Int J Clin Exp Med 2017;10(2):3494-3501
www.ijcem.com /ISSN:1940-5901/IJCEM0043596

Original Article

Relationship between pterygium and age-related cataract among rural populations living in two different latitude areas in China

Xiao-Guang Cao, Xiao-Xin Li, Yong-Zhen Bao

People Eye center, Peking University People's Hospital, Key Laboratory of Vision Loss and Restoration, Ministry of Education, Beijing, China

Received November 4, 2016; Accepted December 8, 2016; Epub February 15, 2017; Published February 28, 2017

Abstract: Purposes: To evaluate the prevalence of pterygium and its relationship with the prevalence of age-related cataract (ARC) among rural populations age 50 years or older in two different latitude areas in Western China. Methods: Cluster sampling was used to randomly select individuals, aged 50 years or older in two rural sites (Qinghai and Guangxi) with different latitude in Western China. A total of 2,496 individuals received questionnaires and comprehensive ocular examinations. ARC was defined as visual impairment secondary to lens opacity, which graded with LOCS II. The geographical information of two investigated sites and the demographic data of two populations were collected and compared. Prevalence of pterygium and ARC were evaluated, and statistical analysis of the relationship between the prevalence of pterygium and ARC with different grading was performed. Results: The response rates were 86.20% and 90.40% for Qinghai and Guangxi, respectively. The prevalence rate of pterygium was 36.05% in Guangxi, the lower latitude area (latitude 22.24) and 12.65% in the Qinghai-Tibetan Plateau (latitude 36.63) among adults aged 50 years or older. In these pterygium patients, 91 in Qinghai (56.17%) and 224 in Guangxi (51.14%) also had ARC. The patients with pterygium had a higher prevalence rate of ARC than those without pterygium (39.77% for Qinghai and 32.82% for Guangxi respectively). Beside the regional difference, the risk factors of pterygium included older age, female and ARC. Conclusions: The prevalence of pterygium among rural adult populations is higher in lower latitude region, and it is strongly associated with age-related cataract.

Keywords: Prevalence, pterygium, age-related cataract, latitude, relationship

Introduction

Pterygium is a potentially blinding disease in the advanced stages, and it has a relatively high recurrence rate, even after complex surgery for visual rehabilitation. Despite being a common ocular disease, the etiology of pterygium is still unclear. Understanding the causes and the distribution of this disease may be helpful for prevention and management [1-6]. The prevalence of pterygium varies widely for different populations and areas. It is as low as 1.2% among urban Caucasians in temperate areas, [4] and as high as 23.4% among black population in tropical areas [7]. The prevalence rates in the tropics were generally higher than those in temperate areas, which indicate that ultraviolet (UV) light exposure may be a major causative factor in the pathogenesis of pterygium. Due to differences in the study criteria and races of studied populations, comparison between different studies may be difficult. An epidemiological study with uniform criteria and participants of the same race from different environments is still needed to explore the etiology of pterygium. As pterygium and age-related cataract (ARC) might have a common risk factor, such as UV light, [8, 9] the relationship between pterygium and ARC is also very interesting.

In this study, we report the prevalence of pterygium in two rural areas of Western China with different latitudes, and try to explore the relationship between pterygium and ARC.

Materials and methods

Sampling

The study was approved by the Human Research Ethics Committee of People's Hospital, Peking

Table 1. The general information about two rural investigated areas

Province	Location	Longitude	Latitude	Altitude (meter)	Annual sunshine time (hours)	GDP ($)	Annual income ($)
Qinghai	Pingan	101.75	36.63	2100	2473	416.36	209.52
Guangxi	Chongzuo	102.71	22.24	350	1786	698.33	292.62

The economic data were collected from Statistics Bulletin 1999, National Bureau of Statistics of China.

University, and adhered to the guidelines of the Declaration of Helsinki. This cross-sectional study included two sites, Pingan county of Qinghai Province (data collected in August 2003) and Chongzuo county of Guangxi Province (data collected in May 2004). General information about the two sites is shown in **Table 1**.

Random cluster sampling was used to select villages (clusters) in these two different rural areas. The methodology had been completely established before the study began. Oral informed consent was obtained from each participant. The sample size necessary for each test site by using the following formula: $N=KZ^2 (p) (1-p)/B^2$, where p is the prevalence of pterygium, which has a presumed value of 20% according to the clinical experience. B is product of prevalence and sampling error, with sampling error assumed to be 15%, B equal to 0.03. With 95% confidence, Z=1.96. It was assumed that a cluster design effect of as high as 2.0 might be present (K=2), so N=1024. The actually study sample was larger than this theoretical number.

Based on the household census, demographic details of eligible respondents in the selected clusters (villages) were collected by trained local social workers, who performed door-to-door screening before the study began. Eligible residents were then invited to a local examination site for a more detailed interview and a comprehensive ocular examination. In order to improve the response rate, we set up a temporary examination site in each village selected.

Before the screening, all potential participants were told the details of the investigation. All participants provided informed consent. All informed consent was collected verbally because a significant proportion of these populations were illiterate.

A structured questionnaire was used to obtain information about demographic data (age, gender, locality, marital status, and education), family history, medical history, and lifestyle (smoking, alcohol intake).

Four ophthalmologists involved in the investigation of these two areas were trained to follow standardized procedures for ocular examination and pterygium grading. During the investigation of the two populations, one ophthalmologist was in charge of IOP measurement, one was in charge of fundus examination, and two were in charge of pterygium grading under a slit lamp biomicroscope. These two ophthalmologists were standardized among themselves as well as to the senior ophthalmologist (Dr. Yongzhen Bao) who was considered to be the gold standard before and during the investigation.

The ocular examination included visual acuity, pupillary response, external and anterior segment examination using a slit lamp biomicroscope (TOPCON SL-1E, Japan), and measurement of intraocular pressure with Tono-pen®XL (Medtronic Company, U.S.A). After these examinations, a clear lens or severe lens opacity was defined, and pupil dilation was carried out in which lens opacity could not be graded without dilation unless otherwise contraindicated by flat chamber. The posterior segment was examined using indirect ophthalmoscope (HEINE mini2000, Volk 90D, U.S.). Direct ophthalmoscope (HEINE Ra-200, U.S.) was used to estimate the refractive condition of the examinees.

Visual acuity was measured separately for each eye, under standardized conditions at 5 meters. An illuminated Snellen E optotype card was placed in full daylight and protected from glare and shadow. Pinhole visual acuity was measured in those eyes with presenting visual acuity worse than 6/18.

Definition and grading of pterygium

Definition: Pterygium was defined as a radially oriented fibrovascular lesion of the conjunctiva

Table 2. The general information about participants in the two rural areas

	Pingan, Qinghai	Chongzuo, Guangxi
Selected samples (person)	1486	1344
Participants (person)	1281	1215
Response rates	86.20%	90.40%
Age range (year)	50~89	50~89
Average age (year)	60.84±8.72*	64.34±9.98*
Male (person)/(percentage)	473/36.92%	471/38.77%
Female (person)/(percentage)	808/63.08%	744/61.23%
Male average age (year)	61.52±8.75	63.18±9.14
Female average age (year)	60.45±8.68	65.09±10.43

*There was statistically significant difference in the two areas (P≤0.003).

crossing the nasal or temporal limbus onto the clear cornea for which there was no alternative explanation, such as ocular trauma.

Grading: Pterygium was graded, by length (L), the number of millimetres from the tip to the middle of the base of the triangular band of fibrovascular tissue. Encroachment on the cornea was required for the definition of pterygium, but optical zone involvement was not. Grade I, L<2 mm; Grade II, 2 mm≤L<3 mm; Grade III, 3 mm≤L<4 mm; Grade IV, 4 mm≤L<5 mm; Grade V, L≥5 mm. As the diameter of pupil usually is 2.5 to 4.0 mm, the grade III-V pterygium might block the pupil and decrease the visual acuity significantly besides inducing astigmatism.

Definition and grading of age-related cataract

Definite ARC was defined as presenting visual acuity of less than 10/16 combined with any category of lens opacity which meets the following criteria according to LOCS II: Cortical cataract was defined as opacity greater than or equal to 1/4 of pupil circumference. Nuclear opacities were graded and cataract was defined as greater than or equal to nuclear opalescence grade 1.0. Posterior subcapsular cataract was defined as posterior subcapsular opacity greater than or equal to grade 1.0. Persons with previous cataract surgery performed after they were 50 years of age due to ARC referring to the questionnaire and eye examination were included for ARC prevalence estimation [8]. Complicated or traumatic cataract was excluded.

Statistical analysis

Statistical analysis was performed using Statistical Analysis System (version 11.5; College Station, TX, USA) software. A *p* value of less than 0.05 was considered to be statistically significant. The prevalence of pterygium and blindness was estimated, with 95% confidence intervals. X^2 Test was performed to test for an association between each independent variable and dependent variable for univariate analysis. The risk factors were calculated with the binary logistic regression. The comparison of age structure between the two populations was analyzed using One-way ANOVA. Age-adjusted prevalence of pterygium was estimated using the following formula: P=ΣNi*pi/N, where p is the age-adjusted prevalence, Ni is the number of people within the different age groups (age 50~59, 60~69, ≥70 years), N is the total number of people aged 50 years or older in the whole country (China Census 2000); pi is the prevalence of different age groups in the study population.

Results

Study population

The response rates were 86.20% and 90.40% for Qinghai and Guangxi, respectively. The populations in these two areas had almost the same demographic data, as shown by **Table 2**, these participants of two areas have the same age range (50-89 years), and the similar rates of female. The average ages of male and female participants in Qinghai were 61.52±8.75 and 60.45±8.68 years. And those of Guangxi were 63.18±9.14 and 65.09±10.43 years.

Prevalence of pterygium

Table 3 shows the prevalence rates of pterygium in the two investigated areas. The participants in Qinghai have 80 unilateral and 82 bilateral pterygia, and there were 158 unilateral and 280 bilateral pterygia in Guangxi (χ^2=8.754, P=0.003). Pterygium was detected in 162 participants (12.65%) in Qinghai and in 438 (36.05%) in Guangxi (χ^2=187.035, P< 0.001). In the two populations, 600 pterygium patients (24.04%) were detected.

It is obvious that the prevalence of pterygium increases significantly with increasing age

Table 3. The prevalence rates of pterygium in the two rural areas

Gender	Age stage (year)	Pingan, Qinghai			Chongzuo, Guangxi		
		Investigated (person)	Patients with pterygium		Investigated (person)	Patients with pterygium	
			Person	%		Person	%
Male	50-59	214	12	5.61*	182	39	21.43*
	60-69	166	17	10.24*	167	55	32.93*
	70-	93	17	18.28*	122	34	27.87*
	Sum	473	46	9.73$,*	471	128	27.18*
Female	50-59	430	41	9.53*	261	84	32.18*
	60-69	219	43	19.63*	221	98	44.34*
	70-	159	32	20.13*	262	128	48.85*
	Sum	808	116	14.36$,*	744	310	41.67$,*
Total	50-59	644	53	8.23*	443	123	27.77#,*
	60-69	385	60	15.58#,*	388	153	39.43#,*
	70-	252	49	19.44*	384	162	42.19#,*
	Sum	1281	162	12.65$,#,*	1215	438	36.05$,#,*

*For each age stage, the difference of prevalence rates in the two areas (P<0.05) is significant. $For each area, the difference of prevalence rates in these three age stages (50-59 years, 60-69 years and ≥70 years) is significant, including both of male and female (P<0.05). #For each area, the difference of prevalence rates between male and female in the same age stage is significant (P<0.05).

Table 4. The grading of pterygium in the two rural area

Grading (eyes/percentage %)	I*	II*	III*	IV*	V*	Sum*
Pingan, Qinghai	1/0.41	79/32.38	86/35.25	41/16.80	37/15.16	244/100.00
Chongzuo, Guangxi	18/2.50	263/36.58	206/28.65	140/19.47	92/12.80	719/100.00

*X^2>13.250, P<0.001.

(Qinghai χ^2=24.92, P=0.000; Guangxi χ^2=21.90, P=0.000). In same age, the difference between the prevalence of pterygium in these two areas was obvious significantly not only in overall but also in gender (male χ^2>24.00, P<0.01; female χ^2>95.00, P<0.001; overall χ^2>125.00, P<0.001). In both areas, the prevalence of pterygium was higher in female than in male.

Table 4 showed the grading of pterygium in these two rural areas. For the participants in Qinghai, grade III take the major part of pterygium, and for the population in Guangxi, grade II take the major part. Although the prevalence of pterygium was higher in Guangxi, the populations in Qinghai had more severe pterygia (equal or severe than grade III).

In order to compare the prevalence of pterygium between the two areas, age-adjusted prevalence of pterygium was calculated relative to the 2000 China census data (19.21% for age 50 years or older in a total population of 1,242.61 million) because there were differences in age structure in the two areas. The age-adjusted prevalence of pterygium of the two investigated areas based on this reference changes to 13.05% from 12.65% for Qinghai, 34.68% from 36.05% for Guangxi, and 23.60% from 24.08% overall.

Relationship of pterygium and ARC

Figure 1 shows 91 (56.17%) in Qinghai and 224 (51.14%) in Guangxi, respectively, of these pterygium patients also had ARC, and the overall rate is 52.50% (315 patients in 600 pterygium patients). These are significant higher than those ARC patients without pterygium (39.77% for Qinghai, 32.82% for Guangxi respectively and 36.92% in overall, P<0.02).

The percentages of patients with both pterygium and ARC increases significantly with increasing age (P=0.000). The prevalence for age 60-69 years is greater than 50% and for age 70 years or older is largely greater than 80%.

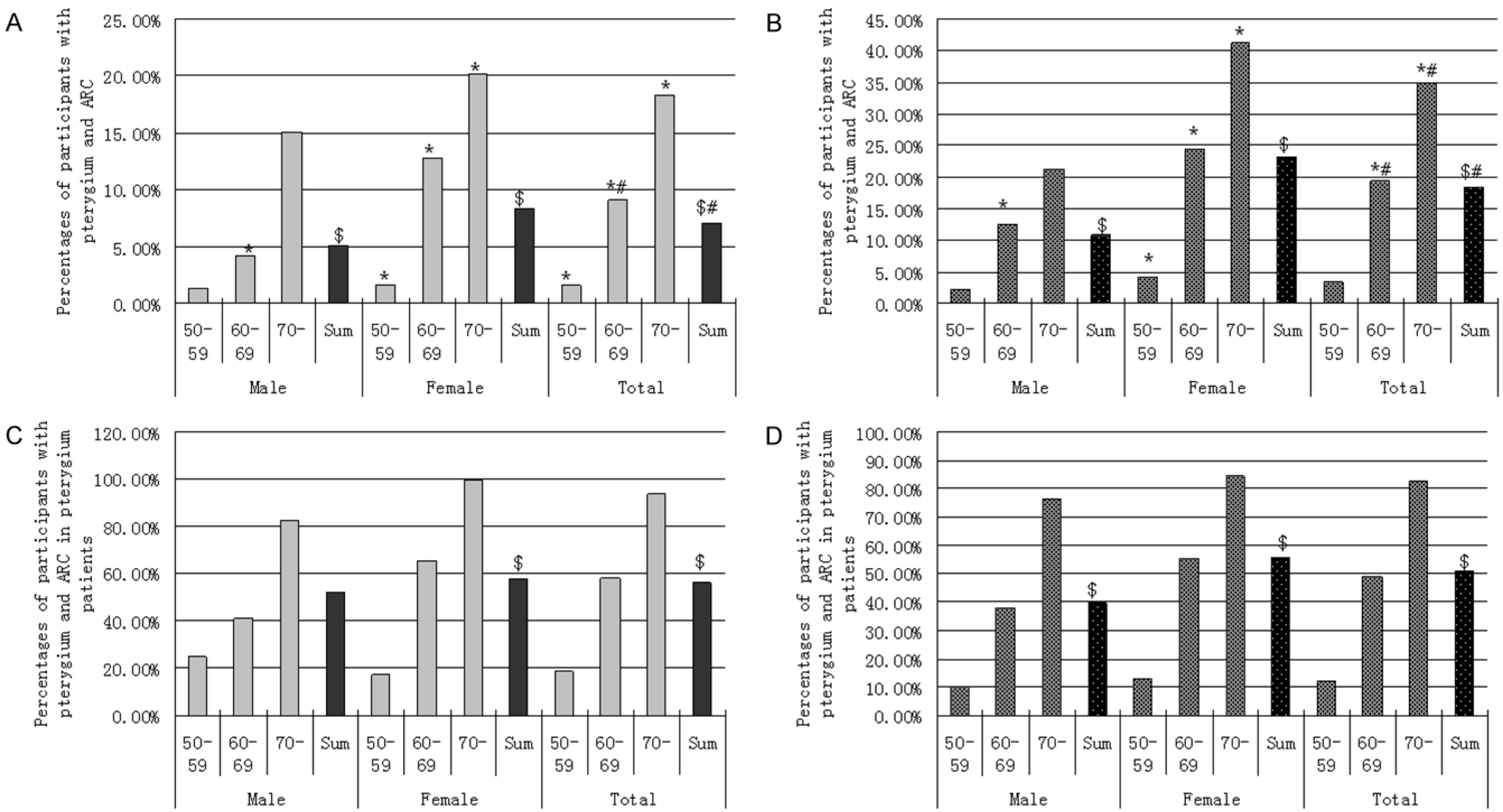

Figure 1. The prevalence rates of ARC in the pterygium patients in the two rural areas. A. The percentage of participants with pterygium and ARC in Pingan, Qinghai, China; B. The percentage of participants with pterygium and ARC in Chongzuo, Guangxi, China; C. The percentage of participants with pterygium and ARC in the pterygium patients in Pingan, Qinghai, China; D. The percentage of patients with pterygium and ARC in the pterygium patients in Chongzuo, Guangxi, China; 50-59: Aged 50-59 years; 60-69: Aged 60-69 years; 70-: Aged 70 years and over; ARC: age-related cataract; *For each age stage, the difference of prevalence rates in the two areas is significant ($P<0.05$); $For each area, the difference of prevalence rates in these three age stages (50-59 years, 60-69 years and ≥70 years) is significant, including both of male and female ($P<0.05$); #For each area, the difference of prevalence rates between male and female in the same age stage is significant ($P<0.05$).

Table 5. The risk factors of pterygium in the two rural areas

Risk factor	p	Exp (B)	95% CI of Exp (B)	
Latitude*	0.001	1.826	1.261	2.644
ARC$	0.002	1.467	1.146	1.879
Female	0.001	1.477	1.164	1.875
Increasing age	0.005	1.019	1.006	1.032

*Compared between the two areas: Pingan, Qinghai and Chongzuo, Guangxi; $The participant has unilateral or bilateral ARC.

Moreover, the percentage of patients with pterygium and ARC in males is lower than in females, but these differences were not significant. **Table 5** shows the ARC is the important risk factor of pterygium.

Discussion

Our study presented the prevalence rates and risk factors of pterygium in rural populations with different geographical environments. The uniform criteria and single race could minimize bias.

Pterygium and ARC might have a common risk factor, such as UV [8-11] and oxidative stress [12, 13]. And previous studies had shown cataract and pterygium are the most important UV-related diseases [9, 14]. The Blue Mountains Eye Study had showed the association between pterygium and cataract [15] And one recently study thought the increasing UV exposure from fluorescent lights might cause an additional 3000 cases of cataracts and 7500 cases of pterygium annually in Australia [16]. Our study showed the patients with pterygium had a higher prevalence rate of ARC than the patients without pterygium. And interesting, for all participants in our studies, ARC is a risk factor for pterygium. It indicated that the association between pterygium and cataract might be complicated and depend on many variations, such gender and age.

As mentioned, the pterygium is associated with UV, and some studies even used pterygium as a surrogate for long-term sunlight exposure [17, 18]. The dose of ultraviolet exposure is based on the intensity of UV light and the number of hours of sunshine. These factors depended on the altitude and the latitude. In our study, the two investigated regions have unique geographical environments. The latitudes, altitudes, and number of hours of sunshine of the investigated locations are in **Table 2**. Guangxi had the higher prevalence rate of pterygium, 36.13%, in our study, which was similar to the prevalence rate determined in a previous study in Guangdong (33.01%, latitude 22.20). So the latitude might be more important than the altitude in the prevalence of pterygium. The number of hours of sunshine might be as important as latitude in the etiology of pterygium, as they both determine the intensity of ultraviolet exposure. However, with a lower altitude and similar climate as Guangxi, the previous study in Hainan showed a much lower prevalence rate (7.86%) [19]. As a result, ultraviolet exposure is a very important risk factor for the etiology of pterygium, but it is not a decisive factor. Additionally, as Guangxi is a coastal province, the humid warm climate might also be a very important risk factor for pterygium.

The different rates of pterygium in these two rural regions might be explained by several factors, including nutrition, genetics, environment and social behavior. As all participants are Han Chinese, they have same genetic and cultural background, which might not play important role in our studies. Due to the similar socio-economic conditions of rural population in west China, the nutrition of the participants in these two rural regions can be dismissed as an important factor. Moreover, the social behavior is decided by the environment and the culture. So we think that the environment was the determinant factor for the explanation of the different prevalence rates of pterygium showed in our studies, it was confident by the logistic regression in the result.

Although many studies reported the prevalence of pterygium was higher in male than in female, some studies reported the female had higher pterygium prevalence [20]. And gender was not associated with pterygium in the BES baseline [7] or incidence investigations or among the Aboriginal Australian population [21]. Our study also showed that the prevalence of pterygium in female were higher than in male. It might be due to the living habits of investigated participants, such as the women have to do cooking beside the agricultural works in the rural regions of China, and might got more ocular irritations in their lifetimes. As we know, cataract in earlier stage might not induce any symptoms.

On the contrary, pterygium, even in small size, could induce significant ocular discomfort. It might drive people to take an eye examination. As women were more likely to report symptoms, [22] we got more female participants and pterygium patients than male in our studies.

In our study, epidemiological investigation was performed in two different rural areas in Western China with the same study criteria. The prevalence of pterygium was 24.08% overall, and for Qinghai and Guangxi, the prevalence was 12.65% and 36.13%, respectively. The prevalence of pterygium was higher in Guangxi than in Qinghai. The prevalence of pterygium decreased with increasing latitude, it is higher in females and older age groups.

Acknowledgements

The study was supported by National Key Technologies R & D Program (2001BA611B-07), China.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Yong-Zhen Bao, People Eye Center, Peking University People's Hospital, 11# Xizhimen South Street, Xicheng District, Beijing 100044, China. Tel: 86-10-88325413; Fax: 86-10-68312393; E-mail: drbaoyz@sina.com

References

[1] Cajucom-Uy H, Tong L, Wong TY, Tay WT and Saw SM. The prevalence of and risk factors for pterygium in an urban Malay population: the singapore malay eye study (SiMES). Br J Ophthalmol 2010; 94: 977-981.

[2] Wong TY, Foster PJ, Johnson GJ, Seah SK and Tan DT. The prevalence and risk factors for pterygium in an adult Chinese population in Singapore: the Tanjong Pagar survey. Am J Ophthalmol 2001; 131: 176-183.

[3] Gazzard G, Saw SM, Farook M, Koh D, Widjaja D, Chia SE, Hong CY and Tan DT. Pterygium in Indonesia: prevalence, severity and risk factors. Br J Ophthalmol 2002; 86: 1341-1346.

[4] McCarty CA, Fu CL and Taylor HR. Epidemiology of pterygium in Victoria, Australia. Br J Ophthalmol 2000; 84: 289-292.

[5] Ma K, Xu L, Jie Y and Jonas JB. Prevalence of and factors associated with pterygium in adult Chinese: the Beijing eye study. Cornea 2007; 26: 1184-1186.

[6] Shiroma H, Higa A, Sawaguchi S, Iwase A, Tomidokoro A, Amano S and Araie M. Prevalence and risk factors of pterygium in a southwestern island of Japan: the Kumejima Study. Am J Ophthalmol 2009; 148: 766-771 e761.

[7] Luthra R, Nemesure BB, Wu SY, Xie SH and Leske MC. Frequency and risk factors for pterygium in the Barbados eye study. Arch Ophthalmol 2001; 119: 1827-1832.

[8] Bao YZ, Cao XG, Li XX, Chen J, Hu JX and Zhu T. [Prevalence of age-related cataract among adults aged 50 and above in four rural areas in western China]. Zhonghua Yi Xue Za Zhi 2008; 88: 1697-1702.

[9] Threlfall TJ and English DR. Sun exposure and pterygium of the eye: a dose-response curve. Am J Ophthalmol 1999; 128: 280-287.

[10] Lucas RM. An epidemiological perspective of ultraviolet exposure--public health concerns. Eye Contact Lens 2011; 37: 168-175.

[11] Norval M, Lucas RM, Cullen AP, de Gruijl FR, Longstreth J, Takizawa Y and van der Leun JC. The human health effects of ozone depletion and interactions with climate change. Photochem Photobiol Sci 2011; 10: 199-225.

[12] Balci M, Sahin S, Mutlu FM, Yagci R, Karanci P and Yildiz M. Investigation of oxidative stress in pterygium tissue. Mol Vis 2011; 17: 443-447.

[13] Ucakhan OO, Kanpolat A, Elgun S and Durak I. The role of oxidative mechanisms in the etiopathogenesis of pterygium: a preliminary study. Ophthalmologica 2009; 223: 41-46.

[14] Hiller R, Sperduto RD and Ederer F. Epidemiologic associations with nuclear, cortical, and posterior subcapsular cataracts. Am J Epidemiol 1986; 124: 916-925.

[15] Lim R, Mitchell P and Cumming RG. Cataract associations with pinguecula and pterygium: the blue mountains eye study. Am J Ophthalmol 1998; 126: 717-719.

[16] Walls HL, Walls KL and Benke G. Eye disease resulting from increased use of fluorescent lighting as a climate change mitigation strategy. Am J Public Health 2011; 101: 2222-2225.

[17] Pham TQ, Wang JJ, Rochtchina E and Mitchell P. Pterygium, pinguecula, and 5-year incidence of cataract. Am J Ophthalmol 2005; 139: 1126-1128.

[18] Pham TQ, Wang JJ, Rochtchina E and Mitchell P. Pterygium/pinguecula and the five-year incidence of age-related maculopathy. Am J Ophthalmol 2005; 139: 536-537.

[19] Liu H, Yang J and Zhong L. [Prevalence survey on pterygium in two counties of Hainan Province]. Zhonghua Yan Ke Za Zhi 2001; 37: 21-23.

[20] Viso E, Gude F and Rodriguez-Ares MT. Prevalence of pinguecula and pterygium in a gen-

eral population in Spain. Eye (Lond) 2011; 25: 350-357.
[21] Moran DJ and Hollows FC. Pterygium and ultraviolet radiation: a positive correlation. Br J Ophthalmol 1984; 68: 343-346.
[22] Lekhanont K, Rojanaporn D, Chuck RS and Vongthongsri A. Prevalence of dry eye in Bangkok, Thailand. Cornea 2006; 25: 1162-1167.