS

There were 2742 residents eligible for the study; 2133 (77.8%) participants were examined. They ranged in age from 50 to 92 years, with a mean age of  $64.5 \pm 8.8$  years. Examination response was highly associated with older age and female sex. Comparing the demographic characteristics of the enumerated sample with the total population of Dali city (National Census 2000), only subjects aged 50 to 59 years were underrepresented in the sample (33.5% in the sample versus 45.7% in total population). The nonparticipants were more likely to be male, but there was no difference in mean age between nonparticipants (64.1 years) and participants (64.6 years). Of the 608 (22.2%) nonexamined subjects, 593 (21.6%) cooperated only in the first step of household interview, and 15 (0.55%) could not be contacted during three visits for the household interview. Nonresponders in each village were usually unable to attend due to occupation-related commitments. Other reasons for refusal to participate were attributed to being too busy, having confidence in one's health, avoiding seeing a doctor so as to conceal one's illness, or our inability to contact the subjects after the interview. Table 1 compares demographic characteristics of the Bai people participants with ophthalmologic examinations according to the presence or absence of pterygium.

The prevalence of pterygium in at least one eye, by age and sex, is shown in Table 2. The prevalence of pterygium was 39.0% (95% confidence interval [CI] 37.0–41.0), and 832 subjects were diagnosed with pterygium in at least one eye. In each age group, women had a prevalence of pterygium twice that of men. Pterygium was increased in frequency in elderly people (32.0%, 43.1%, 41.3%, and 44.1%, respectively, in the 50–59, 60–69, 70–79, and  $> 80$  age groups). Pterygium was equally common in left as in right eyes (29.6% vs. 32.1%, respectively). The bilateral pterygium prevalence was 14.8% (95% CI 13.3–16.3), with a mean 38% of pterygium subjects having bilateral disease. The visual acuity (VA) of eyes with pterygia was worse than for eyes without pterygia (median logarithm of minimal angle of resolution [logMAR] acuity 0.55 vs. 0.63, *P* < 0.001). The difference between grade of lesion

TABLE 1. Demographic and Other Variables among Bai People in the YMES by Pterygium Status

Variable	No Pterygium (n = 1301)	Pterygium (n = 832)	P Value
Female (%)	781 (60.0)	583 (70.0)	<0.001
Age (y)			
50-59	486	229	<0.001
60-69	441	334	<0.001
70-79	308	217	0.21
>80	66	52	0.25
Outdoor work (%)	761 (58.5)	566 (68.0)	<0.001
No education (%)	409 (31.4)	350 (42.1)	<0.001
Height (cm), mean $\pm$ SD	159 $\pm$ 8.4	157 $\pm$ 7.9	0.041
Weight (kg), mean $\pm$ SD	55 $\pm$ 9.8	54 $\pm$ 9.5	<0.001
Hypertension (%)	628 (48.3)	457 (54.9)	0.003
Diabetes (%)	35 (2.7)	13 (1.6)	0.087
Smoking (%)	353 (27.1)	186 (22.4)	0.013
Alcohol use (%)	198 (15.2)	118 (14.2)	0.51

and VA was significant (median VA for grade 1 lesions = 0.63, with grade 2 = 0.56, grade 3 = 0.47, and grade 4 = 0.13,  $P < 0.001$ ), and the grade 4 subjects had the worst VA. There were 31 cases (36 eyes) with pterygia with visual impairment (BCVA  $<20/63$ - $\geq 20/200$ ) or blindness (BCVA  $<20/200$ ). There were 61 people who were blind in both eyes in the present study, one of whom was blind in both eyes from pterygium (1.6%; 95% CI 0-8.8). There were 15 blind eyes with pterygium.

The prevalence was different in different grades. Grade 2 was the most common grade of pterygium in both males and females, in all age groups. Pterygium was associated with age and sex ( $P < 0.001$ ).

Logistic regression analysis results are presented in Table 3. Pterygium was significantly more likely in age  $>59$  as opposed to ages 50 to 59. Furthermore, pterygium was associated with female sex and outdoor work. There was no significant difference in pterygium prevalence according to height, weight, hypertension, diabetes, smoking, or alcohol use history. Those people who primarily worked outdoors were more likely than people who primarily worked indoors to have pterygium ( $P < 0.001$ ). All people enrolled in our study were not accustomed to using protective tools (sunglasses, hats, or umbrellas) when outdoors. Whether the protection could influence the prevalence of pterygium was not certain. Therefore the use of sunglasses or hats was not included in the analysis.

## DISCUSSION

The Bai ethnic group is a major component of the Chinese minority nationality. The main occupation of the Bai ethnic

group is agriculture, accounting for their exposure to outdoor work. In summary, 39.0% of rural Chinese Bai people older than 50 years had pterygium in either eye, with 14.8% having pterygium in both eyes. The prevalence rate was higher than in most similar studies conducted in a general population or in other regions of China, which have reported ranges from less than 0.3% to 33.01%.<sup>3,7-10</sup> However, the results reported by different groups may not be directly comparable since prevalence rates are influenced by factors such as the type of the population screened, the age range of the respondents, variable exposure to environment, and occupational and genetic factors. Various grading systems between different studies also make it difficult to compare the severity of the disease between them.<sup>15</sup>

The results demonstrate a high prevalence of pterygium among the Bai Nationality of Dali. It appears that nearly two-fifths of people over the age of 50 years suffer from pterygium. Dali is a city with a tropical high-altitude, arid climate and perennial windy conditions. The environment includes factors such as dry and warm weather, prolonged and increased exposure to sunlight, and strong solar UV radiation, which all have effects on the eyes in particular. UV radiation has been suggested as a very important factor in the pathogenesis of pterygium.<sup>2,17-19</sup> It is believed that UV light causes thickening and hyperplasia in subconjunctival connective tissue. Differences in exposure to UV radiation may account for variation with geographical location and time spent outdoors, which is itself affected by the occupation of the subjects. In 1965, Cameron described a "pterygium belt" located between 37° north and south of the equator, where pterygia are supposedly more common.<sup>20</sup> The "pterygium belt" was named by the areas with high sun radiation; the people have more chance of

TABLE 2. Prevalence of Pterygium by Age and Sex in 2133 Bai Individuals

Age (y)	Male		Female		Total	
	N (Pterygia/Total)	Prevalence (95% CI)	N (Pterygia/Total)	Prevalence (95% CI)	N (Pterygia/Total)	Prevalence (95% CI)
50-59	53/220	24.1 (18.6-30.3)	176/496	35.5 (31.3-39.8)	229/716	32.0 (28.6-35.5)
60-69	111/307	36.2 (30.8-41.8)	223/468	47.6 (43.0-52.3)	334/775	43.1 (39.6-46.6)
70-79	66/203	32.5 (26.1-39.5)	151/321	47.0 (41.5-52.7)	217/524	41.4 (37.2-45.8)
>80	19/39	33.3 (19.1-50.1)	33/79	41.8 (30.8-53.4)	52/118	44.1 (35.0-53.5)
Overall	249/769	32.4 (29.1-35.8)	583/1364	42.7 (40.1-45.4)	832/2133	39.0 (37.0-41.0)
Unilateral	119/769	15.5 (13.0-18.2)	397/1364	29.1 (26.7-31.6)	516/2133	24.2 (22.4-26.0)
Bilateral	130/769	16.9 (14.3-19.7)	186/1364	13.6 (11.9-15.6)	316/2133	14.8 (13.3-16.3)

**TABLE 3.** Results of Logistic Regression Analysis for Association with Pterygium in YMES

	Odds Ratio (95% CI)	P
Female sex	1.42 (1.08-1.88)	0.012
Age (y)		
50-59	1.00	
60-69	1.55 (1.24-1.93)	<0.001
70-79	1.47 (1.13-1.91)	0.004
>80	1.79 (1.17-2.73)	0.007
Outdoor work	1.51 (1.26-1.81)	<0.001
No education	1.26 (1.03-1.56)	0.028
Height (cm)	0.99 (0.97-1.01)	0.158
Weight (kg)	1.01 (1.00-1.02)	0.204
Hypertension	1.19 (0.99-1.43)	0.056
Diabetes	0.55 (0.28-1.08)	0.082
Smoking	1.06 (0.81-1.38)	0.686
Alcohol use	1.22 (0.91-1.64)	0.176

exposure to UV radiation. Dali is located near 25°42'N, within the belt. A high prevalence in Dali seems to support the "pterygium belt" theory. However, there are some places with a low prevalence of pterygium despite a similar location near the equator.<sup>3</sup> In contrast, Eskimos in Greenland have a relatively high prevalence (9.6%) outside of this belt.<sup>21</sup> So the amount of time spent working outdoors and exposed to sunlight is an important factor.<sup>22,23</sup> The participants in the present study mostly live by fishing and farming. They spend most of their working hours outdoors without sunglasses or other protective measures, which means more exposure to the UV radiation and reflection.

Dali city is also famous for windy conditions. Previous studies have reported that a windy environment contributes to the formation of pterygia.<sup>24,25</sup> The mechanism has not been confirmed. Adverse environmental conditions such as weather that is windy, dry, or low in humidity could lead to reduced tear production, poor tear quality, and/or excessive tear evaporation.<sup>18,26,27</sup> Unstable tear film may contribute to the initiation of pterygium.<sup>28</sup> It should be pointed out that the association between pterygium and dry eye is equivocal. Therefore we presume that windy conditions could irritate hyperplasia in subconjunctival connective tissue and lead to the breakdown of ocular surface homeostasis, which induces tissue susceptibility to UV radiation. The present study was conducted at the Yunnan-Guizhou Plateau, with an average altitude of 2000 m, and the participants in the survey were all native Bai living at high altitude. Only a small minority of published studies in the ophthalmic literature deals with the effects of windy and high altitude on the formation of pterygium. In the Qinghai-Tibet Plateau, the prevalence of pterygium was reported as 17.9% to 22.79% in people aged 40 years and older.<sup>29,30</sup> In another study of rural people in south China, 33.01% of subjects aged 50 years or above were diagnosed with pterygium.<sup>10</sup> We believe that a variety of environmental factors and lifestyles, acting alone or in combination, influence or trigger the pathophysiological events that result in pterygium. In our study, pterygium was increased in frequency in elderly people (>60 years) compared to the 50 to 59 age group. With increasing age, the damage of UV radiation accumulates, so the prevalence of pterygium was higher in older than in younger people.

Sex has been suggested as another risk factor for the development of pterygia, although the results have been mixed, possibly confounded by other factors such as the

populations being studied, lifestyle, and exposure to environmental risk factors. In our study, the prevalence in females (27.3%) was higher than that in males (11.7%). The results were different from those reported in most previous studies.<sup>5,8,12,17</sup> The Bai minority culture has always been a matriarchal society. The minority women are always involved in outdoor work, particularly in farming or fishing, and they do not traditionally wear glasses to protect their eyes. The rural men are usually engaged in business, as drivers or in various indoor jobs. Women in this area work outdoors more than men. We believe that this is the reason that pterygium occurred more in females in our study. Some earlier studies in Qinghai, China, yielded a similar result.<sup>9</sup>

Lack of formal education was a risk factor in our study, possibly as a result of a lower socioeconomic status in the Bai people. The subjects without education were limited in employment, most of them living by primary agricultural and fishing activities, so they have more chance to be exposed to UV radiation. In this study we found that those who were illiterate had increased incidence of pterygium; and similar to what has been reported in Chesapeake Bay watermen, more than 8 years of education was found to be beneficial in protecting them from pterygium.<sup>2</sup> In the Barbados Eye Study, logistic regression analyses indicated a positive association between pterygium and fewer years of education.<sup>7</sup>

Logistic regression analysis showed that the systemic characteristics of subjects (height, weight, hypertension, and diabetes) were not associated with pterygium. We also did not find evidence to support smoking or use of alcohol as risk factors.

In conclusion, the prevalence of pterygium was 39.0% among the Bai Nationality aged 50 years and older in rural Dali, a southwestern low-latitude county of China; this is one of the highest prevalence rates reported when compared to results from previous population-based studies. Older age (>59 years), female sex, educational experience, and outdoor job history without eye protection were independently associated with a higher risk of pterygium. Based on the present study, we should focus on public education encouraging outdoor workers to take appropriate protective measures in rural China, such as wearing sunglasses and brimmed hats to avoid unnecessary sunlight exposure and strong wind irritation. We will make further efforts to study pterygia in more Chinese minorities with emphasis on ethnic or genetic predisposition.

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