Clinical and Epidemiologic Research

Population-Based Assessment of Prevalence and Risk Factors for Pterygium in the South Indian State of Andhra Pradesh: The Andhra Pradesh Eye Disease Study

Srinivas Marmamula,[1–3] Rohit C. Khanna,[1] and Gullapalli N. Rao[1,2]

[1]Allen Foster Community Eye Health Research Centre, International Centre for Advancement of Rural Eye Care, L V Prasad Eye Institute, Hyderabad, India
[2]Bausch & Lomb School of Optometry, L V Prasad Eye Institute, Hyderabad, India
[3]Dana Center for Preventive Ophthalmology, Wilmer Eye Institute, Johns Hopkins School of Medicine, Baltimore, Maryland

Correspondence: Srinivas Marmamula, Allen Foster Community Eye Health Research Centre, ICARE, L V Prasad Eye Institute, L V Prasad Marg, Banjara Hills, Hyderabad, India 500034; srioptom@lvpei.org.

Submitted: June 3, 2013
Accepted: July 7, 2013

Citation: Marmamula S, Khanna RC, Rao GN. Population-based assessment on prevalence and risk factors for pterygium in the South Indian state of Andhra Pradesh: the Andhra Pradesh Eye Disease Study. *Invest Ophthalmol Vis Sci.* 2013;54:5359–5366. DOI:10.1167/iovs.13-12529

Purpose. To describe the prevalence and risk factors for pterygium in a population-based sample of individuals aged 30 years and older in South Indian state of Andhra Pradesh.

Methods. A cross-sectional study was conducted in one urban and three rural locations in which 10,293 subjects were examined. All the subjects underwent comprehensive eye examination and a detailed interview by trained professionals. Pterygium was defined as fleshy fibro vascular growth, crossing the limbus, and typically seen on the nasal conjunctiva in either eye.

Results. Data were analyzed for 5586 subjects who were aged 30 years and older at the time of participation. The mean age of the participants was 47.5 years (SD 13 years; range 30–102 years). In total, 46.4% were male, 56.7% had no education, 52.2% of them were involved in outdoor occupations, and 25% belonged to urban area. The prevalence of pterygium was 11.7% (95% confidence interval [CI]: 10.9–12.6). The multiple logistic regression analysis revealed significantly higher odds of pterygium among older age groups, rural residents (odds ratio [OR]: 1.8; 95% CI: 1.4–2.4; $P > 0.01$), and those involved in outdoor occupations (OR: 1.8; 95% CI: 1.5–2.2, $P < 0.001$). Education had a protective effect (OR: 0.6; 95% CI: 0.5–0.7; $P < 0.001$).

Conclusions. Pterygium is common in the South Indian state of Andhra Pradesh. Exposure to sunlight is a significant modifiable risk factor. Protecting the eyes from sunlight may decrease the risk of pterygium. However, the important public health challenge is to encourage the use of this protection as a routine in developing countries such as India.

Keywords: pterygium, risk factors, outdoor occupations, Andhra Pradesh, India

Pterygium is a wedge shaped abnormal fibrovascular growth that is typically seen on the nasal conjunctiva and extends over to the cornea. Several researchers have studied both the epidemiologic associations and pathophysiology of pterygium.[1–3] Among the several risk factors reported, exposure to UV rays is perhaps the most common risk factor for the occurrence of pterygium.[4–13] The presence of pterygium results in a cosmetic blemish and it occasionally may extend on to the corneal surface resulting in irregular astigmatism and leading to visual impairment.[14]

Andhra Pradesh (AP) lies between 12°41′ and 22°N latitude and 77° and 84°40′E longitude. It is one of the largest states in India with a large proportion of its population engaged in agricultural activities and several other outdoor occupations. Nearly one third of the population reside in rural areas as per the 2011 census.[15] There are no studies on the prevalence of pterygium in Andhra Pradesh, though a survey from the neighboring state of Tamil Nadu reported a prevalence of 9.5% in the population aged 40 years and older.[16] We undertook a large population based epidemiologic cross-sectional study (Andhra Pradesh Eye Disease Study [APEDS]) to evaluate the prevalence and risk factors for ocular morbidity and visual impairment. The prevalence and causes of visual impairment have been reported from this study.[17,18] In this paper, we report on the prevalence and risk factors for pterygium in a population aged 30 years and older in the South Indian state of Andhra Pradesh.

Methods

Informed Consent

The Institutional Review Board (Scientific and Ethics Committee) of the L V Prasad Eye Institute, Hyderabad, India, reviewed and approved the study design of APEDS. The study followed the tenets of the Declaration of Helsinki. All the participants provided written informed consent for participating in the study. The data collection was accomplished from 1996 to 2000.

Study Area and Participants

The detailed methodology and findings of APEDS were reported previously.[19,20] Briefly, a multistage cluster random sampling procedure was used to select a study sample of 10,000 persons of all ages including 5000 individuals aged 30 years and older. One urban and three rural areas from different parts of AP were selected with an equal distribution of 2500 participants in each area, to reflect the urban–rural and socioeconomic distribution of the population of this state in the year 2000. The four areas selected were Hyderabad (urban), West Godavari district (economically well off, rural), and Adilabad and Mahabubnagar districts (poor, rural).

Interview

All the participants underwent a comprehensive interview by trained field investigators. Detailed information on study instruments is published elsewhere.[20] In the context of the current study, the data collected included personal-, demographic-, and lifestyle-related information comprising age, sex, education, occupation, residence, smoking, alcohol consumption, use of spectacles, and systemic history including hypertension and diabetes.[20]

Ophthalmologic Examination

Two ophthalmologists and two optometrists, specially trained in the study procedures, performed the examinations. Distance and near visual acuity were assessed under standard testing conditions using logarithm of minimum angle of resolution charts. Both presenting and best corrected visual acuity after refraction were recorded. Detailed anterior segment examination was performed using slit-lamp biomicroscopy. All the participants underwent dilated posterior segment evaluation, unless contraindicated. The detailed examination protocol has been previously published.[20]

Definitions

The primary outcome was the presence of pterygium in either eye, which was defined as fleshy fibro vascular growth, crossing the limbus, and typically seen on the nasal conjunctiva. The covariates are defined as follows: the level of formal education was categorized under two groups, 'no education' and 'any education'; occupation was categorized as 'indoor' and 'outdoor' occupation, based on the working environment, as a surrogate measure of exposure to UV sunlight; smoking and alcohol status was defined as 'ever' and 'never' based on the history. Previous and current smokers and alcohol consumers were both classified as 'ever' smokers, and alcoholics for the purpose of data analysis; the diagnosis of hypertension and diabetes is based on self-report by the participants; all the participants were classified as spectacle users and nonspectacle users. The use of sunglasses is uncommon among this study population, but a small proportion of those who reported use ($n = 191$; 3.4%) were also included in the category of spectacles users.

Data Analysis

The dataset that included individuals aged 30 and older was used for analysis. Data were analyzed using Stata statistical package for windows version 12 software (StataCorp, College Station, TX).[21] Univariate analysis for exploring the differences between participants with and without pterygium was done using χ^2 test. Simple logistic regression was done to find the relationship between pterygium (dependent variable) and each of the risk factors followed by likelihood ratio tests. Multiple logistic regression models were used to examine the strength of association between pterygium and all the risk factors including age, sex, education, occupation, alcohol intake, smoking, use of spectacles, diabetes, and hypertension. Hosmer-Lemeshow goodness of fit tests was used to assess the goodness of the model fit. Variance inflation factors (VIF) were used to test for collinearity between the covariates after fitting a multiple regression model. The final regression model reported a VIF equal to 1.4, and the goodness of fit test was not significant ($P = 0.23$), indicating a good fit of model. The adjusted odds ratio (OR) with 95% confidence intervals (CI) is presented. The statistical significance was assessed at the conventional level of P less than 0.05 (two-tailed); however, exact P values are reported.

Results

Of a total of 11,786 subjects sampled for APEDS, 10,293 (87.3%) participated in the main study. Data were analyzed for 5586 subjects who were 30 years of age and older at the time of participation. The mean age of the participants was 47.5 years (SD 13 years; range 30–102 years). In total, 46.4% ($n =$ 2594) were male, 56.7% ($n = 3170$) had no education, and 52.2% ($n = 2915$) of them were involved in outdoor occupations. A quarter ($n = 1399$) of the sample belonged to urban area. Nearly 20% ($n = 1137$) of the participants reported use of spectacles. The proportion of ever smokers and ever alcohol consumers was 33.6% ($n = 1878$) and 35.8% ($n =$ 1998), respectively (Table 1).

The overall prevalence of pterygium in either eye was 11.7% (95% CI: 10.9–12.6; $n = 655$). The prevalence was significantly higher among older age groups ($P < 0.001$), but similar in both sexes. The prevalence was significantly higher among those with no education (15.4%; 95% CI: 14.2–16.7) compared with those with any education (6.9%; 95% CI: 5.9–8.0) ($P < 0.001$), it was higher among rural residents (14.0%; 95% CI: 13.0–15.1) compared with 4.9% (95% CI: 3.8–6.2) ($P <$ 0.001) in urban area, and higher among those who had a predominantly outdoor occupation (15.6%; 95% CI: 14.3–17.0) compared with indoor work (7.5%; 95% CI: 6.5–8.5) ($P <$ 0.001). The pterygium was less frequent among those who had hypertension ($P < 0.001$) and diabetes. Though the prevalence of pterygium was similar among smokers and nonsmokers, it was higher among those who reported alcohol intake ($P <$ 0.001) (Table 2). The pterygium was not a cause of visual impairment in our study population. The prevalence of bilateral pterygium was 6.9% (95% CI: 6.2–7.6).

The univariate analysis showed significantly higher odds (unadjusted) of pterygium in older age groups, rural residents (OR: 3.1, 95% CI: 2.4–4.0; $P < 0.001$), those involved in outdoor occupations (OR: 2.3, 95% CI: 1.9–2.7; $P < 0.001$), and alcohol consumption (OR: 2.1, 95% CI: 1.8–2.4; $P <$ 0.001). Any education (OR: 0.4, 95% CI: 0.3–0.5; $P < 0.001$), use of spectacles (OR: 0.6, 95% CI: 0.4–0.7; $P < 0.001$), and having hypertension (OR: 0.6, 95% CI: 0.4–0.8; $P < 0.01$) had a protective effect. No statistically significant association was seen with pterygium and smoking, sex, and among those with diabetes (Table 3).

The multiple logistic regression analysis revealed significantly higher odds (adjusted) of pterygium with increasing age. Compared with those aged 30 to 39 years, the odds of pterygium increased more than 2-fold in the 40 to 49 years age group and the upward trend of increasing odds continued with odds of 3.9 (95% CI: 2.7–5.6; $P < 0.001$) among those aged 70 years and older. Education had a protective effect (OR: 0.8; 95% CI: 0.5–0.7; $P < 0.001$). In comparison to those residing in urban area, the odds of pterygium were almost twice as high as in rural residents (OR: 1.8; 95% CI: 1.4–2.4; $P > 0.01$). The participants involved in outdoor occupations had nearly twice the odds for pterygium (OR: 1.8; 95% CI: 1.5–2.2: $P < 0.001$) compared with their counterparts who had no outdoor work. There was no statistically significant association found between pterygium and sex, diabetes, and hypertension. Though the use of spectacles had a protective effect (OR: 0.8, 95% CI: 0.6–1.0; $P = 0.12$), it was not statistically significant. The odds of pterygium were higher among ever alcoholic (OR: 1.7, 95% CI: 1.4–2.0; $P < 0.001$) compared with

TABLE 1. Characteristics of the Study Sample Stratified by Presence and Absence of Pterygium ($n = 5586$)

	No Pterygium		Pterygium		Total		
	n	%†	*n*	%†	*n*	%†	*P* Value*
Age group, y							<0.001
30–39	1731	35.1	131	20	1862	33.3	
40–49	1262	25.6	162	24.7	1424	25.5	
50–59	886	18	161	24.6	1047	18.7	
60–69	760	15.4	140	21.4	900	16.1	
70 and above	292	5.9	61	9.3	353	6.3	
Sex							0.627
Male	2284	46.3	310	47.3	2594	46.4	
Female	2647	53.7	345	52.7	2992	53.6	
Education							<0.001
No education	2681	54.4	489	74.7	3170	56.7	
Any education	2250	45.6	166	25.3	2416	43.3	
Area of residence							<0.001
Urban	1330	27	69	10.5	1399	25	
Rural	3601	73	586	89.5	4187	75	
Occupation							<0.001
No outdoor	2471	50.1	200	30.5	2671	47.8	
Outdoor work	2460	49.9	455	69.5	2915	52.2	
Smoking status							0.225
Never	3287	66.7	421	64.3	3708	66.4	
Ever	1644	33.3	234	35.7	1878	33.6	
Alcohol intake							<0.001
Never	3269	66.3	319	48.7	3588	64.2	
Ever	1662	33.7	336	51.3	1998	35.8	
Spectacles use							<0.001
No	3880	78.7	569	86.9	4449	79.6	
Yes	1051	21.3	86	13.1	1137	20.4	
Hypertension							0.002
No	4464	90.5	617	94.2	5079	90.9	
Yes	467	9.5	38	5.8	505	9	
Diabetes mellitus							0.018
No	4743	96.2	642	98	5385	96.4	
Yes	188	3.8	13	2	201	3.6	
Total	**4931**	**100**	**655**	**100**	**5586**	**100**	

Bold is for emphasis only.

* *P* values are determined using χ^2 test comparing the risk factors and presence of pterygium.

† Column percentages presented.

TABLE 2. Prevalence of Pterygium Stratified by Risk Factors ($n = 655$)

	Prevalence, %	95% CI	*P* Value*
Age group, y			<0.001
30–39	7.0	5.9–8.3	
40–49	11.4	9.8–13.1	
50–59	15.4	13.2–17.7	
60–69	15.6	13.2–18.1	
70 and above	17.3	13.5–21.6	
Sex			0.627
Male	12.0	10.7–13.3	
Female	11.5	10.4–12.7	
Education			<0.001
No education	15.4	14.2–16.7	
Any education	6.9	5.9–8.0	
Area			<0.001
Urban	4.9	3.8–6.2	
Rural	14.0	13.0–15.1	
Occupation			<0.001
No outdoor	7.5	6.5–8.5	
Outdoor work	15.6	14.3–17.0	
Smoking status			0.225
No	11.4	10.3–12.4	
Yes	12.5	11.0–14.0	
Alcohol intake			<0.001
No	8.9	7.8–9.9	
Yes	16.8	15.2–18.5	
Spectacles use			<0.001
No	12.8	11.8–13.1	
Yes	7.6	6.1–9.2	
Hypertension			0.002
No	12.1	11.3–13.1	
Yes	7.5	5.4–10.2	
Diabetes mellitus			0.018
No	11.9	11.0–12.8	
Yes	6.5	3.5–10.8	
Overall	**11.7**	**10.9–12.6**	

Bold is for emphasis only.

* *P* values are determined using χ^2 test.

never alcoholics, while smoking revealed a protective effect (OR: 0.6, 95% CI: 0.4–0.7; $P < 0.001$) (Table 3). There was no interaction between education and age. However, education had a significant interaction with outdoor occupation. On excluding education variable from the model, the overall effects attenuated, but this change in odds was not significant and there no change in direction (data not shown).

DISCUSSION

A wide variation in the prevalence of pterygium is reported ranging from nearly 2% in Greater Beijing, China[22] and 2.8% in Victoria, Australia,[23] to 39% in rural Dali, China,[24] and about 48% in Spain.[25] Though a lower prevalence of 1.3% was reported from Tehran, the study included all ages compared with other studies that included individuals aged 40 years or older.[26] We found a 11.7% prevalence of pterygium in our study, which is comparable to the previously reported prevalence of 9.5% from Tamil Nadu in South India. [16]

We summarized the prevalence and risk factors for pterygium from large population-based, cross-sectional studies in Table 4. A large number of risk factors were shown to be associated with pterygium pointing toward a multifactorial nature of occurrence of the condition. [1-3] Though an unequivocal evidence of association is shown between pterygium with older age and outdoor occupations (a surrogate measure of UV exposure), associations with other risk factors are differently reported.[4-13] The increasing odds of pterygium with increase in age reported from several studies can be considered as suggestive of increased cumulative lifetime exposure to sunlight.

While most studies demonstrated an increased risk of pterygium among men compared with women,[22,23,25,27–34] some studies, including the present study and the report from

Table 3. Results of Simple and Multiple Logistic Regression Analyses for Association Between Pterygium and the Risk Factors

	Crude OR*	95% CI	*P* Values	Adjusted OR†‡	95% CI	*P* Values
Age group, y						
30–39	(base)			(base)		
40–49	1.7	1.3–2.2	<0.001	1.8	1.4–2.3	<0.001
50–59	2.4	1.9–3.1	<0.001	2.6	2.0–3.3	<0.001
60–69	2.4	1.9–3.1	<0.001	2.8	2.1–3.6	<0.001
70 and above	2.8	2.0–3.8	<0.001	3.9	2.7–5.6	<0.001
Sex						
Male	(base)			(base)		
Female	1.0	0.8–1.1	0.98	0.8	0.6–1.0	0.07
Education						
No education	(base)			(base)		
Any education	0.4	0.3–0.5	<0.001	0.6	0.5–0.7	<0.001
Area of residence						
Urban	(base)			(base)		
Rural	3.1	2.4–4.0	<0.001	1.8	1.4–2.4	<0.001
Occupation						
No outdoor	(base)			(base)		
Outdoor work	2.3	1.9–2.7	<0.001	1.8	1.5–2.2	<0.001
Smoking status						
Never	(base)			(base)		
Ever	1.1	0.9–1.3	0.23	0.6	0.4–0.7	<0.001
Alcohol use						
Never	(base)			(base)		
Ever	2.1	1.8–2.4	<0.001	1.7	1.4–2.0	<0.001
Spectacles use						
No	(base)			(base)		
Yes	0.6	0.4–0.7	<0.001	0.8	0.6–1.0	0.12
Hypertension						
No	(base)			(base)		
Yes	0.6	0.4–0.8	<0.01	0.9	0.6–1.2	0.43
Diabetes mellitus						
No	(base)			(base)		
Yes	0.5	0.3–0.9	0.02	0.8	0.5–1.5	0.56

* Based on simple logistic regression with pterygium as the outcome and each of the risk factor as the predictors.
† Based on multiple logistic regression with pterygium as the outcome and all the predictors entered at the same time.
‡ AIC (Akaike Information Criterion) for the regression model = 3144.7.
§ Hosmer-Lemeshow test for goodness of fit for the regression model, $P = 0.23$.
|| Variance inflation factor for the multiple logistic regression model = 1.4.

Tamil Nadu, found a similar prevalence in both the sexes.[16] The two studies from rural Dali and Tibet, China, found a higher prevalence among women.[24,35] The studies have shown a higher prevalence of pterygium among those with lower levels of education and those belonging to lower socioeconomic status.[24,31,33,35–37] We also found a significantly higher prevalence of pterygium (5.5% vs. 13.8%) among those with no education; we have not included socioeconomic status in our risk factor models. Similar to other studies, we found a significantly higher prevalence of pterygium in the rural population.[16,23,24]

Although the causal association between pterygium and other systemic conditions such as hypertension and diabetes is not clearly known, several authors have used these as risk factors and studied their association with pterygium. A study among the Malay population in Singapore found an increased risk of pterygium among those with higher systolic blood pressure.[27] Both the present study and the other studies from South India and China found no significant association between pterygium and hypertension.[16,24] Similar to other studies, we did not find any significant association between pterygium and diabetes after adjusting for other covariates. Due caution has to be exercised when diagnosis of hypertension and diabetes are based on self-report, as it can grossly underestimate the prevalence of these conditions, as a significant proportion of people may be unaware of the condition in developing countries such as India.

Alcohol intake and smoking have been subject in several studies as risk factors for pterygium, though the biologic mechanism between pterygium and these factors is not clearly understood. Both alcohol intake and smoking association from epidemiologic cross-sectional studies can be occasionally confounded with other risks, and smoking itself may be confounded with alcohol intake. The study among the Bali rural population in China, Tamil Nadu in India, and Spain, showed no association between smoking and pterygium[16,24,25]; however, a study from the United States showed a protective effect of smoking[33] In our study, smoking was not

TABLE 4. Summary on Prevalence and Associations With Pterygium in Large Population-Based Cross-Sectional Studies Around the World

Place	Year of Study	Age Group, y	Sample Size, Examined	Prevalence, %	Other Variables in the Multivariable Model	Significant Risk Factors in the Multivariable Analysis
Shahroud, Iran (Urban)[31]	2012	>40	5,190	9.4% (either eye); 2.9% (bilateral)	Smoking (no association)	Older age, male sex, working outdoors, and the lower level of education
Bai minority population in rural Dali, China[24]	2012	≥50	2,133	39.0% (either eye)	Height, weight, hypertension, diabetes, smoking, alcohol use (ns)*	Older age, female sex, older age, lack of formal education, outdoor work
Indigenous Australians within central Australia[42]	2011	≥40	1,884	9.3% (either eye)	Sex (ns)*	Older age
Malay population of Singapore[27]	2010	40–79	3,280	12.3% (either eye)	Smoking (ns),* education (ns)*	Older age, male sex, higher systolic blood pressure, outdoor occupation (only for severe pterygium), total cholesterol
Kumejima Island, Japan[32]	2009	≥40	3,762	30.8% (either eye); 13.1% (bilateral)	Height, weight, blood pressure, use of hat, (all ns)*	Older age, male sex, hyperopic refraction, lower IOP, and outdoor occupation
Beijing, China (Rural)[22]	2008–2009	55–89	37,067	3.8% (either eye)	None	Older age, male sex, UV radiation living in low latitude
Latinos in Arizona, USA[33]	2008	≥40	4,774	16% (either eye)	Smoking showed a protective effect, Diabetes (borderline protective), bilateral cataract surgery (protective)	Male sex, lower socioeconomic status, lower levels of education
Rural Myanmar[14]	2007	≥40	2,076	19.6% (either eye); 8.0% (bilateral)	Smoking (ns)*; age (ns)*	Outdoor occupation, female sex
Greater Beijing, China[29]	2007	≥40	4,439	1.9% (either eye); 2.9% subjects	Level of education (ns)* or refractive errors (ns)*	Older age, male sex, outdoor work
Southern Harbin population, China[43]	2006	≥50	5,057	3.7% (either eye); 2.6% (bilateral)	age and education (no association)	Male sex, smoking, astigmatism
Tibetans in China[35]	2006	≥40	2,229	14.5% (either eye)	Sea level	Older age, female sex, not using sunglasses, lower level of education, lower socio economic status
Mongolian population at high altitude in Henan County, China[36]	2006	≥40	2,112	17.9% (either eye)	None	Older age, lower levels of education, alcohol intake, lower socio economic status, non use of sunglasses or hat and cataract
North-Western Spain[25]	2005–2006	≥40	619	5.9% (either eye)	Alcohol intake, smoking, diabetes, iris color, pseudo exfoliation (ns)*	Older age, male sex, outdoor occupation
Singapore (included studies multi ethic Asian population)[44]	2004–2011	≥40	8,906	10.1% (either eye); 4.6% (Bilateral)	Hypertension, total cholesterol (ns)*	Older age, male sex, Malay race, poorer education, outdoor occupation
Tehran[26]	2002	All ages	4,564	1.3% (either eye)	Race	Older age, Male sex, smoking

Table 4. Continued

Place	Year of Study	Age Group, y	Sample Size, Examined	Prevalence, %	Other Variables in the Multivariable Model	Significant Risk Factors in the Multivariable Analysis
Doumen County, southern China (rural)[45]	2002	≥50	4,214	33.0% (either eye)	Not reported	Risk factors not reported
Sumatra, Indonesia (rural)[46]	2002	≥21	1,210	10.0% (either eye); 4.1% (bilateral)	Smoking protective, sex (ns)*	Older age, outdoor occupations
Tamil Nadu, India[16]	2001–2004	≥40	7,774	9.5% (either eye)	Smoking, alcohol, nature of work, diabetes, hypertension (ns)*	UV exposure, rural residence, older age, lower socio economic status
Barbados[37]	2001	≥40	2,781	23.4% black, 23.7% mixed, and 10.2% white participants (either eye)	Darker skin complexion, use of sunglasses/ prescription glasses were protective factors; Current smoking (protective)	African ancestry, older age, lower levels of education, outdoor occupation
Australian state of Victoria [23]	2000	≥40	5,147	2.8% (either eye)	None	Older age, male sex, rural residence, and life ocular sun exposure
Chinese population in Singapore[34]	1997–1998	≥40	1,232	6.9% (either eye); 2.9% (bilateral)	None	Older age, male sex, outdoor occupations, factory workers
Australia[30]	1992–1994	≥49	3,564	7.3% (either eye)	Iris color (ns)*	Male sex, darker skin color, black hair color
Australia[4]	1984 (published)	All ages	105,113	3.4% (Aborigines); 1.1% (Non aboriginals) (eye or person not reported)	Not reported	Not reported

* ns = nonsignificant.

significant in univariable model; it showed a protective effect when introduced in multivariable model. We found a higher prevalence of pterygium among those who reported alcohol intake with twice the odds compared with those who reported no alcohol intake. Other studies from India, China, and Spain found no such association.[16,24,25]

The use of sunglasses and other devices to protect themselves from sunlight is not common in the population studied. Though we found that the use of spectacles had a protective effect when we studied the total effect in univariable model, this effect was not statistically significant in the multivariable model. The protective effect of spectacles use is reported in other studies.[16,35,37]

Although the early researchers on pterygium reported a direct relationship between pterygium and UV exposure, in fact there are reports on the 'pterygium belt' that extends to 37° north and south of the equator.[4,13,38] As more research work is now available that indicate a significant variation in the prevalence of pterygium in regions belonging to same geographic locations. It is now clear that though UV exposure is a key risk factor, there are several other risk factors including genetic predisposition for pterygium. However, in public health parlance, UV exposure remains is one of the important modifiable risk factors.

We studied a randomly selected representative sample and obtained a high response rate, which makes our results externally valid and comparable with other population-based studies done elsewhere. The categories we used for alcohol intake and smoking status may have been subject to misclassification bias as we have not taken the dose or frequency, nor have we quantified the intake. We are unable to make any inferences on dose-response relationship between these risk factors and pterygium. We relied on self-report on diabetes and hypertension, hence this could have underestimated the true prevalence of hypertension and diabetes in our study population. Finally, we have not used any specific technology or measure to quantify the actual UV exposure or lifetime UV exposure as used in previous studies.[16,23,39] We used outdoor occupation as a surrogate measure of sunlight exposure and this is prone to result in bias and in imprecision in our estimates.[40,41]

In conclusion, exposures to sunlight and alcohol intake are important modifiable risk factors. The use of sunglasses or protection from sunlight for those who predominantly work outdoors may decrease the risk of prevalence. However, the public health challenge is to inculcate the use of this protection as routine, and introduce suitable lifestyle modifications in the rural populations in developing countries such as India.

Acknowledgments

The authors thank Lalit Dandona and Rakhi Dandona, who conducted the detailed study, and Hugh R. Taylor and Catherine A. McCarty for their guidance in the study design. They also thank the participants of APEDS for their participation in the study, as well as the entire APEDS team, including Pyda Giridhar, Kovai

Vilas, and Mudigonda N. Prasad for conducting the in depth interviews.

Supported by grants from the Hyderabad Eye Research Foundation, India, and Christoffel-Blindenmission, Bensheim, Germany.

Disclosure: **S. Marmamula**, None; **R.C. Khanna**, None; **G.N. Rao**, None

References

1. Bradley JC, Yang W, Bradley RH, Reid TW, Schwab IR. The science of pterygia. *Br J Ophthalmol*. 2010;94:815–820.
2. Saw SM, Tan D. Pterygium: prevalence, demography and risk factors. *Ophthalmic Epidemiol*. 1999;6:219–228.
3. Hill JC, Maske R. Pathogenesis of pterygium. *Eye (Lond)*. 1989; 3:218–226.
4. Moran DJ, Hollows FC. Pterygium and ultraviolet radiation: a positive correlation. *Br J Ophthalmol*. 1984;68:343–346.
5. Chao SC, Hu DN, Yang PY, et al. Ultraviolet-A irradiation upregulated urokinase-type plasminogen activator in pterygium fibroblasts through ERK and JNK pathways. *Invest Ophthalmol Vis Sci*. 2013;54:999–1007.
6. 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 Ophthalmologica*. 2013;91:363–370.
7. Sekelj S, Dekaris I, Kondza-Krstonijevic E, Gabric N, Predovic J, Mitrovic S. Ultraviolet light and pterygium. *Collegium Antropologicum*. 2007;31:45–47.
8. Yan QC, Wang XL, Bai QH, et al. Relationship between the morbidity of pterygium and the duration of ultraviolet rays exposure in Sanya, China. *Chin Med J*. 2006;119:1308–1310.
9. Nolan TM, DiGirolamo N, Sachdev NH, Hampartzoumian T, Coroneo MT, Wakefield D. The role of ultraviolet irradiation and heparin-binding epidermal growth factor-like growth factor in the pathogenesis of pterygium. *Am J Pathol*. 2003; 162:567–574.
10. Coroneo MT. Pterygium as an early indicator of ultraviolet insolation: a hypothesis. *Br J Ophthalmol*. 1993;77:734–739.
11. Spierer A, Rosner M, Belkin M. Pterygium, solar ultraviolet radiation and myopia. *Metab Pediatr Syst Ophthalmol*. 1985; 8:47–48.
12. Taylor HR. Ultraviolet radiation and pterygium. *JAMA*. 1982; 247:1698.
13. Darrell RW, Bachrach CA. Pterygium among veterans. An epidemiologic study showing a correlation between frequency of pterygium and degree of exposure of ultraviolet in sunlight. *Arch Ophthalmol*. 1963;70:158–169.
14. Durkin SR, Abhary S, Newland HS, Selva D, Aung T, Casson RJ. The prevalence, severity and risk factors for pterygium in central Myanmar: the Meiktila Eye Study. *Br J Ophthalmol*. 2008;92:25–29.
15. Census. Registrar General and Census Commissioner, Census of India 2011. *Ministry of Home Affairs, Government of India*. New Delhi, India: Government of India; 2011.
16. Asokan R, Venkatasubbu RS, Velumuri L, Lingam V, George R. Prevalence and associated factors for pterygium and pinguecula in a South Indian population. *Ophthalmic Physiol Opt*. 2012;32:39–44.
17. Dandona L, Dandona R, Srinivas M, et al. Blindness in the Indian state of Andhra Pradesh. *Invest Ophthalmol Vis Sci*. 2001;42:908–916.
18. Dandona R, Dandona L, Srinivas M, et al. Moderate visual impairment in India: the Andhra Pradesh Eye Disease Study. *Br J Ophthalmol*. 2002;86:373–377.
19. Dandona R, Dandona L. Review of findings of the Andhra Pradesh Eye Disease Study: policy implications for eye-care services. *Indian J Ophthalmol*. 2001;49:215–234.
20. Dandona R, Dandona L, Naduvilath TJ, Nanda A, McCarty CA. Design of a population-based study of visual impairment in India: the Andhra Pradesh Eye Disease Study. *Indian J Ophthalmol*. 1997;45:251–257.
21. StataCorp. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP; 2011.
22. Liang QF, Xu L, Jin XY, You QS, Yang XH, Cui TT. Epidemiology of pterygium in aged rural population of Beijing, China. *Chin Med J*. 2010;123:1699–1701.
23. McCarty CA, Fu CL, Taylor HR. Epidemiology of pterygium in Victoria, Australia. *Br J Ophthalmol*. 2000;84:289–292.
24. Zhong H, Cha X, Wei T, 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;53:6617–6621.
25. Viso E, Gude F, Rodriguez-Ares MT. Prevalence of pinguecula and pterygium in a general population in Spain. *Eye (Lond)*. 2011;25:350–357.
26. Fotouhi A, Hashemi H, Khabazkhoob M, Mohammad K. Prevalence and risk factors of pterygium and pinguecula: the Tehran Eye Study. *Eye (Lond)*. 2009;23:1125–1129.
27. 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;94:977–981.
28. Li Z, Cui H. Prevalence and associated factors for pterygium in a rural adult population (the Southern Harbin Eye Study). *Cornea*. 2013;32:806–809.
29. Ma K, Xu L, Jie Y, Jonas JB. Prevalence of and factors associated with pterygium in adult Chinese: the Beijing Eye Study. *Cornea*. 2007;26:1184–1186.
30. Panchapakesan J, Hourihan F, Mitchell P. Prevalence of pterygium and pinguecula: the Blue Mountains Eye Study. *Aust N Z J Ophthalmol*. 1998;26:S2–S5.
31. Rezvan F, Hashemi H, Emamian MH, et al. The prevalence and determinants of pterygium and pinguecula in an urban population in Shahroud, Iran. *Acta Medica Iranica*. 2012;50: 689–696.
32. Shiroma H, Higa A, Sawaguchi S, et al. Prevalence and risk factors of pterygium in a southwestern island of Japan: the Kumejima Study. *Am J Ophthalmol*. 2009;148:766–771. e761.
33. West S, Munoz B. Prevalence of pterygium in Latinos: Proyecto VER. *Br J Ophthalmol*. 2009;93:1287–1290.
34. Wong TY, Foster PJ, Johnson GJ, Seah SK, 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.
35. Lu P, Chen X, Kang Y, Ke L, Wei X, Zhang W. Pterygium in Tibetans: a population-based study in China. *Clin Experiment Ophthalmol*. 2007;35:828–833.
36. Lu J, Wang Z, Lu P, et al. Pterygium in an aged Mongolian population: a population-based study in China. *Eye (Lond)*. 2009;23:421–427.
37. Luthra R, Nemesure BB, Wu SY, Xie SH, Leske MC. Barbados Eye Studies G. Frequency and risk factors for pterygium in the Barbados Eye Study. *Arch Ophthalmol*. 2001;119:1827–1832.
38. Detels R, Dhir SP. Pterygium: a geographical study. *Arch Ophthalmol*. 1967;78:485–491.
39. Taylor HR, West SK, Rosenthal FS, Munoz B, Newland HS, Emmett EA. Corneal changes associated with chronic UV irradiation. *Arch Ophthalmol*. 1989;107:1481–1484.
40. Rosenthal FS, Phoon C, Bakalian AE, Taylor HR. The ocular dose of ultraviolet radiation to outdoor workers. *Invest Ophthalmol Vis Sci*. 1988;29:649–656.
41. Taylor HR. Risk factors for pterygium. *Ophthalmology*. 2013; 120:441.

42. Landers J, Henderson T, Craig J. Prevalence of pterygium in indigenous Australians within central Australia: the Central Australian Ocular Health Study. *Clin Experiment Ophthalmol*. 2011;39:604–606.

43. Li Z, Cui H. Prevalence and associated factors for pterygium in a rural adult population (the Southern Harbin Eye Study). *Cornea*. 2013;32:806–809.

44. Ang M, Li X, Wong W, et al. Prevalence of and racial differences in pterygium: a multiethnic population study in Asians. *Ophthalmology*. 2012;119:1509–1515.

45. Wu K, He M, Xu J, Li S. Pterygium in aged population in Doumen County, China. *Yan Ke Xue Bao*. 2002;18:181–184.

46. Gazzard G, Saw SM, Farook M, et al. Pterygium in Indonesia: prevalence, severity and risk factors. *Br J Ophthalmol*. 2002; 86:1341–1346.