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Risk Factors for Pterygium in Korea: The Korean National Health and Nutrition Examination Survey V, 2010–2012

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Abstract: The aim of this study is to report general and age-specific risk factors for pterygium prevalence in the Korean population.

This in an observational case series study.

Data from total 24,812 participants (age 40 years or older) from the Korean National Health and Nutrition Examination Surveys conducted from 2010 to 2012 were retrieved. After applying exclusion criteria, data from 13,204 participants (821 with pterygium and 12,383 without) were used for univariate and multivariate analyses. General risk factors were identified and participants were grouped by decade: 40 s, 50 s, 60 s, 70 s, and 80+. Age-specific risk factors were investigated for each group.

After univariate analysis, 2 multiple regression models were constructed. Model 1: age + sex + spherical equivalent (SE) + sun exposure hours + occupation (indoor vs outdoor) + residency area (rural vs urban) + education level; model 2: age + sex + SE + sun exposure hours. In model 1, older age (odds ratio [OR]: 1.05 95% confidence interval [CI]: 1.05–1.06), male gender (OR: 1.28, 95% CI: 1.01–1.61), and longer sun exposure hours (OR: 1.47, 95% CI: 1.11–1.94) were significant risk factors for pterygium prevalence whereas higher level of education (elementary school vs college, OR: 3.98, 95% CI: 2.24–7.06) and urban residency (vs rural residency, OR: 0.56, 95% CI: 0.45–0.70) were protective factors. Higher SE (OR 1.11, 95% CI: 1.03–1.19) refractive error was considered a risk factor when using model 2 for the analysis. Age-specific risk factors were different in each age group. Male gender was associated with higher pterygium prevalence in younger age groups while longer sun exposure (5+ hours/day) increased pterygium prevalence in older age groups.

Previously characterized risk factors were also found in this large population study. However, we found that risk factors may vary according to the age group. Myopic eyes were found to have lower prevalence than hyperopic eyes.

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Abbreviations: KNHANES = Korean National Health and Nutrition Examination Surveys, OR = odds ratio, SE = spherical equivalent, UV = ultraviolet.

INTRODUCTION

Pterygium is a common ocular disorder with fibrovascular proliferation emanating from the conjunctiva and Tenon capsule onto the cornea. The exact etiology of pterygium remains uncertain; however, several risk factors have been proposed. Previous studies have suggested that geographical latitude, rural residency, older age, race, gender, outdoor activity, and low educational levels were associated with greater risk for pterygium.[1–10] The link with smoking has also been investigated but remains inconclusive.[4–6,11–13] A summary of risk factors based on recent population-based studies is outlined in Table 1.

Also described previously is the correlation between pterygia and irregular astigmatism. However, it cannot be considered a risk factor because it results from pterygium compressing on the perilimbal cornea. The association between spherical refractive errors (hyperopia or myopia) and pteryigum have been reported. Spierer et al[14] reported a low prevalence of myopia in patients who underwent pterygium excision based on their retrospective review of 93 pterygium patients. Shiroma et al[15] suggested hyperopia as a risk factor in their population-based study (n = 3762) in Japan. Both studies reported spectacles as being protective, shielding against ultraviolet (UV) exposure.

In the current study, we analyzed the population-based survey conducted by the Korean government from 2010 to 2012. Univariate and multivariate analyses were used to determine risk factors associated with pterygium prevalence.

MATERIALS AND METHODS

Study Design and Population

Korean National Health and Nutrition Examination Surveys (KNHANES) is a nationwide survey administered by the Korean Centers for Disease Control and Prevention. KNHANES V, conducted from 2010 to 2012, was a random sampling of 11,520 households across 576 national districts selected by a panel to represent the South Korean population using a stratified, multi-stage, and clustered sampling method. Included were health and nutrition surveys by trained interviewers, and a health examination. Participants over 19-years old underwent ophthalmic examination by epidemiologic survey members (ophthalmologists) from the Korean Ophthalmologic Society. Ophthalmic examinations included visual acuity testing, noncycloplegic autorefraction (KR8800 autorefractor, Topcon, Tokyo, Japan), and slit-lamp examination.

TABLE 1. Risk Factors of Population-Based Studies Reported From 2013 to 2014

First author	Place	N	Year	Risk Factors	OR	95% CI
Li[7]	China	8445	2014	Age	NA	NA
				Male gender	1.9	1.4–2.6
				Outdoor occupation	1.8	1.2–2.6
Jiao[8]	China	17,816	2014	Age	NA	NA
				Outdoor time (>4 hours)	1.32	1.18–1.49
				Higher education	0.83	0.73–0.94
				Sunglass or hat	0.10	0.05–0.21
Nangia[9]	India	4711	2013	Age	1.02	1.01–1.03
				Female gender	0.48	0.39–0.61
				Higher education	0.74	0.69–0.80
Marmamula[3]	India	5586	2013	Age	NA	NA
				Rural residence	1.8	1.4–2.4
				Outdoor occupation	1.8	1.5–2.2
				Higher education	0.6	0.5–0.7
Rim[5]	Korea	14,920	2013	Age	NA	NA
				Female gender	0.5	0.4–0.6
				Higher education	NA	NA
				Rural residence	1.2	1.1–1.4
				Outdoor occupation	1.2	1.0–1.5
				Smoking	0.7	0.6–0.9
				Sun exposure (>5 hours)	1.2	1.0–1.4
Sun[4]	China	6685	2013	Age	NA	NA
				Female gender	2.0	1.4–2,8
				Smoking	0.5	0.4–0.7
Tano[12]	Japan	2312	2013	Age	NA	NA
Zhao[10]	China	2628	2013	Urban residence	0.24	0.14–0.42
Li[13]	China	5057	2013	Male gender	1.73	1.37–2.19
				Smoking	1.90	1.51–2.35

CI = confidence interval, n = number, NA = not available, OR = odds ratio.

Participants and Data Selection

This study followed the tenets of the Declaration of Helsinki and was approved by the institutional review board of Dongguk University, Ilsan Hospital. All the participants' data were anonymized and deidentified prior to analysis. Among 24,812 participants age 40 or older, 13,204 participants were analyzed after application of the exclusion criteria. Exclusion criteria were as follows: participants who lacked documented ophthalmic examination, those who did not respond 2 or more information about pterygium risk factors were excluded. The response rate to the question about smoking was 70.2% and the response rate to sun exposure hours was 51.6%. The response rate for other risk factors such as education level and occupation were both over 99%. The presence of pterygium was defined as a radially oriented fibrovascular lesion crossing the nasal or temporal corneal limbus on slit-lamp examination. In order to eliminate data duplication bias when both eyes of a single patient were used, we evaluated data only from right eyes. Participants who had pterygium in the right or both eyes were included in this study and participants who had pterygium only in the left eye were excluded. Participants who had no pterygium in either eye were included as controls. To eliminate the effect of refractive or cataract surgery on refractive status assessment, any participants reporting ophthalmic surgical histories (cataract surgery, glaucoma procedures, strabismus, ptosis, retina, and refractive surgery) were excluded.

Demographic variables included age, sex, daily sun exposure hours, primary residential area (rural or urban), education level (elementary, middle, high school, or college), occupation type (indoor vs outdoor), and smoking experience (at least 100 cigarettes smoked cumulatively). Daily sun exposure was categorized as less than 2 hours, 2 to 5 hours, and more than 5 hours. Residential area was considered urban if the participant's city had a population over 1 million (Seoul, Busan, Daegu, Gwangju, Daejeon, Incheon, and Ulsan). Occupation type was categorized as 1: manager and specialized job, 2: office job, 3: service and sales job, 4: agriculture, fishery, and forestry, 5: blue-collar laborer, and 6: unemployed. Categories 4 and 5 were considered outdoor occupations.

Refractive error measured by noncycloplegic autorefraction was used to calculate the spherical equivalent (SE), that is, sphere $+ 0.5 \times$ cylinder.

Statistical Analysis

Continuous variables were expressed as mean $\pm$ standard deviation and categorical variables were described by numbers and percentages. Continuous data were analyzed by Student's *t*-test for 2 group comparisons and the analysis of variance test for 3 or more group comparisons. All categorical data were analyzed using the Chi-square or Fisher exact test.

Two different analytical methods were employed. First, all participants (13,204 individuals) were analyzed to search for pterygium risk factors. Significant risk factors were further

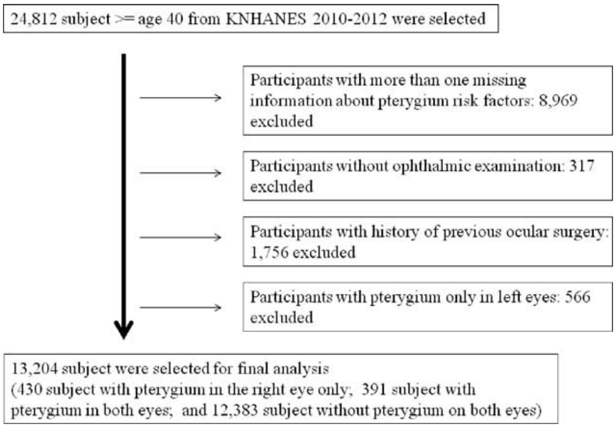

FIGURE 1. The stepwise approach to final selection of study population. Among 24,812 participants age 40 or older, 8969 participants were excluded because of lack of information about pterygium risk factors, 317 participants were excluded because of lack of ophthalmic examination, 1756 participants were excluded because of previous history of ocular surgery, and 566 participants were excluded because of pterygium only in the left eye. Finally, 13,204 subjects (821 with pterygium and 12,383 without pterygium) were analyzed.

verified using multiple regression analysis. Second, participants were divided into 5 age groups; group 1 (age 40–49), group 2 (age 50–59), group 3 (age 60–69), group 4 (age 70–79), and group 5 (age 80 or over). For each age group, univariate and multivariate regression analyses were used to search for risk factors associated with pterygium prevalence. Akaike information criterion was used to assess the relative quality of regression models. All statistics were 2-sided, and significant level of P-value was set at 0.05. Statistical analyses were carried out using SAS, version 9.3(SAS Institute Inc., Cary, NC).

RESULTS

A total of 821 individuals with pterygium in their right eyes and 12,383 individuals without pterygium on either eyes were investigated. Figure 1 describes the selected participants.

The pterygium prevalence of this study population is depicted in Table 2. The prevalence was 6.2% and, as expected, the prevalence increased with age (2.0% in age 40 seconds vs 19.4% in age 80 seconds or over).

Univariate regression analysis revealed that higher pterygium prevalence was evident in those who were older, male, had greater sun exposure, came from lower education levels,

TABLE 2. The Prevalence of Pterygium

Age	Total	Pterygium (−)	Pterygium (+)	%
≥40	13,204	12,383	821	6.2
40–49	4144	4064	80	2.0
50–59	3839	3674	165	4.5
60–69	3098	2806	292	10.4
70–79	1803	1571	232	14.8
≥80	320	268	52	19.4

worked outdoors, resided in a rural area, and had higher SE refractive errors. Pterygium was found only in 1.07% of eyes with myopia greater than or equal to −6.0 diopters. However, the risk increased for more hyperopic refractive errors; 20% of eyes with hyperopia greater or equal to 6.0 diopters were reported to have a pterygium (Table 3).

Although the test for colinearity in our study population has shown that variables such as occupation, residential area, education levels, and sun exposure hours can be used as independent variables in a multiple regression model (Table 4), significant associations between these variables were evident, as shown in Table 5. Greater sun exposure was expected with rural areas, lower education levels, outdoor occupations, and more hyperopic people. Therefore, we decided to perform multiple regression analysis using 2 different models. model 1: age + sex + SE + sun exposure hours + occupation + residential area + education level; model 2: age + sex + SE + sun exposure hours. Model 1 included all variables that were significant in univariate regression analysis. In model 2, occupation, residential area, and education level were omitted, and SE and sun exposure hours were used for the analysis. To date the association between SE refractive errors with pterygium prevalence has not been reported in a population-based study of this size. Therefore, we decided to maintain SE as an independent variable in model 2. When comparing model 1 and model 2 with the Akaike information criterion, the difference between the 2 was small and model 2 showed better fitness in the analysis of total study eyes (age 40 or older) (Table 6).

Sun exposure hour is significantly higher in outdoor occupation, rural residency, and lower education level. Spherical equivalent was more hyperopic in people with longer sun exposure hours.

In the total study population, most of the previously reported risk factors reached statistical significance in our study. In model 1, older age, male gender, and longer sun exposure were suggestive of being independent risk factors (Table 7). On the contrary, higher education levels and rural residency appeared to be protective factors. Pterygium appeared to be more prevalent in hyperopic eyes; however, it failed to reach statistical significance in model 1 ($P = 0.057$). In model 2, older age, male gender, longer sun exposure, and higher spherical equivalence were suggestive of being independent risk factors (Table 8).

The risk profile appeared to be different in each age category. In model 1, urban residency was protective against pterygium development for all age groups. In group 1 (40 s), the prevalence was higher with increasing age while college education decreased the risk almost 3-fold. In group 2 (50 s), male gender increased the risk while college education again, decreased the risk. In group 3 (60 s), daily sun exposure more than 5 hours significantly increased pterygium risk. In group 4 (70 s), college education decreased pterygium risk (Table 7). In model 2, increasing age in group 1 and longer sun exposure hours in group 3 were found to be consistent risk factors. In addition, increasing spherical equivalence (greater hyperopic change) was noted to be a risk factor in group 2 (Table 8). Interestingly, moderate daily sun exposure (2–5 hours) did not increase pterygium prevalence in either model 1 or model 2. Model 1 failed to reach significance in the oldest, group 5 ($P = 0.051$) while model 2 failed to reach significance in group 4 and group 5 ($P = 0.056$ and 0.154, respectively). Therefore, these age groups were omitted from the multiple regression analyses.

TABLE 3. Characteristics of Eyes With or Without Pterygium

	Pterygium	Yes (n = 821)	No (n = 12,383)	*P* Value
Age	40 or older	64.56 ± 0.36	56.31 ± 0.10	<0.001*
Sex, n, %	Male	396 (48.2%)	5393 (43.5%)	0.009†
	Female	425 (51.8%)	699 (56.5%)	
Sun exposure, n, %	<2 hours	162 (42.9%)	3854 (59.8%)	<0.001†
	2–5 hours	88 (23.3%)	1537 (23.9%)	
	>5 hours	127 (33.6%)	1051 (16.3%)	
Smoking, n, %	Yes	112 (19.9%)	1874 (21.5%)	0.41†
	No	447 (80.1%)	6838 (88.5%)	
Education, n, %	Elementary school	503 (62.3%)	4043 (33.3%)	<0.001†
	Middle school	122 (15.0%)	1950 (15.6%)	
	High school	143 (17.9%)	3763 (30.8%)	
	College	37 (4.7%)	2466 (20.2%)	
Occupation, n, %	Outdoor	307 (38.2%)	2676 (21.9%)	<0.001†
	Indoor	497 (61.8%)	9529 (78.1%)	
Residence, n, %	Urban	353 (42.9%)	8040 (64.9%)	<0.001†
	Rural	468 (57.1%)	4343 (35.1%)	
Spherical equivalent, n, %				<0.001†
	≤−6.0 D	3 (0.3%)	278 (2.2%)	
	−5.99 to −3.0	16 (1.9%)	746 (6.0%)	
	−2.99 to −0.5	147 (17.9%)	3469 (28.0%)	
	−0.49–0.49	208 (25.3%)	3877 (31.3%)	
	0.5–2.99	426 (51.9%)	3867 (31.2%)	
	3.0–5.99	20 (2.4%)	142 (1.1%)	
	≥6.0	1 (0.1%)	4 (0.03%)	

D = diopter, n = number
* *P*-value derived from Student's *t*-test.
† Chi-square test.

DISCUSSION

In this study, we found several significant risk factors associated with pterygium prevalence in the South Korean population. Older age, male gender, extended exposure to sun (over 5 hours per day), rural residence, and hyperopia were significant risk factors.

Pterygium prevalence in this study (6.2%) is lower than previously reported prevalence (8.9%) in the Korean population (age 40 or older). The reason for this difference may be the exclusion of participants who had pterygium only in left eyes from our analysis. When adding the excluded participants (n = 566) with left-only pterygium, the recalculated prevalence was 10.4%. This rate is similar to the prevalence of 10.2% pooled from 20 studies, which included a worldwide total of 900,545 participants.[2]

Consistent with the findings in model 2, in South Korea, one's education level is highly correlated with the participant's occupation and area of residence. Farming and fishing are outdoor occupations and these participants live mostly in rural areas with lower levels of education than their urban counterparts. Therefore, rural residency, lower level of education, and outdoor occupation are linked and these variables are combined, result in higher sun exposure hours. Previously, Liu et al[2] conducted a meta-analysis of 20 studies about pterygium risk factors and found the pooled risk factors to be age, male gender, sun exposure, and geographical latitude. Other risk factors such as residential area (rural/urban), education level, and type of occupation failed to reach statistical significance in Liu et al's study. Interestingly, even gender differences in pterygium risk can be lost amidst the sun exposure variable. Pterygium has been reported to be more prevalent in women rather than in men in Tibet, where women work much more outdoors than men.[16] To minimize statistical bias from lumping related variables into a multiple regression analysis, we devised model 2 and combined 3 sun exposure-related variables (occupation, residential area, and education level) into 1 variable (sun exposure hours). With the application of model 2, we found SE to be an independent risk factor for pterygium.

We propose an explanation between pterygium and spherical equivalence (more pterygium prevalence in hyperopic eyes). Using sun-glasses or spectacle glasses, which block UV

TABLE 4. Multicolinearity of Sun Exposure, Occupation, Residency, and Education Level for Pterygium Prevalence; Variation Inflation Less Than 10 Means These Variables Can Be Used Without Significant Colinearity in Multiple Analysis Model

	Beta	*P* Value	Variation Inflation
Sun exposure	0.01668	<0.001	1.14
Occupation	0.01174	0.10	1.20
Residency	−0.03303	<0.001	1.07
Education level	0.02098	<0.001	1.24
Spherical equivalent	−0.00524	<0.001	1.12

TABLE 5. The Distribution of Sun Exposure Hours According to Types of Occupation, Residency Areas, and Education Levels; Sun Exposure Hour Is Significantly Higher in Outdoor Occupation, Rural Residency, and Lower Education Level; Spherical Equivalent Was More Hyperopic in People With Longer Sun Exposure Hours

	Sun Exposure Hours			
	5 hours ≤	2–5 hours	<2 hours	*P*-Value
Occupation, n, %				
Outdoor	596 (41.27)	312 (21.61)	536 (37.12)	<0.001*
Indoor	560 (10.70)	1274 (24.35)	3399 (64.95)	
Residency, n, %				
Urban	545 (12.11)	1193 (26.51)	2762 (61.38)	<0.001*
Rural	633 (27.30)	432 (18.63)	1254 (54.08)	
Education level, n, %				
Elementary school	599 (28.35)	501 (23.71)	1013 (47.94)	<0.001*
Middle school	227 (21.52)	262 (24.83)	566 (53.65)	
High school	255 (12.10)	520 (24.68)	1332 (63.22)	
College	79 (5.60)	306 (21.69)	1026 (72.71)	
Spherical equivalent†				
Mean (SD)	0.09 (1.70)	−0.27 (1.94)	−0.50 (2.08)	<0.001‡
Median (Min, Max)	0.25 (−12.37, 8.62)	0.00 (−12.75, 4.75)	−0.12 (−22.75, 5.25)	

n = number, SD = standard deviation.
* *P*-value obtained from Chi-square test.
† Statistically significant difference between groups using multiple comparison (Scheffe) method; spherical equivalent (SE) of ''≥5 hours'' > SE of ''2–5 hours'' > SE of '' < 2 hours.''
‡ *P*-value obtained from ANOVA.

light, have been previously reported as protective factors. Sakamoto et al[17] reported that eye glasses effectively reduced UV exposure to sunlight as long as the lenses were of adequate size and had coating to block UV rays shorter than 400 nm. Lu et al,[16] Mackenzie et al,[18] and Luthra et al[19] also reported that wearing prescription glasses could reduce pteyrgium risk significantly (odds ratio [OR]: 0.75, 95% confidence interval: 0.60–0.93). It is widely accepted that a myopic shift usually starts earlier in life, and myopic patients start to wear spectacles at a younger age compared with hyperopic patients.[20,21] Therefore, myopic individuals would benefit from earlier UV protection than hyperopic or emmetropic individuals. Almost all spectacle lenses prescribed in South Korea can reduce UV exposure in varying degrees, although the extent of UV blockage can fall short of United States Food and Drug Administration recommendations.[17,22]

The protective effect of myopia on pterygium prevalence may have another explanation related to the anatomic feature of myopic eyes. It is generally accepted that highly myopic eyes have thinner cornea and sclera compared with hyperopic eyes.[23–25] In addition, some conditions associated with the elderly, such as conjunctivochalasis, the thinning and redundancy of conjunctiva, are more common in myopic than in hyperopic eyes.[26] Therefore, it is possible that some anatomic difference of myopic eyes may impose unknown protective effect against pterygium development.

Myopia is also known to be associated with higher education, indoor occupations, and lower exposure to sunlight.[27–30] We acknowledge that the protective effect of myopia in our study might result from the indirect effect of sun exposure difference between myopic and hyperopic participants. However, as shown in Table 5, the SE difference in varied sun exposure eyes showed very small difference. And the colinearity of these 2 variables failed to reach the exclusion level.

As shown in Table 1, increasing age is one of the most commonly reported risk factors for pteryigum prevalence. Some risk factors such as sun exposure hours and spherical equivalence not completely independent from age. For example, 2-hour daily sun exposure for 40 years translates into more cumulative sun exposure than someone with 5-hour daily sun exposure for

TABLE 6. The Comparison of 2 Regression Models; Model 1 Versus Model 2; AIC Was Used to Compare the Fitness of Model 1 and Model 2; the Lower AIC, the Fitter the Multiple Regression Model Is

	Age ≥ 40	Age 40–49	Age 50–59	Age 60–69	Age 70–79
Model 1 AIC	2696.3	281.3	680.3	868.6	649.2
Model 2 AIC	2686.8	287.5	707.9	887.8	NA

AIC = Akaike information criterion, NA = not available.

TABLE 7. Multiple Logistic Analysis Using Model 1 to Investigate Risk Factor for Pterygium Prevalence

	Age ≥40 (n = 13,204) Model $P < 0.001$	Age 40–49 (n = 4144) Model $P < 0.001$	Age 50–59 (n = 3839) Model $P < 0.001$	Age 60–69 (n = 3098) Model $P < 0.001$	Age 70–79 (n = 1803) Model $P < 0.001$
	OR (95%CI) P Value	OR (95%CI) P Value	OR (95%CI) P Value	OR (95%CI) P Value	OR (95%CI) P Value
Age	1.05 (1.05–1.06) $P < 0.001$	1.19 (1.03–1.37) $P = 0.021$	0.97 (0.89–1.05) $P = 0.47$	1.01 (0.95–1.08) $P = .67$	1.08 (1.00–1.17) $P = 0.060$
Male sex	1.28 (1.01–1.61) $P = 0.038$	2.15 (0.98–4.74) $P = 0.056$	1.80 (1.12–2.89) $P = 0.015$	1.12 (0.75–1.67) $P = 0.57$	1.12 (0.72–1.75) $P = 0.62$
Spherical equivalent	1.07 (0.99–1.15) $P = 0.058$	1.4 (0.99–1.19) $P = 0.051$	1.14 (0.95–1.38) $P = 0.15$	1.11 (0.96–1.27) $P = 0.15$	1.02 (0.91–1.15) $P = 0.73$
Sun exposure					
>5 hours vs <2 hours	1.47 (1.11–1.94) $P = 0.016$	0.76 (0.23–2.48) $P = 0.54$	0.96 (0.51–1.81) $P = 0.79$	1.91 (1.22–3.01) $P = 0.002$	1.50 (0.90–2.50) $P = 0.25$
2–5 hours vs <2 hours	1.15 (0.87 to1.51) $P = 0.66$	1.17 (0.47–2.95) $P = 0.54$	1.12 (0.65–1.92) $P = 0.63$	0.99 (0.60–1.62) $P = 0.14$	1.30 (0.75–2.23) $P = 0.81$
Outdoor occupation	1.19 (0.92–1.53) $P = 0.18$	1.58 (0.62–4.06) $P = 0.34$	0.95 (0.55–1.64) $P = 0.86$	1.45 (0.96–2.19) $P = 0.081$	0.93 (0.57–1.51) $P = 0.76$
Urban residency	0.56 (0.45–0.70) $P < 0.001$	0.45 (0.21–0.97) $P = 0.041$	0.52 (0.33–0.83) $P = 0.005$	0.63 (0.43–0.94) $P = 0.022$	0.45 (0.29–0.70) $P < 0.001$
Education level					
Edu 1 vs edu 4	3.98 (2.24–7.06) $P < 0.001$	2.94 (0.44–19.47) $P = 0.96$	3.57 (1.47–8.65) $P = 0.001$	2.25 (0.77–6.55) $P = 0.22$	8.88 (0.98–66.87) $P = 0.068$
Edu 2 vs edu 4	3.59 (2.0–6.43) $P = 0.003$	5.21 (1.2–22.64) $P = 0.013$	2.34 (0.95–5.76) $P = 0.32$	2.28 (0.76–6.80) P = .24	8.95 (1.12–71.40) $P = 0.011$
Edu 3 vs edu 4	2.78 (1.58–4.89) $P = 0.003$	4.43 (1.26–15.55) $P = 0.017$	1.58 (0.65–3.81) $P = 0.36$	1.95 (0.66–5.77) $P = 0.66$	8.61 (1.10–67.29) $P = 0.012$

Model 1: adjusted for age, sex, spherical equivalent, sun exposure, outdoor occupation, urban residency, and education level in each group. Participants aged 80 or over failed to reach statistical significance ($P = 0.051$). CI = confidence interval, Edu 1 = elementary school graduate, Edu 2 = middle school graduate, Edu 3 = high school graduate, Edu 4 = college graduate, n = number, OR = odds ratio.

TABLE 8. Multiple Logistic Analysis Using Model 2 to Investigate Risk Factor for Pterygium Prevalence

	Age ≥ 40 Model $P < 0.001$	Age 40–49 Model $P < 0.001$	Age 50–59 Model $P < 0.001$	Age 60–69 Model $P < 0.001$
	OR (95%CI), P Value	OR (95%CI), P Value	OR (95%CI), P Value	OR (95%CI), P Value
Age	1.06 (1.05–1.07) $P < 0.001$	1.21 (1.05–1.39) $P = 0.009$	0.99 (0.92–1.08) $P = 0.87$	1.01 (0.95–1.08) $P = 0.73$
Male sex	1.09 (0.88–1.35) $P = 0.459$	1.73 (0.80–3.74) $P = 0.056$	1.47 (0.94–2.30) $P = 0.095$	1.04 (0.72–1.49) $P = 0.855$
Spherical equivalent	1.11 (1.03–1.19) $P = 0.004$	1.4 (0.99–1.19) $P = 0.16$	1.21 (1.01–1.45) $P = 0.034$	1.12 (0.97–1.28) $P = 0.11$
Sun exposure				
>5 hours vs <2 hours	2.12 (1.65–2.72) $P < 0.001$	1.20 (0.39–3.70) $P = 0.90$	1.42 (0.80–2.50) $P = 0.29$	2.72 (1.80–4.11) $P < 0.001$
2–5 hours vs <2 hours	1.18 (0.90–1.55) $P = 0.10$	1.25 (0.51–3.07) $P = 0.77$	1.13 (0.66–1.92) $P = 0.83$	0.99 (0.61–1.62) $P = 0.24$

Model 2: adjusted for age, sex, spherical equivalent, and sun exposure in each group. Participants aged 70 to 79 and 80 or older failed to reach statistical significance. ($P = 0.056$ and 0.15, respectively). CI = confidence interval, OR = odds ratio.

10 years. It is well known that hyperopia increases in the aging population. Therefore, we performed a separate analysis using similar aged populations (groups 1–5) to search for age-independent risk factors and found that the prevalence was different in each age group. For example, from the ORs of Tables 7 and 8, we can infer that male gender increased the risk mainly in the younger population (group 1 and 2, OR 2.15 and 1.80, respectively) and sun exposure hours (>5 hours) increased the risk mainly in the older population (group 3 and 4, OR 1.91 and 1.50, respectively). Urban residency, college education, and myopia were common protective factors in almost all age categories, the effect of these aforementioned factors were evenly distributed in all age groups. Interestingly, the type of occupation had no significant effect on pterygium prevalence in our study. The recent rise of outdoor leisure activity of the urban population and the widespread use of UV-blocking eyewear during outdoor labor in South Korea may be plausible explanation. Our finding that the risk factors are different by age group may also account for the inconsistency of risk factors described by previous studies (Table 1). That is, the proportion of each age group in study populations may determine the significance of each risk factor investigated.

Our study is based on data from a large population study performed by the government. Therefore, it has several limitations. As previously described, over 9000 participants out of 24,812 participants of KNHANES V were excluded from the analysis with any information missing from the survey. Separate analysis ignoring missing information may yield different results; however, the complexity of advanced statistics is beyond the scope of this article. The lack of data regarding axial length and keratometry is another limitation. Also, potential participants who underwent cataract surgery were excluded although some had pterygia. Additionally, aging nucleosclerosis may induce myopic refractive errors and it was impossible to exclude these eyes based on available data. Moreover, previous surgical history was based only on participants' self-reporting. The lack of data regarding spectacle wear is another drawback of our study. Because we excluded any participants with a history of ocular surgery, participants with prior pterygium surgery were excluded with recurred pterygium cases, and this may lead to underestimation of pterygium prevalence. Finally, performing cycloplegic refraction, which was not done, would have enhanced the accuracy of measurement of refractive status.

In summary, we demonstrate several risk factors associated with pterygium prevalence in the South Korean population. Older age, male gender, daily sun exposure for more than 5 hours, rural residency, lack of college education, and hyperopia were suggestive of being significant risk factors. In addition, we found that risk factors may vary according to age groups. The complex interplay of biological, environmental, and social factors makes it challenging to isolate completely independent risk factors. However, growing knowledge of the risk and preventive factors may help curb the prevalence of pterygia in the future.

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