

Prevalence and associated factors for Pterygium in Han and Mongolian adults: across-sectional study in inner Mongolian, China

Yuhan Wang

Peking Union Medical College Hospital

Guangliang Shan

Chinese Academy of Medical Sciences and Peking Union Medical College

Linyang Gan

Peking Union Medical College Hospital

Yonggang Qian

Inner Mongolia Center for Disease Control and Prevention

Ting Chen

Peking Union Medical College Hospital

Hailing Wang

Inner Mongolia Center for Disease Control and Prevention

Xiaodan Pan

Peking Union Medical College Hospital

Wenrui Wang

Inner Mongolia Center for Disease Control and Prevention

Li Pan

Chinese Academy of Medical Sciences and Peking Union Medical College

Xia Zhang

Peking Union Medical College Hospital

Meng Wang

Peking Union Medical College Hospital

Jin Ma

Peking Union Medical College Hospital

Yong Zhong (✉ yzhong_eye@163.com)

Peking Union Medical College Hospital

Research Article

Keywords: Pterygium, prevalence, Han and Mongolian, risk factors, protective factors

Posted Date: January 10th, 2019

DOI: <https://doi.org/10.21203/rs.2.196/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published on February 3rd, 2020. See the published version at <https://doi.org/10.1186/s12886-020-1324-6>.

Abstract

Background: To investigate the prevalence of and factors associated with pterygium in Han and Mongolian adults at four survey sites in Inner Mongolia, China.

Methods: A population-based, cross-sectional study was conducted. Using a stratified sampling method, we eventually included 2,651 participants of at least 30 years of age from a total of 3,468 eligible residents. Factors associated with pterygium were analysed using univariate analysis and logistic regression models.

Results: There were 1,910 Han adults and 741 Mongolian adults included in this study. The mean \pm standard deviation of age for individuals in the study cohort was 48.93 ± 11.06 years. The overall prevalence of pterygium was 6.4% (n=169), and the prevalences of bilateral and unilateral pterygium were 1.4% (n=38) and 4.8% (n=128), respectively. The most common grade of pterygium was Grade 2. After univariate analysis, eleven factors were considered in a multivariate analysis. The results indicated that age ($P < 0.001$), education level ($P < 0.001$), outdoor occupation ($P = 0.026$), and time spent in rural areas ($P < 0.001$) were significantly associated with pterygium, whereas gender and ethnicity were not risk factors. In subgroup analysis, $BMI \geq 28$ was a protective factor for Han individuals (OR 0.42, 95% CI 0.21-0.81, $P = 0.01$), but a risk factor for Mongolian individuals (OR 2.39, 95% CI 1.02-5.58, $P = 0.044$). The BF% in Han and Mongolian individuals had significant difference ($P < 0.001$).

Conclusions: Our results indicated that an outdoor occupation, old age and time spent in rural areas are risk factors for pterygium in Inner Mongolia. Living near an urban survey site (Hohhot and Tsining District) and having a higher education level are protective factors for pterygium. Ethnicity, gender, smoking, diabetes and high blood pressure are not associated with pterygium. Different dietary structures in Han and Mongolian adults may lead to different fat content of body and therefore contributes to the prevalence of pterygium.

Keywords: Pterygium, prevalence, Han and Mongolian, risk factors, protective factors

Background

Pterygium is a proliferative fibrovascular tissue overgrowth arising from bulbar conjunctiva and encroaching onto the cornea. As the disease develops, it can induce severe astigmatism and poor vision. A systematic review[1] of 68 articles with a total of 415,911 participants in 24 countries in 2018 reported that the overall prevalence of pterygium was 12%. A review of the previous literature shows that the prevalence of pterygium varies widely for different regions or ethnic groups, with rates as low as 1.1%[2] and as high as 39.0%[3]. Most of the epidemiological surveys for Chinese pterygium are single-ethnic analyses, lacking comparison between different ethnicities. The prevalence of pterygium in remote areas of China is relatively high. For instance, reported prevalence of pterygium are 11.95% in Xinjiang[4], 14.49% for Tibetans in Zeku County, Qinghai Province[5], 17.9% for Mongolians in Henan

Mongolian Autonomous County, Qinghai Province[3], and 39.0% for individuals of the Bai ethnicity in Dali[6].

There are many risk factors for pterygium, such as ultraviolet radiation, geographic latitude, ageing, nationality and skin colour. The most widely proved factor is ultraviolet radiation. Intensity and time of exposure to ultraviolet radiation are significantly correlated with the prevalence of pterygium[4,5]. At the same time, some studies have found that the geographical latitude is related to pterygium; for instance, the "pterygium belt" located between the latitudes of 37°N and 37°S features a high prevalence of pterygium[7]. With the increasing cultural and trade exchanges between countries, we should also consider the impact of population migration. A study of Riau Islanders in 2006[8] found a higher prevalence of pterygium among people who had lived on the island since childhood than among foreigners. However, even among those who live in the same fixed environment, the genetic heterogeneity of different races and ethnic groups may affect the prevalence of pterygium. In 2014, our prior study based on a survey in Xinjiang[4] showed that the prevalence of pterygium in Uygur was lower than that observed for Han living in the same area. Meanwhile, pterygium also has protective factors. For example, wearing hats and sunglasses can reduce the prevalence of pterygium in Shandong, Yunnan and Ethiopia[9-11].

The China National Health Survey (CNHS) is a nationally representative population-based cross-sectional study conducted in various provinces in China[12]. As a part of CNHS, we selected Inner Mongolia Autonomous Region as our survey province. Inner Mongolia is located in the north part of China, at eastern longitude 97°-126° and northern latitude 37°-53°. According to the results of the China Population Census 2010, people of the Han and Mongolian ethnicities represent the largest proportions of the population, with 79% and 17%, respectively. Through the study of the CNHS in Inner Mongolia Autonomous Region, differences in disease prevalence have been found between people of the Han and Mongolian ethnicities. For example, the prevalence of hypertension and obesity is significantly higher in Mongolians than in Han[13]. In this study, we compared various demographic characteristics between Han and Mongolians in four regions of Inner Mongolia Autonomous Region, China, to assess the prevalence and related factors of pterygium.

Methods

Sample Population

In this cross-sectional study, stratified sampling was conducted according to level of urbanization, and four survey sites were enrolled (Table 1): Hohhot, a large city located at 40.83°N that has short sunshine hours and is little affected by sandstorms; Tsining District, which includes a midsize city and commercial trade zone located at 41.03°N, is at high altitude, has longer sunshine hours and is known for its dry, windy weather and sandstorms; Wuyuan, a county seat located at 40.10°N that has the longest sunshine duration among the survey sites; and Xilingol League, a pastoral area located at 44.58°N that is at the

lowest altitude of the survey sites, is predominantly grassland, and has sufficient sunshine and precipitation. In these cities and counties, we randomly selected different districts in cities and rural townships. The samples were stratified according to the sex and age distribution of the Inner Mongolian population in the China Population Census 2010. We set the proportion of Han and Mongolian participants according to the proportions of the local population. This study included only residents who had lived in the area for more than one year and excluded mental patients, pregnant women, and active military personnel. Only residents whose ethnicity was the same as their parents' were enrolled in the study; in other words, Han participants had Han parents, and Mongolian participants had Mongolian parents. Of 3,468 eligible residents, ophthalmological examinations were performed on 3,185, with an overall response rate of 91.84%. We ultimately included 2,651 individuals of at least 30 years of age.

Physical Examinations, Data Collection and Stratification Standard

The fieldwork of data collection was conducted from July 2014 to August 2014. A team of three ophthalmologists, medical workers from general hospitals in Beijing and administrative personnel from the region carried out the data collection. Trained counsellors asked each participant questions and presented questionnaires to collect data, including information about age, sex, ethnic group, birthplace, residence (urban or rural), occupation (worker, farmer, management, service and sales, technical work, student, or housework, among others; agricultural work was classified as an outdoor occupation, whereas the other occupations were considered to be indoor occupations), education level (elementary or lower, middle school to high school, or university or higher), level of exercise^[14] (light, moderate or heavy), history of hypertension and diabetes, and lifestyle (e.g., smoking and alcohol consumption). Smoking was divided into two categories: never-smokers and ever-smokers (including current smokers and former smokers). Similarly, drinking consumption was classified into never-drinker and ever-drinker (including current drinkers and former drinkers). The systolic and diastolic blood pressure of the participants was taken three times using an electronic automatic blood pressure monitor (HEM-907, Omron, Japan). The average was used as the mean blood pressure. Height was measured by using a fixed stadiometer. Body weight and body fat percentage were measured by bioelectrical impedance analysis (BC-420, Tanita, Japan). BMI was calculated as weight in kilograms divided by height in metres squared (kg/m^2).

Ophthalmologic Examination

Ophthalmologic examinations included daily visual acuity at 4 m (EDTRS, Wehen Co., Ltd., Guangzhou, China). Data related to refraction, such as corneal curvature radius, were measured with an auto ref-keratometer (ARK- 510A, Nidek Co., Ltd., Tokyo, Japan). Astigmatism was defined as cylinder value < -0.50 D. We used a portable hand-held slit-lamp to examine the anterior segment of the eye (KJ5S2, Suzhou Kangjie Medical Co., Ltd., Jiangsu, China).

Diagnostic Criteria and Grading Standard of Pterygium

Pterygium (in either eye) was defined as a raised fibrovascular tissue encroaching through the limbus into the cornea or a history of pterygium excision. The grading was based on the location of pterygium head under standard lighting conditions[4,10]. Grade 1: at the limbus. Grade 2: between the limbus and the undilated pupil margin. Grade 3: within the pupil margin. Grade 4: beyond the pupil margin. If diagnosed as bilateral pterygium, the higher grade eye was counted.

Statistical Analysis

Statistical analysis was performed with SPSS software (Statistical Package for Social Sciences Inc., Chicago, IL, USA, version 21.0.0.0). Figures were created with GraphPad Prism 7.0. We performed a chi-square test using the pterygium growth site and monocular and binocular as variables to calculate the prevalence of pterygium and calculated the age-adjusted prevalence after referring to the China Population Census 2010. Independent sample t-test and chi-square test were used to analyse the demographic characteristics of the Han and Mongolian participants and the grades of pterygium. After a chi-square test to assess the association between pterygium and related factors, factors with $P < 0.05$ were brought into a multivariate regression analysis model to assess possible risk factors or protective factors for pterygium. Then, we used gender and ethnicity as subgroups to further analyse relevant factors with multivariate regression.

Results

Prevalence and Demographic Characteristics

We eventually included 2,651 participants aged 30 years old or older. These participants included 1,104 men (39.3%) and 1,608 women (60.7%); there were 1,910 Han Chinese adults (72%) and 741 Mongolian adults (28%) (Table 2). The participants ranged in age from 30 to 79 years old, with an average age of 48.93 ± 11.06 years old.

The prevalence of pterygium in this study was 6.4% (169/2,651, 95% CI 5.5-7.3), and the age-adjusted prevalence rate of pterygium was 6.38% among people aged 30 years and older. We noted that the prevalence increased with age ($P < 0.001$). There was a higher incidence of unilateral pterygium than of bilateral pterygium ($P < 0.001$). We found a significant difference in prevalence between the right and left eyes ($P < 0.001$); specifically, there were 54 cases (43.0%) involving the right eye and 73 cases (57.0%) involving the left eye. Concerning the location of the disease, pterygium was mostly located on the nasal side, as occurred in 38 cases (1.2%); there were 4 cases of pterygium on the temporal side (0.1%), and no cases involving pterygium on both sides.

Grading Analysis of Pterygium

Concerning the pterygium grading, 5 (0.2%) were grade 1, 162 (6.2%) were grade 2, and none were grades 3 or 4. In general, grade 2 pterygium was the most common grade among the two ethnic groups. As Figure 1 and Figure 2 shows, Grade 2 was mainly concentrated in 50-59 years old Mongolian adults.

Multivariate Logistic Regression Results

The multivariate logistic regression model was based on univariate analysis and study settings; the factors considered in the final calculation were ethnicity, gender, age group, smoking status, education level, occupation, BMI, body fat percentage(BF%), low density lipoprotein cholesterol, survey site and time spent in rural areas. The results showed that having an outdoor occupation (OR 1.66, 95% CI: 1.02-2.70, P=0.042), living in rural areas for more than 30 years (OR 1.92, 95% CI: 1.25-2.94, P=0.003), and being 50-59 years old (OR 2.65, 95% CI: 1.46-4.79, P=0.001) or ≥ 60 years old (OR 2.49, 95% CI: 1.31-4.73, P=0.005) were risk factors for pterygium. Having a university or higher education level (OR 0.48, 95% CI: 0.26-0.88, P=0.017) and living near urban survey sites such as Hohhot (OR 0.47, 95% CI: 0.27-0.80, P=0.005) and Tsining District(OR 0.31, 95% CI: 0.17-0.54, P<0.001) were protective factors. We found that pterygium had no correlation with gender, ethnicity, BF%, low density lipoprotein cholesterol or smoking status. Logistic regression analysis results are presented in Table 3 and Figure 3.

Subgroup Analysis of Pterygium

Furthermore, we performed subgroup logistic regression analysis using ethnicity and gender as the classification criteria (Figures 4 and 5).

From the results of the ethnic subgroups, being older and having lived longer in rural residence areas risk factors among the male and female participants. High education level and Tsining District were protective factors. In analysis of males alone, having an outdoor occupation was a risk factor for pterygium, and living in Hohhot was a protective factor.

In the ethnic subgroup analysis, being older and having lived in a rural area for 11-20 years or more than 30 years were risk factors for pterygium in Han adults. High education level, BMI ≥ 28 , Hohhot and Tsining District were protective factors. BMI ≥ 24 was a risk factor for pterygium in the Mongolian adults. None of the Mongolian participants in Tsining District suffered from pterygium.

Discussion

This study is a rare cross-sectional study of Han and Mongolian adults in Inner Mongolia Autonomous Region of China. A stratified sampling method was used to include 3,185 participants who completed the ophthalmologic examination at the four survey sites. The mean age was 48.93 ± 11.06 years, and the overall prevalence after age adjustment was 6.38%. Pterygium occurred mainly on the nasal side (38/2,651, 1.2, and the most common grade was grade 2 (162/2,651, 6.1%). Having an outdoor occupation, living in a rural area for more than 30 years, and being older than 50 years old were risk factors for pterygium. Having a university or higher education level and living near an urban survey site (Hohhot and Tsining District) were protective factors.

Numerous epidemiological surveys have confirmed that ageing is an important risk factor for pterygium[4,10,15]. The prevalence of pterygium in people over 80 years old has been found to be as high as 19.5%[1]. Similar to the results of the above studies, our results showed that participants over 50 years old had a significantly increasing risk of pterygium.

In a study of the relationship between the onset of pterygium and UV exposure time in Hainan Province, China, in 2004[16], a research group confirmed that length of pterygium was positively correlated with UV exposure time. The study participants were divided into three groups according to youth, middle-aged, and old age. The length of pterygium was positively correlated with UV exposure time, with those in the old group having had pterygium the longest. Accordingly, we speculate that the increase in the prevalence of pterygium in people over 50 years old may be related to the increase in the cumulative UV exposure time.

There is currently no consistent conclusion on the relationship between gender and pterygium. Many studies, including investigations in China, India, Japan, Singapore, Iran and Ethiopia[9,11,17-21], have identified being male as a risk factor for pterygium. Nevertheless, the study of Dali and Tibet Autonomous Region of China confirmed that being a woman was risk factor; this may be related to the social division of men and women in the cultures of different regions. In most parts of Asia and Africa, men represent the main labour force in the family, taking responsibility for going out to work. Women spend most of their time at home doing housework. In western China, especially in Yunnan Province, lifestyle is affected by the matriarchal clan society. Women are the main labour force and carry out more outdoor work. In recent years, with the process of non-agriculturalization in western China, the social division of labour among Inner Mongolian farmers and herdsmen has changed[22,23]. More men choose to go to work in large cities, while women stay in rural areas for agricultural activities or livestock farming. During the busy farming season, men return to the countryside to participate in agricultural work. Therefore, in general, men and women spend roughly the same amount of time doing outdoor work. Our data analysis also confirmed that there was no significant differences in the prevalence of pterygium between men and women, which is similar to the results of a study in Spain in 2011 (4.8% for men, 6.5% for women, $P=0.346$)[24].

Previous multi ethnic studies of pterygium have found differences in the prevalence among ethnicities; for example, the prevalence of pterygium among people of Han ethnicity in Xinjiang and among people of

Yi ethnicity in Yunnan were significantly increased[4,10]. Our study found no significant difference in the prevalence of pterygium between Han and Mongolian people (5.8% vs 7.8%, $P=0.06$). There was no significant association between ethnicity and pterygium after age and gender correction.

The multivariate analysis of this study showed that living in towns such as Hohhot and Tsining District were protective factors for pterygium. This may be related to their urbanization, residents' living habits and the geographical environment, in which the sunshine time is short and there is little sandy wind. In a study in Jordan in 2004[25], living in a dry, dusty environment with long-term exposure to large amounts of particles was a risk factor for pterygium. Although Tsining District has an extremely dry climate and sandy wind, during the epidemiological investigation, we observed that the local residents paid attention to self-protection and went outside wearing sunglasses and hats. Interestingly, after pooling the influence of environmental and social factors on pterygium, the results of multivariate analysis showed that living in Tsining District was a protective factor. This reminds us that in a dry and dusty environment, using more protective measures and avoiding long-term exposure to ultraviolet light will greatly reduce the occurrence of pterygium. Protective factors and risk factors are influenced by culture, geography and health awareness.

Our results confirmed a positive correlation between pterygium and education level. In this study, especially among people of Han ethnicity, the prevalence of pterygium was greatly affected by education level. The OR value of middle or high school education level was twice that of university or higher level. This is similar to the results of a multiethnic study in Malaysia in 2012 (university education level OR 0.5, 95% CI 0.3–0.7, $P=0.001$)[26]. We speculate that because people with higher education levels have a higher likelihood of indoor work, they have less exposure to sunshine and are therefore exposed to ultraviolet light for a shorter period of time. A pterygium epidemic survey in 2009 in which 4,774 Latin American individuals older than 40 years were enrolled found that people who were educated for less than 6 years were 2.81 times more likely to suffer from pterygium than those who were educated for 12 years or longer[27], a result that is in accordance with our findings.

Activities such as outdoor activity, surfing and fishing have been proven to be risk factors for pterygium in prior literature[8,28]. At the same time, high-intensity exposure to ultraviolet light during youth increases the risk of pterygium. According to a case-control study in Brisbane in 1992, those who lived at low latitudes (30°N) for the first five years after birth had a 40-fold higher prevalence of pterygium than patients who lived at higher latitudes (40°N)[29]. This suggests that the cumulative duration of UV exposure had a greater impact on pterygium. Another study on Norfolk Island in 2013 reported that the youngest group had the highest conjunctival ultraviolet autofluorescence[30]. Owing to the higher UV exposure level, the prevalence of pterygium in the youngest group was similar to that in adults older than 30. Consistent with these results, we found that living in rural areas longer than 30 years and outdoor occupation were risk factors for pterygium.

Oxidative stress caused by obesity may have an effect on pterygium; a study by Kormanovski discovered higher nitric oxide levels and total antioxidant levels in individuals in the primary pterygium group

compared with normal subjects[31]. The level of oxidation state increased, and all antioxidant enzyme levels decreased. We usually use BMI to quantitatively analyse obesity, but the effect of high BMI on pterygium is still inconclusive. For example, in an Australian study in 2015, the prevalence of pterygium was lower for obese people (BMI>5) than for normal-weight subjects (6.3% vs. 33.8%)[32]. A large sample in a Korean study on pterygium and obesity yielded the opposite results. Being a woman and having a higher BMI were risk factors for pterygium (OR=1.43, P=0.008)[33]. In our subgroup analysis, differences between two ethnic groups were found. BMI \geq 28 was a protective factor for Han individuals (OR 0.42, 95% CI 0.21-0.81, P=0.01) but a risk factor for Mongolian individuals (OR 2.39, 95% CI 1.02-5.58, P=0.044). We speculate that people with higher BMI may engage in less outdoor activity and therefore face less UV radiation.

However, BMI is not the only evaluation index of obesity. In recent years, body fat percentage (BF%) has also been used to evaluate the degree of obesity, and it assesses fat mass more effectively than BMI[34,35]. Previous studies have found that the Chinese have relatively low BMI and relatively high BF% [36]. At the same time, two surveys have found great differences in the diet and living habits of individuals of Han and Mongolian ethnicities[37,38]. Compared with people of the Han ethnicity, Mongolians had higher meat and salt intake and lower intake of fruits and vegetables. Having high meat intake means that Mongolians ingest more fat and protein. It is well recognized that high-fat diets can increase the oxidative stress level in the body, and the conclusion that oxidative stress is caused by high-protein diets remains controversial[39,40]. We used participants' BF% to more accurately assess obesity. The BF% of the Han ethnicity was 29.58 \pm 7.70%, and the BF% of the Mongolian ethnicity was 30.99 \pm 7.78%, representing a significant difference (P<0.001). Therefore, we believe that although the BMI of both ethnic groups is elevated, the different dietary structures lead to different fat content and therefore different degrees of oxidative stress. However, the effects of systemic oxidative stress on the ocular surface need to be confirmed by further studies.

The association between smoking and pterygium has been controversial. Certain studies have suggested that smoking is a risk factor for pterygium[41], but a meta-analysis in 2014 showed that smoking had a protective effect[42]. The biological impact of smoking on pterygium remains unclear. Some researchers have speculated that smoking could inhibit the expression of pro-inflammatory cytokines, reduce ocular surface inflammation, and inhibit vasoconstriction through various receptors[43,44]. In our study, we found that smoking was not a factor related to pterygium in people of Han or Mongolian ethnicity.

This study has some limitations. First, information concerning aspects such as medical history and living habits was collected by questionnaire, allowing recall bias. Second, we did not quantitatively measure the intensity and duration of UV exposure. Finally, as a cross-sectional study, we were unable to determine the causal relationship between these factors and pterygium. The next step should be a cohort study.

Conclusions

This study find that outdoor occupation, old age and time spent in rural areas are risk factors for pterygium in Inner Mongolia. Living near an urban survey site(Hohhot and Tsining District) and having a higher education level are protective factors for pterygium. Ethnicity, gender, smoking, diabetes and high blood pressure are not associated with pterygium.

Abbreviations

BMI Body mass index

BF% Body fat percentage

Declarations

Ethics approval and consent to participate

This study is based on the principles of the Declaration of Helsinki. The ethical approval was granted by the bioethical committee of the Institute of Basic Medical Sciences, the Chinese Academy of Medical Sciences. After a full explanation of the nature and possible consequences of the study, written informed consent was obtained from every participant.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

Funding

This study was supported by the National Science and Technology Pillar Program during the Twelfth Five-Year Plan Period sponsored by the Ministry of Science and Technology of China (Grant

2012BAI37B02). The funders had no role in the study design, data collection, analysis or preparation of the manuscript. The authors alone are responsible for the content of the paper.

Authors' Contributions

YW participated in the data collection and drafted the manuscript. TC, XP, HW, WW, YQ, participated in the data collection. GS, LG, XZ, MW, LP, JM, YZ participated in the design of the study and undertook statistical analyses. All authors were involved in writing the paper and had final approval of the submitted and published versions.

Acknowledgements

We sincerely thank Huijing He, Chengdong Yu, Guoju Li, Ke Wang, Fen Dong, Haiying Gong, Guodong Xu, Yanlong Li, Bin Wang, and Guangjin Zhu for their assistance in data collection. We are also grateful to the participants in Inner Mongolia for their generous coordination of this survey.

References

1. Rezvan F, Khabazkhoob M, Hooshmand E, Yekta A, Saatchi M, Hashemi H. Prevalence and risk factors of pterygium: a systematic review and meta-analysis. *Surv Ophthalmol.* 2018;63:719-35.
2. Moran DJ, Hollows FC. Pterygium and ultraviolet radiation: a positive correlation. *Br J Ophthalmol.* 1984;68:343-6.
3. Lu J, Wang Z, Lu P, Chen X, Zhang W, Shi K, et al. Pterygium in an aged Mongolian population: a population-based study in China. *Eye.* 2009;23:421-7.
4. Chen T, Ding L, Shan G, Ke L, Ma J, Zhong Y. Prevalence and racial differences in pterygium: a cross-sectional study in Han and Uygur adults in Xinjiang, China. *Invest Ophthalmol Vis Sci.* 2015;56:1109-17.
5. Lu P, Chen X, Kang Y, Ke L, Wei X, Zhang W. Pterygium in Tibetans: a population-based study in China. *Clin Exp Ophthalmol.* 2007;35:828-33.
6. Zhong H, Cha X, Wei T, Lin X, Li X, Li J, et al. Prevalence of and risk factors for pterygium in rural adult Chinese populations of the Bai nationality in Dali: the Yunnan Minority Eye Study. *Invest Ophthalmol Vis Sci.* 2012;53:6617-21.
7. Detels R, Dhir SP. Pterygium: a geographical study. *Arch Ophthalmol.* 1967;78:485-91.
8. Tan CS, Lim TH, Koh WP, Liew GC, Hoh ST, Tan CC, et al. Epidemiology of pterygium on a tropical island in the Riau Archipelago. *Eye.* 2006;20:908-12.
9. Jiao W, Zhou C, Wang T, Yang S, Bi H, Liu L, et al. Prevalence and risk factors for pterygium in rural older adults in Shandong Province of China: a cross-sectional study. *Biomed Res Int.*

- 2014;2014:658648.
10. Zhong H, Chen Q, Li J, Shen W, Sheng X, Niu Z, et al. Ethnic variations in pterygium in a rural population in Southwestern China: the Yunnan Minority Eye Studies. *Ophthalmic Epidemiol.* 2016;23:116-21.
 11. Anbesse DH, Kassa T, Kefyalew B, Tasew A, Atnie A, Desta B. Prevalence and associated factors of pterygium among adults living in Gondar city, Northwest Ethiopia. *PLoS One.* 2017;12:e0174450.
 12. He H, Pan L, Pa L, Cui Z, Ren X, Wang D, et al. Data resource profile: the China National Health Survey (CNHS). *Int J Epidemiol.* 2018;47:1734-5f.
 13. Li Y, Wang H, Wang K, Wang W, Dong F, Qian Y, et al. Optimal body fat percentage cut-off values for identifying cardiovascular risk factors in Mongolian and Han adults: a population-based cross-sectional study in Inner Mongolia, China. *BMJ Open.* 2017;7:e014675.
 14. Shan G, Wei D, Wang C, Zhang J, Wang B, Ma M, et al. Trends of overweight and obesity in Yi people between 1996 and 2007: an Yi migrant study. *Biomed Environ Sci.* 2011;24:467-74.
 15. Rim T, Kang M, Choi M, Seo K, Kim S. The incidence and prevalence of pterygium in South Korea a 10year population-based Korean cohort study. *PLoS One.* 2017;12:e0171954.
 16. Yan QC, Liu ZX, Di Y, Wang W, Gao Q, Zhang JS, et al. Relationship between pterygium onset and ultraviolet rays exposure time. *Zhonghua Yi Xue Za Zhi.* 2006;86:1686-8.
 17. Li Z, Cui H. Prevalence and associated factors for pterygium in a rural adult population (the Southern Harbin Eye Study). *Cornea.* 2013;32:806-9.
 18. Shiroma H, Higa A, Sawaguchi S, Iwase A, Tomidokoro A, Amano S, et al. Prevalence and risk factors of pterygium in a southwestern island of Japan: the Kumejima study. *Am J Ophthalmol.* 2009;148:766-71 e1.
 19. Nangia V, Jonas JB, Nair D, Saini N, Nangia P, Panda-Jonas S. Prevalence and associated factors for pterygium in rural agrarian central India. The central India eye and medical study. *PLoS One.* 2013;8:e82439.
 20. Cajucom-Uy H, Tong L, Wong TY, Tay WT, 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;94:977-81.
 21. Rezvan F, Hashemi H, Emamian MH, Kheirkhah A, Shariati M, Khabazkhoob M, et al. The prevalence and determinants of pterygium and pinguecula in an urban population in Shahroud, Iran. *Acta Med Iran.* 2012;50:689-96.
 22. Hu X. Analysis of the influence of population structure change on social and economic development in ethnic areas—taking horqin left-wing flag as an example. *Contemp Econ.* 2015;19:34-6.
 23. Wang W. A study on the influence of labor gender division on the relationship of family rights in the process of non-agriculturalization in Western China—a case study of Duolun County, Xilin Gol League, Inner Mongolia. *New West.* 2011;7:24-5.

24. Viso E, Gude F, Rodriguez-Ares MT. Prevalence of pinguecula and pterygium in a general population in Spain. *Eye*. 2011;25:350-7.
25. Al-Bdour M, Al-Latayfeh MM. Risk factors for pterygium in an adult Jordanian population. *Acta Ophthalmol Scand*. 2004;82:64-7.
26. Ang M, Li X, Wong W, Zheng Y, Chua D, Rahman A, et al. Prevalence of and racial differences in pterygium: a multiethnic population study in Asians. *Ophthalmology*. 2012;119:1509-15.
27. West S, Munoz B. Prevalence of pterygium in Latinos: Proyecto VER. *Br J Ophthalmol*. 2009;93:1287-90.
28. Lin AD, Miles K, Brinks MV. Prevalence of pterygia in Hawaii: examining cumulative surfing hours as a risk factor. *Ophthalmic Epidemiol*. 2016;23:264-8.
29. Mackenzie FD, Hirst LW, Battistutta D, Green A. Risk analysis in the development of pterygia. *Ophthalmology*. 1992;99:1056-61.
30. Sherwin JC, Hewitt AW, Kearns LS, Griffiths LR, Mackey DA, Coroneo MT. The association between pterygium and conjunctival ultraviolet autofluorescence: the Norfolk Island Eye Study. *Acta Ophthalmol*. 2013;91:363-70.
31. Kormanovski A, Parra F, Jarillo-Luna A, Lara-Padilla E, Pacheco-Yeppez J, Campos-Rodriguez R. Oxidant/antioxidant state in tissue of primary and recurrent pterygium. *BMC Ophthalmol*. 2014;14:149.
32. McKnight CM, Sherwin JC, Yazar S, Forward H, Tan AX, Hewitt AW, et al. Pterygium and conjunctival ultraviolet autofluorescence in young Australian adults: the Raine study. *Clin Exp Ophthalmol*. 2015;43:300-7.
33. Nam GE, Kim S, Paik JS, Kim HS, Na KS, and the Epidemiologic Survey Committee of the Korean Ophthalmologic Society. Association between pterygium and obesity status in a South Korean population. *Medicine*. 2016;95:e5664.
34. Romero-Corral A, Somers VK, Sierra-Johnson J, Thomas RJ, Collazo-Clavell ML, Korinek J, et al. Accuracy of body mass index in diagnosing obesity in the adult general population. *Int J Obes (Lond)*. 2008;32:959-66.
35. Meeuwssen S, Horgan GW, Elia M. The relationship between BMI and percent body fat, measured by bioelectrical impedance, in a large adult sample is curvilinear and influenced by age and sex. *Clin Nutr*. 2010;29:560-6.
36. Wang C, Hou XH, Zhang ML, Bao YQ, Zou YH, Zhong WH, et al. Comparison of body mass index with body fat percentage in the evaluation of obesity in Chinese. *Biomed Environ Sci*. 2010;23:173-9.
37. Zhang J, Zheng Y, Guo Z, Qiao J, Gesudu Q, Sun Z, et al. The diversity of intestinal microbiota of Mongolians living in Inner Mongolia, China. *Benef Microbes*. 2013;4:319-28.
38. Dalai N, Cui H, Yan M, Rile G, Li S, Su X. Risk factors for the development of essential hypertension in a Mongolian population of China: a case-control study. *Genet Mol Res*. 2014;13:3283-91.

39. Sophia D, Ragavendran P, Raj CA, Gopalakrishnan VK. Protective effect of *Emilia sonchifolia* (L.) against high protein diet induced oxidative stress in pancreas of Wistar rats. J Pharm Bioallied Sci. 2012;4:60-5.
40. Petzke KJ, Elsner A, Proll J, Thielecke F, Metges CC. Long-term high protein intake does not increase oxidative stress in rats. J Nutr. 2000;130:2889-96.
41. Sun LP, Lv W, Liang YB, Friedman DS, Yang XH, Guo LX, et al. The prevalence of and risk factors associated with pterygium in a rural adult Chinese population: the Handan eye study. Ophthalmic Epidemiol. 2013;20:148-54.
42. Rong S, Peng Y, Liang Y, Cao D. Does cigarette smoking alter the risk of pterygium? A systematic review and meta-analysis. Invest Ophthalmol Vis Sci. 2014;55:6235-43.
43. Goncalves RB, Coletta RD, Silverio KG, Benevides L, Casati MZ, da Silva JS, et al. Impact of smoking on inflammation: overview of molecular mechanisms. Inflamm Res. 2011;60:409-24.
44. Rom O, Avezov K, Aizenbud D, Reznick AZ. Cigarette smoking and inflammation revisited. Respir Physiol Neurobiol. 2013;187:5-10.

Tables

Due to technical limitations, the tables have been placed in the supplementary files section

Figures

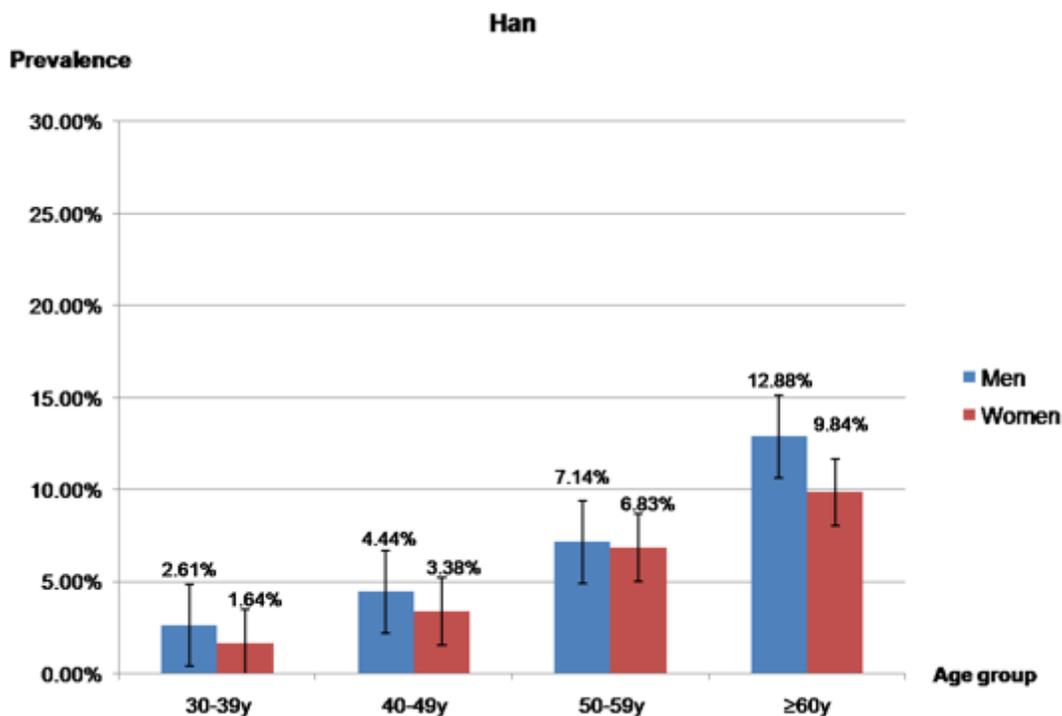


Figure 1

Pterygium grade 2 age distribution of men and women in Han adults.

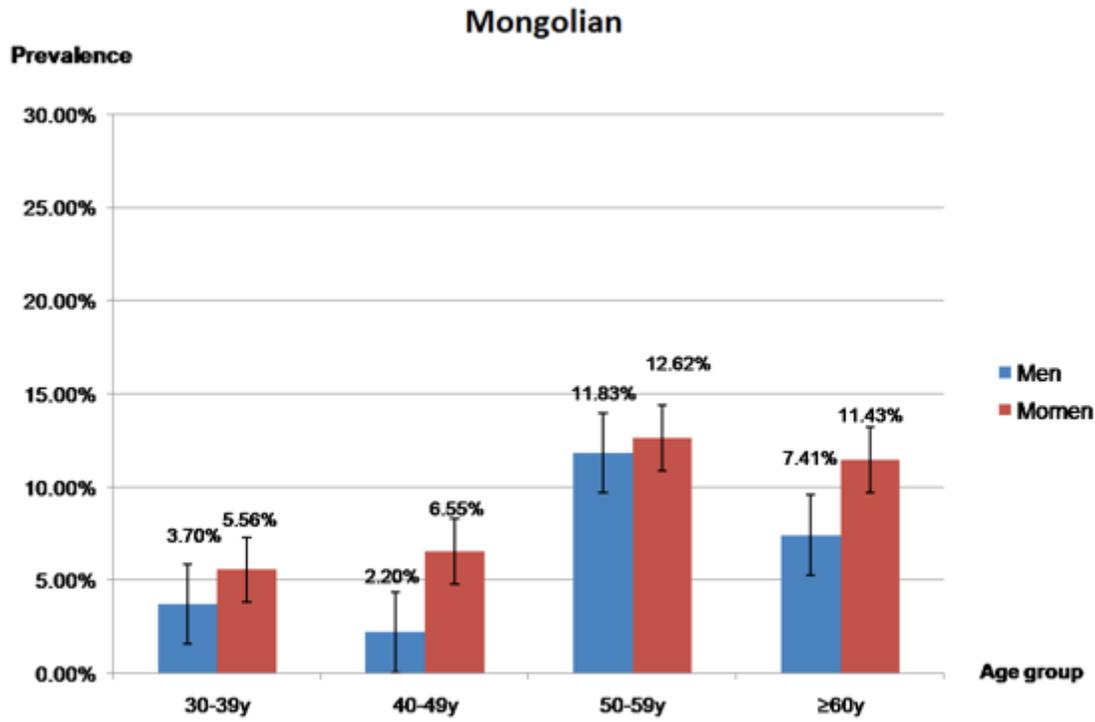


Figure 2

Pterygium grade 2 age distribution of men and women in Mongolian adults.

Pterygium

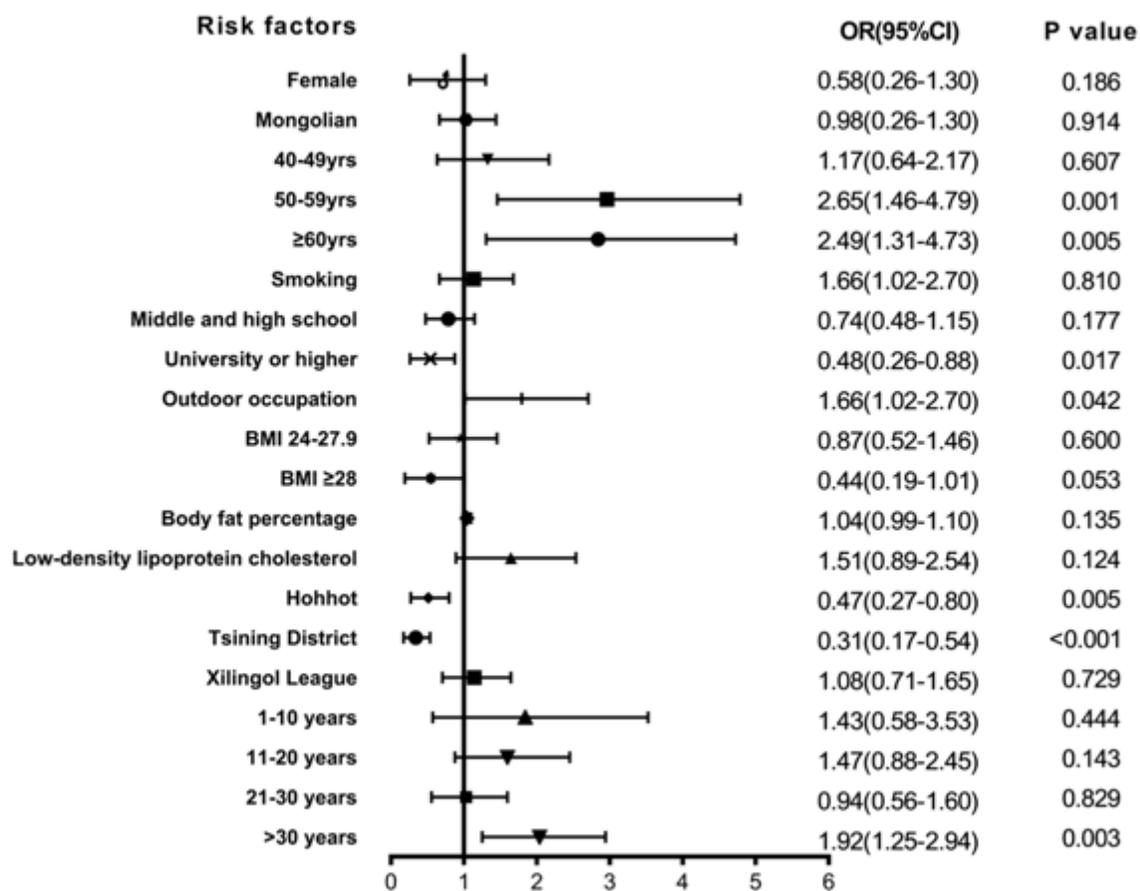


Figure 3

Multivariate analysis of factors associated with pterygium.

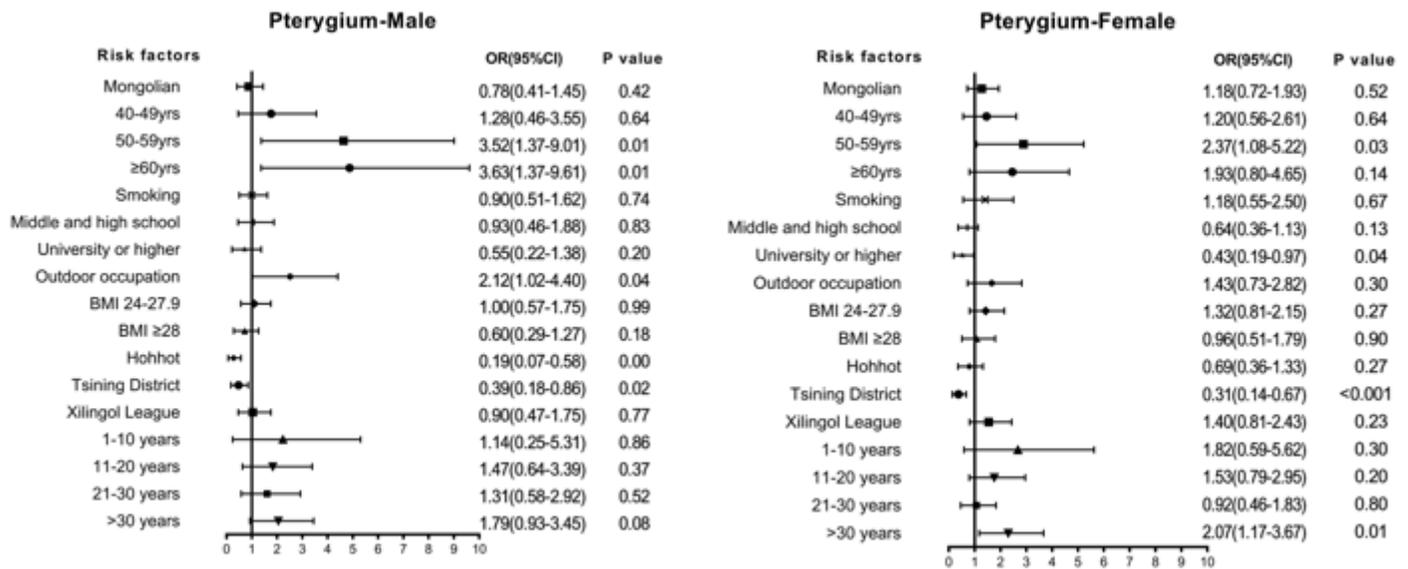


Figure 4

Multivariate analysis of factors associated with pterygium in men and women.

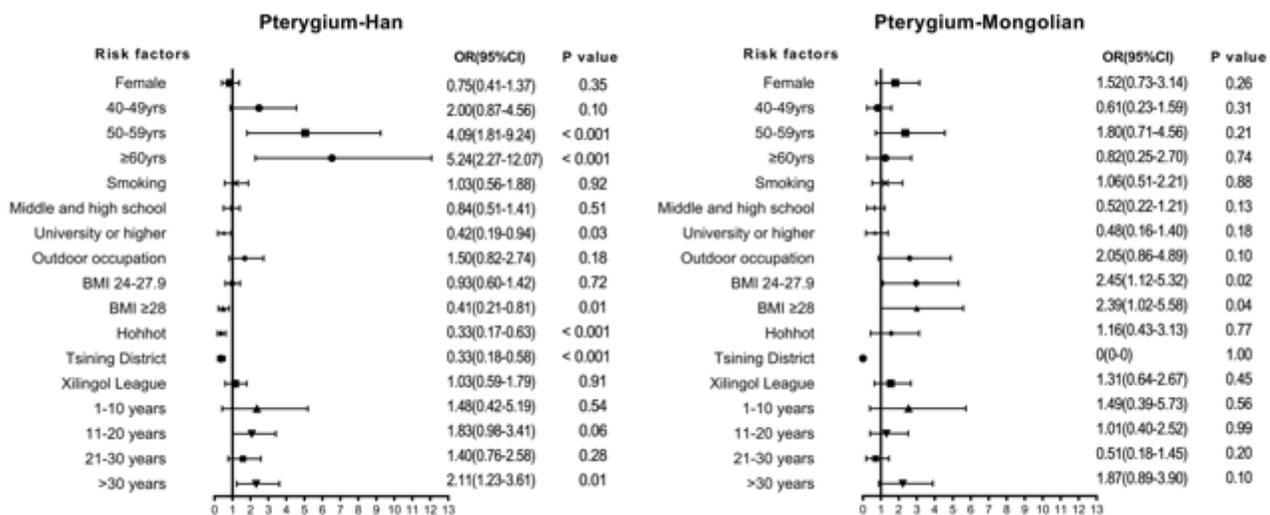


Figure 5

Multivariate analysis of factors associated with pterygium in people of Han or Mongolian ethnicity.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [supplement1.docx](#)
- [supplement2.pdf](#)