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Prevalence and risk factors for pterygium: a cross-sectional study in Han and Manchu ethnic populations in Hebei, China

Zhouxian Pan,[1,2] Jiantao Cui,[1] Guangliang Shan,[3] Yuyu Chou,[1] Li Pan,[3] Zixi Sun,[1] Ze Cui,[4] Jixin Sun,[4] Yajing Cao,[4] Jingjing Zhao,[4] Xinyan Ma,[5] Jifei Ma,[6] Huijing He,[3] Jin Ma,[1] Yong Zhong[1]

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JM and YZ contributed equally.

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For numbered affiliations see end of article.

Correspondence to
Dr Jin Ma; majin1912@163.com

ABSTRACT

Aims To investigate the prevalence, ethnic differences and associated risk factors for pterygium in Han and Manchu populations aged 40–79 years in Hebei province, China.

Design Cross-sectional study, as a part of the China National Health Survey.

Setting Hebei province, China.

Participants A multistage cluster sampling method with urbanisation level-based stratification was used to select participants for this study. A total of 4591 individuals over 40 years were recruited for this study. Inclusive criteria: (1) residents who had been living in Hebei for more than 1 year; (2) Han individuals with both parents being Han, or Manchu individuals with both parents being Manchu; (3) underwent ophthalmic examinations and (4) information in the questionnaire was complete.

Main outcome measures Multiple logistic regression analysis was used to evaluate the association between pterygium prevalence and factors of interest.

Results A total of 3790 individuals (2351 Hans and 1439 Manchus) met the study criteria, of which 248 were diagnosed with pterygium (6.5%). There was no significant difference between the prevalence rates in Hans (6.2%) and Manchus (7.2%) (p=0.232). Multivariate analysis revealed that the risk factors for grade 2 or higher pterygium were increasing age (p<0.001) and rural residence (OR 1.83; 95% CI 1.11 to 3.02; p=0.018), while the protective factors include gender (female) (OR 0.58; 95% CI 0.37 to 0.88; p=0.011), cigarette smoking (OR 0.53; 95% CI 0.34 to 0.83; p=0.005) and myopia (OR 0.50; 95% CI 0.33 to 0.77; p=0.002). Premature menopause (OR 2.66; 95% CI 1.05 to 6.72; p=0.038) increased the risk of grade 2 or higher pterygium in females, while higher high-density lipoprotein (HDL) (OR 1.94; 95% CI 1.08 to 3.47; p=0.027) was a risk factor of grade 2 or higher pterygium in males.

Conclusion The overall prevalence of pterygium in Han and Manchu population in Hebei, China was approximately 6.1%. There were no differences in the prevalence of pterygium between Hans and Manchus, and the race was not a risk factor. This is the first study to report on the positive association between premature menopause and pterygium in females and between higher HDL levels and pterygium in males.

Strengths and limitations of this study

- This is the first large-scale cross-sectional study of pterygium conducted in Hebei, China, which compares the prevalence and risk factors of pterygium between the Han and Manchu ethnic populations.
- Premature menopause and high-density lipoprotein that were rarely investigated in previous studies were investigated in this study.
- The daily sunlight exposure durations and protective measures were not measured in this study.
- It is unable to determine causality between the risk factors and pterygium in this cross-sectional study.
- The findings on the prevalence of pterygium in Hebei, China cannot be generalised since not all ethnic groups were included in this study.

INTRODUCTION

Pterygium, a wing-shaped fibrovascular growth of the bulbar conjunctiva towards and over the corneal limbus, affects a patient's vision and appearance. Over 200 million people worldwide were diagnosed with this common ocular surface disorder in 2000,[1] while about 108 million people in 2010 were diagnosed in China.[2] Prevalence rates of pterygium in individuals over 40 vary significantly worldwide from 2.2% in high latitude-dwelling Chinese populations[3] to 41.8% in Ethiopia located in the tropics.[4] A strong association between geographical latitude and pterygium has been widely accepted. Populations residing closer to the equator have higher risks of developing pterygium.[4]

The mechanism underlying pterygium formation is poorly understood. A large number of studies have demonstrated the role of ultraviolet (UV) light exposure in pterygium.[5–11] However, conflicting data regarding gender, age and smoking on pterygium have been reported.[5–13] The exact

pathogenesis of pterygium remains to be elucidated. The race was found to be the risk factor for pterygium in several studies.[8 9 11] Studies that include two or more ethnic groups may provide a deeper insight into the effects of genetic predisposition or lifestyle differences on pterygium.

Hebei province is located in the middle part of China and surrounds the capital Beijing, at Eastern longitude 113°27′–119°50′ and Northern longitude 36°05′–42°40′. Based on the sixth China national population census, Han was the major ethnicity in Hebei (95.83%) while Manchu was the largest minority group in Hebei (3.02%).[14] The Manchu population mainly resides in Northeastern China (specifically, Liaoning province, Hebei province, Heilongjiang province, Jilin province and Inner Mongolia). The cultural heritage of the Manchu is horse riding and archery.[15 16] These types of activities increase UV exposure, however, only a small proportion of the Manchu population participate in these traditional activities nowadays.[16] Hans and Manchus differ slightly in dietary in-take, with the Manchu population preferring sticky foods and high-salt diet.[17] With modernisation, traditional clothing worn by the Han and Manchu has been replaced with modern clothing for both ethnic groups.[17] The prevalence of hypertension in Manchu population (20.5%) is higher compared with the Han population (16.2%), based on a China nationwide study,[18] while the prevalence of diabetes mellitus in the Han population (12.1%) is higher compared with the Manchu population (8.4%) in Heilongjiang province.[19] To our best knowledge, no study has investigated the prevalence of pterygium among the different ethnic groups in Hebei province, or to assess the ethnic differences of pterygium observed between Hans and Manchus in any area. In the present study, we report the prevalence of pterygium in these two major ethnic groups (Han and Manchu) in Hebei province, as well as the ethic differences for risk factors of pterygium in these two ethnic groups living in the same location.

METHODS

This cross-sectional study is a part of the China National Health Survey (CNHS), a nationally representative and population-based cross-sectional survey that was conducted in different provinces in China from 2012 to 2017. The detailed methodology of this survey has been published.[20] A brief description of the methods is as follows.

Population

From 19 July 2017 to 12 September 2017, a multistage stratified cluster sampling method was used to select representative samples in Hebei province, China. The sampling process was stratified according to the levels of urbanisation, economic development levels (based on local GDP [Gross Domestic Product]) and the distribution of local predominant minority ethnic populations. Shijiazhuang (provincial capital), Baoding (mid-size city), Chengde (mid-size city), Weichang (country seat) and Fengning (country seats) in Hebei province were selected as the field sites.

Inclusive and exclusive criteria

A total of 6554 individuals between 20 and 79 years of age were selected for this study, of which 4591 individuals were over 40 years old. The following were the inclusive criteria: (1) between 40 and 79 years; (2) residents who had been living in Hebei for more than 1 year; (3) Han individuals with both parents being Han, or Manchu individuals with both parents being Manchu; (4) underwent ophthalmic examinations and (5) all information in the questionnaire was complete. A total of 3790 individuals met the inclusion criteria for the study.

Data collection and examinations

A comprehensive interview with unified questionnaires was held by trained interviewers to obtain demographic (age, sex, birth date, race, education level), UV-related information (rural residence, occupation, and physical work), lifestyle (smoking, alcohol consumption) and medical history (hypertension, diabetes mellitus, eye disease, and menarche and menopause age of females). Agriculture work was classified as outdoor occupation, while other occupations were considered as indoor. Smoking/drinking status was recorded as never or ever. A standardised systemic examination included measurement of height (cm), weight (kg), blood pressure, fasting blood sample collection and ophthalmic examination. Systolic blood pressures and diastolic blood pressures (SBPs and DBPs) were measured with a digital automatic blood pressure monitor after the participants were seated for at least 5 min. The average of three measurements was recorded. Fasting venous blood samples were collected for biochemistry tests, including fasting blood glucose (FBG) and serum lipids (total cholesterol, high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol and triglyceride). Individuals with a history of diabetes or whose FBG ≥7.0 mmol/L were defined as diabetic. Individuals with a hypertension history or whose SBP ≥140 mm Hg or whose DBP ≥90 mm Hg were defined as hypertensive.

Ophthalmic examination and definition

Ophthalmic examination included the daily life visual acuity, the slit-lamp examination and an auto ref-keratometer. Distance visual acuity was measured using an ETDRS (Early Treatment Diabetic Retinopathy Study) chart (Wehen, Guangzhou, China) at 4 m. The non-cycloplegic refraction and corneal curvature radius were measured with an auto ref-keratometer (ARK- 510A, Nidek, Tokyo, Japan). The anterior segment of the eye was examined with a portable hand-held slit-lamp (KJ5S2, Suzhou Kangjie Medical, Jiangsu, China). Individuals with a radially oriented fibrovascular lesion passing laterally through the limbus into the cornea or a history of pterygium excision were diagnosed as pterygium.[11 21]

Grading was classified by the location of the pterygium head under standard lighting conditions. Grade 1: on the limbus. Grade 2: between the limbus and the undilated pupil margin. Grade 3: on the pupil margin. Grade 4: beyond the pupil margin.[5 11] Individuals with a history of pterygium history was recorded as grade 3. If bilateral pterygium was observed, the eye with the higher grade was used for analysis.[5 11] Myopia was defined as spherical equivalent (SE) of less than −0.5 D. Hyperopia was defined as SE of greater than +0.5 D. Astigmatism was defined as cylinder value of more than −0.50 D.[22–24]

Statistics

Statistical analysis was performed with the IBM SPSS statistical package for Mac, V.23 (IBM). Distribution of continuous data was expressed as mean and SD, and categorical variables were expressed as number and percentage. Continuous data were compared using t-test, while categorical variables were compared using χ^2 test. The age-standardised and gender-standardised prevalence was calculated based on the Hebei province data gathered from sixth China National Census in 2010. Risk factors were first analysed using univariate logistic regression model and then factors with p<0.05 and other factors of interest were included in multiple logistic regression models. A p<0.05 was considered statistically significant.

Patient and public involvement

Study participants were not involved in the design of research questions and outcome measurements, and were not involved in the design, recruitment and how the study was conducted. The results of the study were not publicised to the study participants.

RESULTS

Patient characteristics

A total of 3790 individuals (1518 males and 2272 females; 2351 Hans and 1439 Manchus) older than 40 years of age were selected for the study (response rate=82.55%). The average age of all subjects was 55.53±9.02 years. The characteristics of all subjects, comparisons between Hans and Manchus and between males and females are listed in table 1.

Prevalence

Pterygium was found in 248 individuals (6.5%), of which 145 were Han and 103 were Manchu. There was no significant difference in pterygium prevalence in Hans versus Manchus (6.2% vs 7.2%, p=0.232). Among individuals diagnosed with pterygium, 118 were males and 130 were females. The prevalence rates in males were higher compared with females (7.8% vs 5.7%, p=0.012). The prevalence rates for pterygium by age group, race and gender, as well as the age-adjusted prevalence and 95% CIs, are shown in detail in table 2.

One hundred and fifty-eight individuals had unilateral pterygium (4.2%) and 90 had bilateral pterygium (2.4%). In individuals with unilateral pterygium, 84 were affected in their right eye and 74 in their left eye. There were no differences in pterygium prevalence between left and right eye (p=0.578). The majority of pterygium was situated in the nasal side, with only one individual having temporal pterygium, and 32 having both nasal and temporal pterygium. Among the 248 individuals diagnosed, 73 were classified as grade 1, 144 as grade 2, 31 as grade 3 and 0 as grade 4. Twenty-eight individuals (31 eyes) had pterygium removal surgery, with 10 eyes having relapses after surgery.

Univariate analysis

The univariate analysis for the prevalence of any grade of pterygium showed that age (p<0.001), rural residence (p<0.001), rural birthplace (p=0.003) and higher HDL (p=0.016) levels were risk factors, while females (p=0.013), education (p<0.001) and myopia (p<0.001) were protective factors (see online supplementary file).

Multivariate analysis

All study participants

Table 3 shows the multivariate analysis for the prevalence of any grade of pterygium and grade 2 or higher pterygium. Among all the factors measured, age was found to be a risk factor for any grade of pterygium (p<0.001), while age (p<0.001) and rural residence (OR 1.83; 95% CI 1.11 to 3.02; p=0.018) were risk factors for grade 2 or higher pterygium. Females (OR 0.55; 95% CI 0.38 to 0.79; p=0.001) and cigarette smoking (OR 0.65; 95% CI 0.45 to 0.95; p=0.024) were found to be the protective factors for any pterygium, while female (OR 0.58; 95% CI 0.37 to 0.88; p=0.011), cigarette smoking (OR 0.53; 95% CI 0.34 to 0.83; p=0.005) and myopia (OR 0.50; 95% CI 0.33 to 0.77; p=0.002) were protective factors for grade 2 or higher pterygium. Race was not associated with the prevalence of any grade of pterygium (OR 1.16; 95% CI 0.88 to 1.53; p=0.292) or grade 2 or higher pterygium (OR 1.11; 95% CI 0.80 to 1.53; p=0.535).

Table 4 shows the multivariate analysis for the prevalence of any grade of pterygium and grade 2 or higher pterygium in Hans and Manchus. In the Han population, older age (p<0.001 for trend), rural residence (OR 1.81; 95% CI 1.03 to 3.17; p=0.038) and higher HDL (OR 1.64; 95% CI 1.03 to 2.62; p=0.038) were risk factors, while female gender (OR 0.60; 95% CI 0.37 to 0.96; p=0.033) was a protective factor of any grade of pterygium. As for grade 2 or higher pterygium, older age (p<0.001 for trend) and rural residence (OR 2.44; 95% CI 1.21 to 4.93; p=0.013) were risk factors, while female gender (OR 0.54; 95% CI 0.32 to 0.94; p=0.028), cigarette smoking (OR 0.54; 95% CI 0.31 to 0.94; p=0.029) and myopia (OR 0.56; 95% CI 0.32 to 0.97; p=0.039) were protective factors in the Han population. In the Manchus population, age was a risk factor (p=0.004), while female gender (OR 0.45; 95% CI 0.25 to 0.80; p=0.007), cigarette smoking (OR 0.45; 95% CI 0.24 to 0.84; p=0.012) and SBP ≥140 mm Hg (OR 0.58; 95% CI 0.34 to 0.97;

Table 1 Characteristics of all participants, Han and Manchu subgroups, male and female subgroups

		Race			Gender		
	All (n=3790)	Han (n=2351)	Manchu (n=1439)	P value	Male (n=1518)	Female (n=2272)	P value
Demographics							
Female	2272 (59.9%)	1390 (59.1%)	882 (61.3%)	0.186	–	–	
Manchu	1439 (38.0%)	–	–		557 (36.7%)	882 (38.8%)	0.186
Age	55.53±9.02	55.81±9.30	55.08±8.52	0.017*	56.36±9.16	54.98±8.88	<0.001*
Age group				<0.001*			<0.001*
40–49	1185 (31.3%)	745 (31.7%)	440 (30.6%)		417 (27.5%)	768 (33.8%)	
50–59	1406 (37.1%)	805 (34.2%)	601 (41.8%)		565 (37.2%)	841 (37.0%)	
60–69	915 (24.1%)	606 (25.8%)	309 (21.5%)		409 (26.9%)	506 (22.3%)	
70–79	284 (7.5%)	195 (8.3%)	89 (6.2%)		127 (8.4%)	157 (6.9%)	
Education				<0.001*			<0.001*
≤6 years	1386 (36.6%)	845 (35.9%)	541 (37.6%)		371 (24.4%)	1015 (44.7%)	
7–12 years	1918 (50.6%)	1260 (53.6%)	658 (45.7%)		919 (60.5%)	999 (44.0%)	
>12 years	486 (12.8%)	246 (10.5%)	240 (16.7%)		228 (15.0%)	258 (11.4%)	
UV related							
Rural residence	2163 (57.1%)	1392 (59.2%)	771 (53.6%)	0.001*	893 (58.8%)	1270 (55.9%)	0.104
Rural birthplace	3230 (85.2%)	1930 (82.1%)	1300 (90.3%)	<0.001*	1308 (86.2%)	1922 (84.6%)	0.182
Outdoor occupation	1764 (46.5%)	1045 (44.4%)	719 (50.0%)	0.001*	672 (44.3%)	1092 (48.1%)	0.022*
Physical work				<0.001*			<0.001*
Light	2575 (67.9%)	1723 (73.3%)	852 (59.2%)		881 (58.0%)	1694 (74.6%)	
Moderate	622 (16.4%)	403 (17.1%)	219 (15.2%)		328 (21.6%)	294 (12.9%)	
Heavy	593 (15.6%)	225 (9.6%)	368 (25.6%)		309 (20.4%)	284 (12.5%)	
Lifestyle							
Smoke				0.014*			<0.001*
Never	2645 (69.8%)	1607 (68.4%)	1038 (72.1%)		474 (31.2%)	2171 (95.6%)	
Ever	1145 (30.2%)	744 (31.6%)	401 (27.9%)		1044 (68.8%)	101 (4.4%)	
Alcohol				<0.001*			
Never	1870 (49.3%)	1236 (52.6%)	634 (44.1%)		176 (11.6%)	1694 (74.6%)	<0.001*
Ever	1920 (50.7%)	1115 (47.4%)	805 (55.9%)		1342 (88.4%)	578 (25.4%)	
Disease and health							
Hypertension	1849 (48.8%)	1197 (50.9%)	652 (45.3%)	0.001*	819 (54.0%)	1030 (45.3%)	<0.001*
SBP	129.80±18.37	130.78±18.24	128.21±18.48	<0.001*	133.03±17.16	127.64±18.84	<0.001*

Continued

Table 1 Continued

		Race			Gender		
	All (n=3790)	**Han (n=2351)**	**Manchu (n=1439)**	**P value**	**Male (n=1518)**	**Female (n=2272)**	**P value**
DBP	79.59±11.35	79.58±11.15	79.62±11.68	0.925	82.86±11.11	77.41±10.98	<0.001*
Diabetes	551 (14.5%)	402 (17.1%)	149 (10.4%)	<0.001*	264 (17.4%)	287 (12.6%)	<0.001*
LDL3	2.88±0.83	2.94±0.83	2.79±0.84	<0.001*	2.8247±0.86	2.9238±0.82	<0.001*
HDL	1.30±0.36	1.30±0.35	1.32±0.37	0.132	1.25±0.38	1.34±0.34	<0.001*
FBG	5.77±1.56	5.93±1.66	5.53±1.33	<0.001*	5.93±1.70	5.67±1.45	<0.001*
TG	1.82±1.42	1.8074±1.34	1.83±1.54	0.657	1.90±1.61	1.76±1.27	0.003*
TC	4.98±0.97	5.00±0.95	4.96±1.00	0.170	4.90±1.00	5.04±0.95	<0.001*
Height	161.33±8.06	161.60±8.20	160.88±7.81	0.008*	168.24±6.12	156.71±5.49	<0.001*
Weight	65.79±11.31	66.82±11.61	64.12±10.60	<0.001*	71.32±11.62	62.10±9.44	<0.001*
BMI	25.21±3.46	25.51±3.52	24.72±3.31	<0.001*	25.13±3.44	25.26±3.48	0.267
Eye conditions							
Astigmatism	3255 (85.9%)	2034 (86.5%)	1221 (84.9%)	0.153	1314 (86.6%)	1941 (85.4%)	0.328
Myopia	1211 (32.0%)	754 (32.1%)	457 (31.8%)	0.841	468 (30.8%)	743 (32.7%)	0.226
Pterygium							
Either eye	248 (6.5%)	145 (6.2%)	103 (7.2%)	0.232	118 (7.8%)	130 (5.7%)	0.012*
Bilateral	90 (2.4%)	56 (2.4%)	34 (2.4%)	0.970	44 (2.9%)	46 (2.0%)	0.083
Grade 2 or higher	175 (4.6%)	103 (4.4%)	72 (5.0%)	0.376	79 (5.2%)	96 (4.2%)	0.159
Menarche age >16	–	–	–	–	–	928 (40.8%)	–
Menopause age <40	–	–	–	–	–	49 (2.2%)	–

The distribution of continuous data was expressed as mean and SD, and categorical variables were expressed as number (%). Continuous data were analysed using t-test, while categorical variables were compared using χ^2 test.

*P<0.05.

BMI, body mass index; DBP, diastolic blood pressure; FBG, fasting blood glucose; HDL, high-density lipoprotein cholesterol; LDL3, low-density lipoprotein cholesterol 3; SBP, systolic blood pressure; TC, total cholesterol; TG, triglyceride; UV, ultraviolet.

Table 2 Prevalence of pterygium by age, race and gender

		Prevalence rate										
						Age groups						
	Cases	Total (95% CI)		Adjusted† (95% CI)		40–49	50–59	60–69	70–79	P value for age for trend	P value for gender	P value for race
Any pterygium (either eye)												
All (n=3790)	248	6.5%	(5.7 to 7.3)	6.1%	(5.4 to 6.9)	2.4%	6.0%	11.4%	10.6%	<0.001*		
Han (n=2351)	145	6.2%	(5.2 to 7.2)	5.5%	(4.6 to 6.4)	1.6%	6.0%	11.1%	9.2%	<0.001*		0.232
Manchu (n=1439)	103	7.2%	(5.9 to 8.5)	7.0%	(5.7 to 8.4)	3.9%	6.2%	12.0%	13.5%	<0.001*		
Men (n=1518)	118	7.8%	(6.5 to 9.1)	6.9%	(5.6 to 8.2)	2.9%	6.5%	12.2%	15.0%	<0.001*	0.012*	
Women (n=2272)	130	5.7%	(4.7 to 6.7)	5.4%	(4.4 to 6.3)	2.2%	5.7%	10.7%	7.0%	<0.001*		
Bilateral pterygium												
All (n=3790)	90	2.4%	(1.9 to 2.9)	2.2%	(1.8 to 2.7)	0.5%	2.3%	4.0%	4.9%	<0.001*		
Han (n=2351)	56	2.4%	(1.8 to 3.0)	2.1%	(1.5 to 2.7)	0.1%	3.0%	4.0%	3.6%	<0.001*		0.970
Manchu (n=1439)	34	2.4%	(1.6 to 3.2)	2.4%	(1.6 to 3.2)	1.1%	1.5%	4.2%	7.9%	<0.001*		
Men (n=1518)	44	2.9%	(2.1 to 3.7)	2.6%	(1.8 to 3.4)	0.7%	2.5%	4.2%	7.9%	<0.001*	0.083	
Women (n=2272)	46	2.0%	(1.4 to 2.6)	1.9%	(1.3 to 2.4)	0.4%	2.3%	4.0%	2.5%	<0.001*		
Grade 1 pterygium												
All (n=3790)	73	1.9%	(1.5 to 2.3)	1.9%	(1.5 to 2.3)	1.3%	1.6%	3.1%	2.5%	0.018*		
Han (n=2351)	42	1.8%	(1.3 to 2.3)	1.6%	(1.1 to 2.1)	0.9%	1.7%	2.8%	2.1%	0.081		0.424
Manchu (n=1439)	31	2.2%	(1.4 to 3.0)	2.2%	(1.4 to 2.9)	1.8%	1.5%	3.6%	3.4%	0.173		
Men (n=1518)	39	2.6%	(1.8 to 3.4)	2.3%	(1.6 to 3.1)	1.2%	2.5%	3.7%	3.9%	0.108	0.019*	
Women (n=2272)	34	1.5%	(1.0 to 2.0)	1.5%	(1.0 to 2.0)	1.3%	1.1%	2.6%	1.3%	0.155		
Grade 2 pterygium												
All (n=3790)	144	3.8%	(3.2 to 4.4)	3.5%	(2.9 to 4.0)	0.8%	4.1%	6.6%	6.3%	<0.001*		
Han (n=2351)	86	3.7%	(2.9 to 4.5)	3.2%	(2.5 to 3.9)	0.4%	3.9%	6.6%	6.2%	<0.001*		0.560
Manchu (n=1439)	58	4.0%	(3.0 to 5.0)	3.8%	(2.8 to 4.8)	1.4%	4.3%	6.5%	6.7%	0.002*		
Men (n=1518)	67	4.4%	(3.4 to 5.4)	3.9%	(2.9 to 4.8)	1.4%	3.4%	7.3%	9.4%	<0.001*	0.106	
Women (n=2272)	77	3.4%	(2.7 to 4.1)	3.1%	(2.3 to 3.8)	0.4%	4.5%	5.9%	3.8%	<0.001*		
Grade 3 pterygium												
All (n=3790)	31	0.8%	(0.5 to 1.1)	0.7%	(0.5 to 1.0)	0.4%	0.4%	1.7%	1.8%	<0.001*		
Han (n=2351)	17	0.7%	(0.4 to 1.0)	0.7%	(0.3 to 1.0)	0.3%	0.4%	1.7%	1.0%	0.012*		0.407
Manchu (n=1439)	14	1.0%	(0.5 to 1.5)	1.0%	(0.5 to 1.6)	0.7%	0.3%	1.9%	3.4%	0.010*		
Men (n=1518)	12	0.8%	(0.4 to 1.2)	0.7%	(0.3 to 1.1)	0.2%	0.7%	1.2%	1.6%	0.304	0.878	
Women (n=2272)	19	0.8%	(0.4 to 1.2)	0.8%	(0.5 to 1.2)	0.5%	0.1%	2.2%	1.9%	<0.001*		

†Based on sixth China national population census on 2010,[14] prevalence for all individuals was adjusted by age and gender, and prevalence for Han, Manchu, Men and Women was adjusted by age.
*$p < 0.05$

Table 3 Multivariate analysis for risk factors of any grade of pterygium and grade 2 or higher pterygium

	Any pterygium				Grade 2 or higher pterygium			
		95% CI				95% CI		
	OR	Lower	Upper	P value	OR	Lower	Upper	P value
Female	0.55	0.38	0.79	0.001*	0.58	0.37	0.88	0.011*
Manchu	1.16	0.88	1.53	0.292	1.11	0.80	1.53	0.535
Age				<0.001*				<0.001*
40–49	1.00				1.00			
50–59	2.34	1.51	3.63	<0.001*	3.40	1.87	6.17	<0.001*
60–69	4.14	2.65	6.47	<0.001*	5.95	3.26	10.88	<0.001*
70–79	3.93	2.23	6.91	<0.001*	6.19	3.02	12.72	<0.001*
Rural residence	1.50	1.00	2.26	0.052	1.83	1.11	3.02	0.018*
Rural birthplace	1.15	0.67	1.99	0.608	1.40	0.67	2.93	0.371
Outdoor occupation	1.28	0.88	1.85	0.194	1.40	0.90	2.17	0.134
Smoke	0.65	0.45	0.95	0.024*	0.53	0.34	0.83	0.005*
Myopia	0.73	0.53	1.01	0.059	0.50	0.33	0.77	0.002*
Education				0.183				0.556
≤6 years	1.00				1.00			
7–12 years	0.75	0.55	1.02	0.068	0.83	0.58	1.20	0.332
>12 years	0.84	0.45	1.56	0.587	1.03	0.47	2.25	0.939
SBP ≥140 mm Hg	0.84	0.63	1.13	0.256	0.81	0.58	1.15	0.237
TC	1.00	0.87	1.15	0.983	0.98	0.83	1.16	0.824
HDL	1.31	0.92	1.87	0.136	1.37	0.90	2.08	0.142

Text in red represents risk factors, while green represents protective factors.
Comparison of pterygium prevalence in Hans and Manchus.
*P<0.05.
HDL, high-density lipoprotein; SBP, systolic blood pressure; TC, total cholesterol.

p=0.037) were protective factors. For grade 2 or higher pterygium, older age was a risk factor (p=0.014 for trend) and myopia was a protective factor (OR 0.44; 95% CI 0.22 to 0.88; p=0.020) in Manchus.

Comparison of pterygium prevalence in men versus women

Table 5 shows the multivariate analysis for the prevalence of any grade of pterygium and grade 2 or higher pterygium in males and females. In males, older age (p<0.001 for trend, p<0.001 for trend, respectively) and higher HDL (OR 1.63, 95% CI 1.00 to 2.64, p=0.049; OR 1.94, 95% CI 1.08 to 3.47, p=0.027, respectively) were risk factors of any grade of pterygium and grade 2 or higher pterygium, while cigarette smoking was a protective factor for any pterygium (OR 0.62, 95% CI 0.41 to 0.95, p=0.026) and grade 2 or higher pterygium (OR 0.50, 95% CI 0.31 to 0.82, p=0.006). In females, older age (p<0.001 for trend) was a risk factor for any grade of pterygium. For grade two or higher pterygium, older age (p=0.001 for trend) and premature menopause (OR 2.66, 95% CI 1.05 to 6.72, p=0.038) were risk factors, while myopia (OR 0.47, 95% CI 0.26 to 0.86; p=0.014) was a protective factor.

DISCUSSION

This is the first large-scale study to compare the prevalence and risk factors of pterygium between Han (the main ethnic group in China) and Manchu population (the second largest ethnic minority in China, and the largest minority group in Hebei) living in the same location. It also represents the only cross-sectional study of pterygium in Hebei, the province surrounding the capital Beijing in China. Han and Manchu ethnic populations in Hebei do not differ in the prevalence rates for pterygium, and race was not a significant risk factor. Female gender, cigarette smoking and myopia were found to be protective factors for pterygium in this study. In addition, premature menopause was positively associated with the prevalence of grade 2 or higher pterygium in female subgroup. To our best knowledge, there are no published studies that have investigated the association between premature menopause and pterygium.

Pterygium was found in 248 individuals of the 3790 participants aged between 40 and 79 years in this study. The age-adjusted and sex-adjusted prevalence was 6.1%, close to that observed in rural Handan (7.1%),[25] which is also located in Hebei province. The prevalence of pterygium

Table 4 Multivariate analysis for risk factors of any grade of pterygium and grade 2 or higher pterygium in Han and Manchu subgroup

	Han (n=2351)								Manchu (n=1439)							
	Any pterygium				Grade 2 or higher pterygium				Any pterygium				Grade 2 or higher pterygium			
		95% CI				95% CI				95% CI				95% CI		
	OR	Lower	Upper	P value	OR	Lower	Upper	P value	OR	Lower	Upper	P value	OR	Lower	Upper	P value
Female	0.60	0.37	0.96	0.033*	0.54	0.32	0.94	0.028*	0.45	0.25	0.80	0.007*	0.60	0.29	1.25	0.172
Age				<0.001*				<0.001*				0.004*				0.014*
40–49	1.00				1.00				1.00				1.00			
50–59	3.75	1.95	7.23	<0.001*	6.17	2.37	16.09	<0.001*	1.45	0.79	2.66	0.234	2.01	0.92	4.40	0.080
60–69	6.35	3.28	12.31	<0.001*	11.27	4.30	29.48	<0.001*	2.72	1.44	5.13	0.002*	3.39	1.50	7.65	0.003*
70–79	5.25	2.38	11.57	<0.001*	10.74	3.65	31.59	<0.001*	3.15	1.33	7.44	0.009*	4.10	1.43	11.75	0.009*
Rural residence	1.81	1.03	3.17	0.038*	2.44	1.21	4.93	0.013*	1.20	0.65	2.21	0.570	1.31	0.63	2.72	0.473
Outdoor occupation	1.05	0.67	1.63	0.848	1.15	0.68	1.94	0.614	1.88	0.97	3.65	0.062	2.02	0.91	4.47	0.085
Smoke	0.80	0.50	1.27	0.345	0.54	0.31	0.94	0.029*	0.45	0.24	0.84	0.012*	0.51	0.23	1.10	0.087
Myopia	0.83	0.54	1.26	0.376	0.56	0.32	0.97	0.039*	0.61	0.37	1.03	0.066	0.44	0.22	0.88	0.020*
Education				0.442				0.693				0.488				0.736
≤6 years	1.00				1.00				1.00				1.00			
7–12 years	0.77	0.51	1.15	0.202	0.89	0.56	1.43	0.637	0.75	0.45	1.24	0.263	0.79	0.44	1.43	0.443
>12 years	0.82	0.33	2.01	0.661	1.32	0.45	3.84	0.616	0.93	0.37	2.31	0.871	0.89	0.27	2.92	0.851
Rural birthplace	1.21	0.61	2.42	0.590	1.42	0.56	3.59	0.466	0.90	0.36	2.29	0.827	1.06	0.30	3.80	0.930
SBP ≥140 mm Hg	1.01	0.70	1.45	0.975	0.96	0.63	1.47	0.863	0.58	0.34	0.97	0.037*	0.57	0.31	1.04	0.069
TC	0.94	0.78	1.13	0.491	0.95	0.76	1.19	0.675	1.09	0.89	1.34	0.395	1.02	0.80	1.31	0.849
HDL	1.64	1.03	2.62	0.038*	1.61	0.92	2.80	0.095	0.96	0.55	1.68	0.895	1.10	0.58	2.11	0.768

Text in red represents risk factors, while green represents protective factors.
*P<0.05.
HDL, high-density lipoprotein; SBP, systolic blood pressure; TC, total cholesterol.

Table 5 Multivariate analysis for risk factors of any pterygium and grade 2 or higher pterygium in male and female subgroups

	Male (n=1518)								Female (n=2272)							
	Any pterygium				Grade 2 or higher pterygium				Any pterygium				Grade 2 or higher pterygium			
		95% CI				95% CI				95% CI				95% CI		
	OR	Lower	Upper	P value	OR	Lower	Upper	P value	OR	Lower	Upper	P value	OR	Lower	Upper	P value
Manchu	1.03	0.68	1.55	0.895	0.91	0.55	1.49	0.695	1.25	0.85	1.83	0.261	1.26	0.81	1.95	0.316
Age				<0.001*				<0.001*				<0.001*				0.001*
40–49	1.00				1.00				1.00				1.00			
50–59	2.27	1.15	4.50	0.018	2.36	0.98	5.69	0.056	2.27	1.27	4.08	0.006*	4.16	1.81	9.55	0.001*
60–69	4.27	2.15	8.48	<0.001*	4.80	2.01	11.48	<0.001*	3.71	2.01	6.81	<0.001*	6.22	2.64	14.62	<0.001*
70–79	5.29	2.34	11.95	<0.001*	6.27	2.27	17.34	<0.001*	2.60	1.12	6.03	0.026*	5.08	1.75	14.76	0.003*
Rural residence	1.42	0.79	2.57	0.246	1.99	0.94	4.21	0.071	1.45	0.82	2.56	0.203	1.57	0.80	3.08	0.189
Outdoor occupation	1.11	0.66	1.86	0.704	1.16	0.62	2.15	0.646	1.50	0.87	2.58	0.142	1.69	0.89	3.22	0.109
Smoke	0.62	0.41	0.95	0.026*	0.50	0.31	0.82	0.006*	0.91	0.42	1.97	0.802	0.87	0.36	2.11	0.752
Myopia	0.71	0.44	1.16	0.170	0.54	0.29	1.02	0.056	0.76	0.48	1.19	0.226	0.47	0.26	0.86	0.014*
Education				0.824				0.468				0.076				0.314
≤6 years	1.00				1.00				1.00				1.00			
7–12 years	0.98	0.62	1.53	0.912	1.04	0.61	1.78	0.888	0.59	0.37	0.94	0.027*	0.70	0.41	1.19	0.188
>12 years	1.22	0.54	2.76	0.632	1.80	0.66	4.89	0.252	0.54	0.19	1.53	0.246	0.44	0.09	2.01	0.287
Rural birthplace	1.84	0.77	4.40	0.171	3.45	0.77	15.50	0.107	0.79	0.38	1.65	0.530	0.90	0.35	2.30	0.820
SBP ≥140 mm Hg	0.83	0.55	1.27	0.395	0.84	0.50	1.39	0.486	0.88	0.58	1.34	0.563	0.84	0.52	1.35	0.459
TC	1.01	0.82	1.23	0.944	0.91	0.71	1.17	0.460	0.98	0.80	1.19	0.807	1.00	0.80	1.25	0.988
HDL	1.63	1.00	2.64	0.049*	1.94	1.08	3.47	0.027*	1.18	0.69	2.01	0.554	1.18	0.63	2.19	0.609
Menarche age >16	–	–	–	–	–	–	–	–	1.08	0.74	1.57	0.702	1.06	0.68	1.63	0.805
Menopause age <40	–	–	–	–	–	–	–	–	2.23	0.95	5.25	0.065	2.66	1.05	6.72	0.038*

Text in red represents risk factors, while green represents protective factors.
*P<0.05.
HDL, high-density lipoprotein; SBP, systolic blood pressure; TC, total cholesterol.

in Beijing (2.9% of the population over 40 years), located in the centre of Hebei, was much lower compared with the findings in this study. This may be due to the significant higher levels of urbanisation.[26] Previous studies have shown that the prevalence of pterygium in urban populations was lower compared with rural populations.[7 11 26–29] This observation could be partially explained by the fact that people living in modern cities tend to spend less time outdoors and thus less exposed to sunlight.

Several studies have demonstrated the differences between Hans and Manchus in disease prevalence. For example, the prevalence of diabetes mellitus in the Han population in Heilongjiang province is higher compared with the Manchu population (12.1% vs 8.4%),[19] and several studies have found difference between Hans and Manchus in terms of hepatitis E virus positivity (15.96% vs 19.80%), *Toxocara* (14.21% vs 11.22%) and *Toxoplasma gondii* (11.85% vs 13.86%).[30–32] Ethnicity, as well as skin colour, was found as a risk factor in Singapore multiethnic population study (Chinese (OR 0.3, p<0.001) and Indians (OR 0.4, p<0.001) compared with Malays),[9] Xinjiang eye study (Han ethnicity compared with Uygur ethnicity, OR 1.63, p<0.001) (which was also a part of CNHS conducted 3 years ago),[11] Yunnan minority eye study (Yi ethnicity compared with Han ethnicity, OR 0.65)[33] and Barbados eye study (darker skin compared with lighter skin, OR 0.67).[8] Lifestyle, such as wearing a headscarf and hat in Uygur population or genetic predisposition to pterygium possibly, contributes to these racial differences. In this study, the prevalence of pterygium in the Han population (6.2%) was not significantly different compared with the Manchu population (7.6%) (p=0.232). In addition, race was not found to be a risk factor in this study. Of noteworthy, clothing and lifestyles of Han and Manchu are becoming similar in modern society.[17] Increase in intermarriage between Hans and Manchus may also reduce genetic differences between the two ethnic groups. A previous study showed that the spouses of 73 individuals among 189 Manchus were not of Manchu ethnicity.[17]

Increased exposure to UVB is widely accepted as the most significant risk factors associated with the prevalence of pterygium.[7–11 13 21 28 33 34] The amount of UVB exposure is usually measured as outdoor time, rural residence, outdoor occupation and wearing sunglasses (or prescription glasses) and hats. In this study, rural residence was found to be a risk factor for grade 2 or higher pterygium in all individuals, which is consistent with previous studies.[7 11 12 26 28 29] However, outdoor occupation was not found to be significantly associated with pterygium. Several studies have reported the positive association between the prevalence of pterygium and outdoor occupation,[3–5 8 10 35 36] while others have not.[9 12 21 29 34] This may be because the definition of outdoor occupation is different among the studies, and it is difficult to record one's true amount of exposure/radiation. Although we did not investigate the effects of prescription eyeglasses, myopia was found to be a protective factor for pterygium. This could be explained by most nearsighted people regularly wearing glasses (which protects against UVB[37]), or that they tend to be more educated and work indoors and thus spend less time being exposed to the sun. Supporting this, two Korean studies reported that myopia protects against pterygium,[38 39] while the Barbados eye study in 2008 reported that prescription eyeglasses protected against pterygium.[8]

A large number of previous studies have shown the positive correlation between increasing age and the prevalence of pterygium.[5 9 11 21 26 28 29 34 40 41] This is in agreement with the findings from this study. However, several studies regarding the incidence of pterygium (Beijing eye study,[7] Yunnan minority eye study[33] and Barbados eye study[8]), age was not associated with the incidence of pterygium. Therefore, the association between the prevalence of pterygium and age may be caused by the accumulation of the number of cases over time.

The association between gender and pterygium is highly controversial. In this study, the female gender was a protective factor for pterygium, which is consistent with most of the published studies.[3 12 13 25–28 34 42–44] However, several other studies found that women were more susceptible,[5 6 33] while some studies that gender was not associated with pterygium.[10 11 21 29 35 40] These different findings suggest a complex relationship between gender and pterygium. The lifestyles of men and women differ significantly. For example, women in China are generally more likely to take protective measures against sun exposure (hats, shawl, sunglasses and sunscreen), which may explain the low prevalence of pterygium in women in this study and other published studies. However, women in some Western countries desire a suntan and take less protective measures against sun exposure. In addition, occupational preferences differ between the genders. Women are less likely to desire heavy physical work outdoors.

Subgroup analysis of women found that premature menopause was a risk factor for grade 2 or higher pterygium (OR 2.66, 95% CI 1.05 to 6.72, p=0.038). The relationship between pterygium and menopause has rarely been reported. A study conducted in South Korea found that oestrogen replacement therapy was associated with a low prevalence of pterygium in postmenopausal women.[45] The specific mechanism of this protective effect is unclear, but may be related to the effect of oestrogen on reducing oxidative stress.[46] This suggests that lower oestrogen levels may be associated with a higher risk of pterygium in premature menopausal women, but also suggests that the effect of oestrogen may be one of the reasons for the low prevalence of pterygium in women in the majority of the studies.

Cigarette smoking was a protective factor for pterygium in this study, which in consistent with several previous studies.[12 13 25 27] However in some studies, smoking was not associated with pterygium,[5 8 9 11 28 34 35] while the Harbin eye study showed that cigarette smoking was a risk factor.[42] Nevertheless, a meta-analysis study showed

that smoking was a protective factor for pterygium, especially in current smokers.[47] Smoking is generally believed to bring adverse consequences and significant health risks. Hence, it is difficult to understand why smoking was protective against pterygium. We need to consider the possibility of unknown confounding factors affecting this observation. Nevertheless, smoking has been demonstrated to have protective effects on several diseases such as ulcerative colitis,[48] which may be associated to smoking-induced immunosuppressant state.[49] The possible protective effect of cigarette smoking on pterygium requires further investigation.

This study also found that higher HDL level was a risk factor for any grade of pterygium in the Han subgroup (OR 1.64, 95% CI 1.03 to 2.62, p=0.038), while higher HDL level was a risk factor for grade 2 or higher pterygium in the male subgroup (OR 1.94, 95% CI 1.08 to 3.47, p=0.027). It is important to note that the p value just reached significance, thus, more studies are needed to replicate these findings. As far as we are aware, no previous studies have investigated the association between HDL and pterygium. However, a small number of studies have explored the association between hyperlipidaemia and pterygium, and no significant differences were found. High HDL levels have consistently been shown to be associated with physical activity and exercise,[50] which could be a confounder with several types of physical activities and exercises conducted outdoors.

This study has several limitations. First, the daily sunlight exposure duration and protective measures (such as sunglasses and hats) were not recorded. This information would have helped determine the direct association between UVB and pterygium. Second, the cross-sectional analysis restricted us to determine causality. Further cohort studies are needed to investigate these associations with causality. Third, only individuals who underwent ophthalmic examinations and provided complete information to the questionnaire were included in this study. Fourth, although Hans and Manchus constitute 98.85% of the population in Hebei, the remaining 1.15% of the population of other minor ethnic groups were not included in the study. These selection biases may lead to incorrect estimation of the prevalence rates of pterygium in the whole population of Hebei. These limitations must be considered when interpreting the results of this study.

CONCLUSION

This large-scale cross-sectional study of 3790 individuals living in Hebei province of China investigated the prevalence and risk factors of pterygium in Manchu and Han ethnic groups living in the same area. Age was found to be a risk factor for pterygium, while the female gender, cigarette smoking and myopia were associated with a reduced prevalence of pterygium. In addition, premature menopause was a risk factor for grade 2 or higher pterygium in females, while higher HDL level in males was a risk factor for grade 2 or higher pterygium.

Author affiliations
[1]Department of Ophthalmology, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China
[2]Eight year program of clinical medicine, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China
[3]Department of Epidemiology and Statistics, Institute of Basic Medical Sciences, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China
[4]Hebei Center for Disease Prevention and Control, Shijiazhuang, China
[5]Institute of Chronic Disease, Shijiazhuang Center for Disease Prevention and Control, Shijiazhuang, China
[6]Institute of Chronic Disease, Baoding Center for Disease Prevention and Control, Baoding, China

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