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Original article

The epidemiology of patients with pterygium in southern Taiwanese adults: The Chiayi survey☆

Ching-Lung Chen [a,d,g], Chien-Hsiung Lai [a,d,e,*,g], Pei-Lun Wu [a,d], Pei-Chang Wu [b,d], Tsung-Hsien Chou [a,d], Hsu-Huei Weng [c,e,f]

[a] Department of Ophthalmology, Chang Gung Memorial Hospital, Chiayi, Taiwan
[b] Department of Ophthalmology, Chang Gung Memorial Hospital, Kaohsiung, Taiwan
[c] Department of Diagnostic Radiology, Chang Gung Memorial Hospital, Chiayi, Taiwan
[d] Chang Gung University, College of Medicine, Tao-Yuan, Taiwan
[e] Department of Nursing, Chang Gung University of Science and Technology, Chiayi, Taiwan
[f] Institute of Occupation and Safety Health, Kaohsiung Medical University, Kaohsiung, Taiwan

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ABSTRACT

Purpose: To investigate patients with pterygium in different geographic regions and the associated risk factors in southern Taiwan.
Methods: A clinical observation survey was conducted in Chiayi County, a rural area in southern Taiwan. The subjects aged 40 years and above underwent complete ocular examinations. Associated risks factors were evaluated, including gender, age, occupations, smoking, and geographical living regions by univariant and multivariant logistic regression analysis.
Results: A total of 2197 participants (790 male, 36.0%) from 44 different villages were evaluated. In these, 554 participants (25.2%) have either unilateral or bilateral pterygium. Age is associated with the percentage of pterygium, and those aged between 60 and 69 had the highest percentage of 30.1% ($p < 0.0001$). The gender effect was higher among men than women (OR = 1.31, 95% CI: 1.08–1.60, $p = 0.006$). The percentage of pterygium lived in plain, seaside, and mountainous areas were 22.6%, 32.6%, and 14.5% respectively. Geographical regions also showed that seaside area had the highest percentage of pterygium (seaside area OR = 1.65, 95% CI: 1.35-2.03, and mountainous area OR = 0.58, 95% CI: 0.35-0.95 compared with plain areas). Primary outdoor workers and residents with smoking history had relative higher risk for pterygium (OR = 1.47, 95% CI: 1.17-1.86; OR = 1.36, 95% CI: 1.02-1.83).
Conclusions: The percentage of pterygium in southern Taiwan is about 25.2% among adults aged over 40 years in this survey. It is significantly higher in the age of 50 or more and in residents living in villages along the seaside than those living in the mountainous and the plain areas.

1. Introduction

Pterygium is an elevated, superficial, external ocular wedge-shaped dysplasia of bulbar conjunctiva that extends onto the cornea.[1,2] In addition to cosmetic reasons, the extension of pterygium is correlated with corneal astigmatism[3,4] and could lead to blinding disease in advanced stages owing to obscure the optical center of the cornea.[4] The etiopathogenesis of pterygium is still not fully elucidated. Sunlight overexposure, genetic factors, or other lifestyle behaviors may contribute to the development of pterygium.[5] Over-expression of vascular endothelial growth factor (VEGF) in angiogenesis of pterygium tissue may play an important role in the formation of pterygium.[6] The prevalence rates of pterygium, according to previous studies, ranged from 1.2% to 23.4%[4,7–12] and 7% to 14.49% among Chinese aged over 40 years.

Pterygium formation is associated significantly with outdoor work and sunlight exposure associated with a broad band of ultraviolet radiation exposure.[10–18] People with special occupation like salt workers, working outdoors postmen, or motorcycle policemen have a relative higher risk of developing pterygium probably because of their long duration of sunlight exposure.[18–22]

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* Corresponding author. Department of Ophthalmology, Chang Gung Memorial Hospital, No. 6, West Sec., Chiapu Road, Putzu City, Chiayi County 613, Taiwan.
E-mail addresses: oph4557@gmail.com, oph4557@cgmh.org.tw (C.-H. Lai).

[g] Dr. Ching-Lung Chen and Dr. Chien-Hsiung Lai contributed equally to this work.

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Wearing sunglasses, brimmed hats, and other devices and avoiding unnecessary sunlight exposure are important for prevention.[17–22]

To the best of our knowledge, the risk factors associated with the geographic characteristics have not been established in the sea island country. In this study, we determine the correlation between the development of pterygium and the risk factors that contributed to pterygium in different geographic regions and associated risk factors like gender, smoking behavior, and primary outdoor or indoor work among the adult population in southern Taiwan.

2. Methods

Community Complex Health Screening, a large-scale, free health program for people aged over 40 years was conducted in Chiayi County, a rural area located in southern Taiwan, half way between Taipei and Kaohsiung at 23.5° north of the Equator, with a subtropical climate. The geographic characteristics consist of plain, seaside (3 ridings nearby sea), and mountainous regions (3 ridings among the Central Mountain of Taiwan). This survey was attached to a huge health care designed—Mobile Hospital Health Delivery—to send medical service to villages for good medical health care. This mobile medical care system will approach those villages selected and geographically in different ridings each week. A total of 2197 subjects (790 male, 36.0%) from 44 different rural villages belonged to 18 ridings of the Chiayi County were evaluated since September 2006 to October 2007. The residents aged over 40 years old, living in those villages and participated voluntarily were all included to this survey.

All participants underwent complete ocular examinations, such as external ocular photography and associated risk factor and history taking by the same ophthalmologist. According to the previous studies, pterygium was graded in three levels of severity.[4,10] The three grades, based on relative transparency of pterygium tissue, were Grade 1 (transparent), Grade 2 (intermediate), and Grade 3 (opaque). In a Grade 1 pterygium, the episcleral vessels underlying the body of the pterygium were clearly visible. In a Grade 3 pterygium, the episcleral vessels were totally obscured. All other pterygia not classified as Grade 1 or 3 were classified as Grade 2.[10]

Associated risks factors for pterygium were evaluated, including gender, age, occupations, smoking, and geographical living regions, including plain, seaside, and mountainous areas. We divided the residents into primary outdoor workers (over 4 hours of sun exposure each day), indoor, and with or without smoking. This study was approved by Chang Gung Memorial Hospital Institutional Review Board. All research procedures followed the tenets of the Declaration of Helsinki.

3. Statistical analysis

Data were analyzed using Chi-square test or Fisher's exact test (if the expected value was under 5) for the univariate analysis of factors associated with pterygium. Probability values of $p < 0.05$ were considered statistically significant. In addition, logistic regression was used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for pterygium associated with possible risk factors. Variables that were significant at the $p < 0.1$ level in the univariate analysis were included in backward logistic regression analysis to select the final list of independent variables. All analyses were computed using SPSS software (v10.0, SPSS Inc, Chicago, IL, USA).

4. Results

A total of 2197 subjects (790 male and 1407 female, 36.0% and 64.0% respectively) from 44 different villages were evaluated at the health survey of Chiayi County government from September 2006 to October 2007. Of these, 554 subjects (25.2%, 95% CI: 23.4-27.1) have either unilateral or bilateral pterygium in the southern Taiwanese people aged 40 and older (Table 1).

The percentage is 28.6% (95% CI: 25.5-31.8) in males and 23.3% (95% CI: 21.1-25.6) in females. In both male and female groups, the percentage rose rapidly followed by the increase in age.

Considering the pterygium percentage 22.6% (95% CI: 20.5-24.9) of residents who are living in plain area, the percentage is 32.6% (95% CI: 32.0-44.5), which is relatively higher, for those living in the seaside area and 14.5% (95% CI: 9.6-21.4) in mountainous areas ($p < 0.001$). The percentage in subjects with smoking history is

Table 1
Percentage of pterygium in residents with associated risk factors.

Variable		*N*	Pterygium in either eye			Bilateral pterygium		
			n	Rate (%)	95% CI	*n*	Rate (%)	95% CI
Age (y)	40–49	110	5	4.5	1.9–10.2	1	0.9	0.1–4.9
	50–59	267	52	19.4	15.1–24.6	18	6.7	4.3–20.4
	60–69	773	233	30.1	27.0–33.4	74	9.5	7.6–11.8
	70+	1047	264	25.2	22.6–27.9	96	9.1	7.3–11.0
	p value	$p < 0.0001$				$p = 0.0128$		
Gender	Female	1407	328	23.3	21.1–25.5	104	7.4	6.0–8.8
	Male	790	226	28.6	25.4–31.8	85	10.8	8.4–12.8
	p value	$p = 0.006$				$p = 0.007$		
Work	Primarily outdoor	1181	321	27.1	24.7–29.7	116	9.8	8.2–11.6
	Primarily indoor	644	130	20.1	17.2–23.4	42	6.5	4.8–8.6
	p value	$p = 0.002$				$p = 0.055$		
Residence	Plain	1390	315	22.6	20.5–24.9	105	7.5	6.2–9.0
	Mountain	137	20	14.5	9.6–21.4	0	—	—
	Seaside	670	219	32.6	32.0–44.5	84	12.5	10.2–15.2
	p value	$p < 0.0001$				$p < 0.0001$		
Smoking	Smoker	170	74	30.3	24.9–36.3	28	11.4	8.0–16.0
	No smoker	1407	448	24.1	22.2–26.1	148	7.9	6.8–9.3
	p value	$p = 0.036$				$p = 0.064$		

All the *p*-values are found by Chi-square test.
N = Case number of population, *n* = case number with pterygium, 95% CI = 95% confidence interval.

Table 2
Percentage in different grades of pterygium by age, gender, work type, and residence.

	N	Grade 1 pterygium			Grade 2 pterygium			Grade 3 pterygium		
		n	Rate (%)	95%CI	*n*	Rate (%)	95%CI	*n*	Rate (%)	95%CI
Age (y)										
40–49	110	5	4.5	1.9–10.2	0	—	—	0	—	—
50–59	267	39	14.6	10.0–19.3	11	4.1	2.3–7.2	2	0.7	0.2–2.7
60–69	773	163	21.0	18.3–24.1	57	7.4	5.7–9.4	13	1.7	1.0–2.8
70+	1047	171	16.3	14.2–18.7	78	7.4	6.0–9.2	15	1.4	0.9–2.3
p		$p < 0.001$			$p = 0.006$			$p = 0.410$		
Gender										
Female	1407	219	15.6	13.7–17.6	89	6.3	5.1–7.2	20	1.4	0.9–2.1
Male	790	159	20.1	17.4–23.0	57	7.2	5.6–9.2	10	1.3	0.7–2.3
p		$p = 0.007$			$p = 0.422$			$p = 0.763$		
Work										
Primarily outdoor	1181	226	19.1	16.9–21.5	79	6.7	5.4–8.2	16	1.3	0.8–2.1
Primarily indoor	644	94	14.6	12.0–17.5	33	5.1	3.6–7.1	3	0.4	0.2–1.4
p		$p = 0.015$			$p = 0.183$			$p = 0.074$		
Residence										
Plain	1390	208	14.9	13.1–16.9	89	6.4	5.2–7.8	18	1.3	0.8–2.0
Mountain	137	14	10.2	6.1–16.4	6	4.3	2.0–9.2	0	—	—
Seaside	670	156	23.2	20.2–26.6	51	7.6	5.8–9.8	12	1.8	1.0–3.1
p		$p < 0.001$			$p = 0.321$			$p = 0.241$		

All the *p*-values are found by Chi-square test.
N = Case number of population, *n* = case number with pterygium, 95% CI = 95% confidence interval.

30.3% (95% CI: 24.9-36.3) comparing to the relatively lower percentage 24.1% (95% CI: 22.2-26.1) in those without smoking history ($p = 0.036$) (Table 1).

Subjects with primary outdoor work had higher percentage 27.1% (95% CI: 24.7-29.7) than those with primary indoor work 20.1% (95% CI: 17.2-23.4, $p = 0.002$) (Table 1).

After dividing the pterygium severity into Grades 1 to 3, the group with Grade 1 in 60-69 years old had a higher percentage of pterygium (Table 2). The incidences with different risk factors such as male gender, primary outdoor worker, and seaside living with Grade 1 pterygium were also relatively higher.

Age is significantly associated with pterygium after stratification into 4 decades (age groups: 40-49 years, 50-59 years, 60-69 years, and above 70 years) ($p < 0.0001$). Compared with the 40-49-year age group, the 50–59-year age group shows OR = 5.07 (95% CI: 1.97–13.00, $p = 0.001$), 60–69-year age group shows OR = 9.06 (95% CI: 3.64–22.5, $p < 0.0001$), followed by the age group above 70 years, which shows OR = 7.08 (95% CI: 2.85–17.5, $p < 0.0001$) (Table 3). The OR of the male gender in comparison to female is 1.31 (95% CI: 1.08-1.60, $p = 0.006$). In participants with smoking history and primary outdoor work, there is relative higher risk for pterygium formation (OR = 1.36, 95% CI: 1.02-1.83, $p = 0.036$; OR = 1.47, 95% CI: 1.17-1.86, $p = 0.001$). Compared to residents who were living in plain area, the OR of pterygium in those living in the seaside area is 1.65 (95% CI: 1.35-2.03; $p < 0.0001$) and is 0.58 (95% CI: 0.35-0.95, $p = 0.031$) for those living in mountainous areas.

In the logistic regression analysis, a glance at Table 3 shows the distribution of possible risk factors for pterygium. A trend towards higher risk was seen for factors of gender, age, smoking, occupation, and area of residence involved ($p < 0.10$). These five variables were included in multivariate analysis. Only two factors, age and area of residence, involved were found to be independently associated with the pterygium percentage (Table 3). Age of 50 or more had higher significance than the age of 40 to 49 ($p < 0.0001$). Residents of seaside had a significantly higher percentage of pterygium compared to the residents of plain areas (OR = 1.67, 95%CI: 1.32 ~ 2.11, $p < 0.0001$).

Table 3
Different ORs of pterygium for various risk factors.

	Univariate		Multivariate	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Gender				
Female	1.0	0.006	1.0	0.249
Male	1.31 (1.08–1.60)		1.16 (0.89–1.52)	
Age (y)				
40–49	1.0		1.0	
50–59	5.07 (1.97–13.0)	0.001	4.23 (1.45–12.2)	0.008
60–69	9.06 (3.64–22.5)	<0.0001	6.89 (2.47–19.2)	<0.001
70+	7.08 (2.85–17.5)	<0.0001	5.4 (1.94–15.0)	0.001
Smoker				
No	1.0	0.036	1.0	0.178
Yes	1.36 (1.02–1.83)		1.28 (0.89–1.83)	
Occupation				
Primarily indoor	1.0	0.001	1.0	0.095
Primarily outdoor	1.47 (1.17–1.86)		1.23 (0.96–1.57)	
Residence				
Plain	1.0		1.0	
Mountain	0.58 (0.35–0.95)	0.031	0.66 (0.40–1.09)	0.105
Seaside	1.65 (1.35–2.03)	<0.0001	1.67 (1.32–2.11)	<0.0001

OR = Odds ratio; 95% CI = 95% confidence interval.

5. Discussion

Previously, some studies about the prevalence and risk factors of pterygium draw on data from hospital-based settings or from different ethnic and social behavior backgrounds.[15] In our study, residents had been involved in each village and were chosen averagely and geographically from different ridings by the county government from seaside to mountainous areas. A near population based and risk factors associated survey for all subjects with same ethnic status and similar social behavior backgrounds was conducted. The lack of exclusive data and randomized population sampling are the limitations of this study.

Unlike the previously described percentage 1.2% to 23.4%,[4,7–13] the percentage of pterygium is relatively higher (25.2%) in southern Taiwan, especially in the rural area. The location at 23.5° north of the Equator and subtropical climate may contribute to this result. Compared with the population-based survey that was conducted in Singapore,[10] the percentage of pterygium is 6.9%, bilateral pterygium

is 2.91%, and severe pterygium is 2.09%. These data in Singapore, located 1° north of the equator, were obviously lower than those in our study (6.9% vs. 25.2%; 2.91% vs. 8.6%), but the percentage of severe pterygium was higher than ours (2.09% vs. 1.37%).

As previous reports, the prevalence of pterygium increased linearly with age,[10,14] there is same result in our current study (Table 1). The 60-69-year-old group had the highest percentage. Whether it is univariate or multivariate analysis, pterygium was independently associated with older age (Table 3).

After clinically dividing pterygium to Grades 1-3,[4–10] Grade 3 pterygium was found to not relate to male sex, unlike the previous study,[10] and it was also not related to age. This may be owing to the very small number of participants with Grade 3 pterygium.

The risk factors associated with the geographic characteristics consisting of plain, seaside, and mountainous regions have not been established in the sea island country thus far. We found that residents living in villages along the seaside have relative higher pterygium percentage than those living in the mountainous and plain areas. In the seaside, the sunlight intensity is heavy owing to direct exposure and reflection from the sea waves. This suggests that residents in seaside would have a higher percentage of pterygium.

Pterygia are reported to occur in males (11%) twice as frequently as in females (4.5%).[14] The percentage is 28.6% (95% CI: 25.5-31.8) in males and 23.3% (95% CI: 21.1-25.6) in females. Comparing to females, the OR is 1.31 (95% CI: 1.08-1.60, $p = 0.006$). Gender seems to be a significantly contributed risk factor.

The percentage 30.3% (95% CI: 24.9-36.3) in subjects with smoking history was relatively higher than 24.1% (95% CI: 22.2-26.1) in those without smoking history ($p = 0.036$). The OR is 1.36 (95% CI: 1.02-1.83; $p = 0.036$) comparing to those without smoking.

It has been reported that people with special occupation such as salt workers, outdoors working postmen, and motorcycle policemen are at a high risk for pterygium formation.[18–20] A lot of residents involved in this study cannot identify their own occupation because they may be practicing more than one occupation. Occupation assessment is very difficult; so we divided occupations into primary outdoor work (sunlight exposure over 4 hours daily) and primary indoor work. Residents with primary outdoor work had a relatively higher prevalence of 27.1% (95% CI: 24.7-29.7) than those with primary indoor work 20.1% (95% CI: 17.2-23.4, $p = 0.002$). The OR is 1.47 (95% CI: 1.17-1.86, $p = 0.001$) when compared to primary indoor work.

People living in villages of the Chiayi County of southern Taiwan are almost senior people and children. People aged over 65 years old form 15.09% of the population of the county.[22] Young people and adult always go out for work or education in the urban city. The population is not a normal distribution but tends to be old aged. This statistical deviation could be also our limitation.

The multivariate risk factor model constructed for this population demonstrated an independent increase in the risk of pterygium with increasing age, among those living in seaside area. Although some risk factors did not reach statistical significant level in the multivariate analysis, male gender, smoking habit, and primary outdoor work influences the formation of pterygium. In univariate analysis, all the predicting factors such as older age, male gender, primary outdoor work, smoking behavior, and seaside areas living reach a statistical significant level. This would support the hypothesis that increased exposure to ultraviolet radiation leads to an increase in the percentage of pterygium.

In this study, we have no knowledge about the demographics or pterygium status of the nonparticipants. In addition, male participants were significantly undercounted because our participants were all nonrandom volunteers (36%). More larger and randomized survey will be needed in the further study.

6. Conclusion

In summary, the percentage of pterygium in southern Taiwan is about 25.2% among adults aged over 40 years. It is significantly higher in the age of 50 or more and in residents living in villages along the seaside than those living in the mountainous and plain areas. Associated risk factors include older age, male gender, primary outdoor work, smoking behavior, and seaside areas living, which suggest a multifactorial cause for this condition. But, the intensity of sunshine in different geographic areas still be considered the very important impact factor.

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