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Geographical prevalence and risk factors for pterygium: a systematic review and meta-analysis

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ABSTRACT

Objective: Pterygium is considered to be a proliferative overgrowth of bulbar conjunctiva that can induce significant astigmatism and cause visual impairment; this is the first meta-analysis to investigate the pooled prevalence and risk factors for pterygium in the global world.

Design: A systematic review and meta-analysis of population-based studies.

Setting: International.

Participants: A total of 20 studies with 900 545 samples were included.

Primary outcome measure: The pooled prevalence and risk factors for pterygium.

Results: 20 studies were included. The pooled prevalence of pterygium was 10.2% (95% CI 6.3% to 16.1%). The pooled prevalence among men was higher than that among women (14.5% vs 13.6%). The proportion of participants with unilateral cases of pterygium was higher than that of participants with bilateral cases of pterygium. We found a trend that the higher pooled prevalence of pterygium was associated with increasing geographical latitude and age in the world. The pooled OR was 2.32 (95% CI 1.66 to 3.23) for the male gender and 1.76 (95% CI 1.55 to 2.00) for outdoor activity, respectively.

Conclusions: The pooled prevalence of pterygium was relatively high, especially for low latitude regions and the elderly. There were many modifiable risk factors associated with pterygium to which healthcare providers should pay more attention.

Strengths and limitations of this study

- We estimated the pooled prevalence data using meta-analysis, rather than the prevalence in a single national population-based study.
- We only included studies written in English or Chinese and published from January 2000 to May 2013, so the pooled prevalence of pterygium in specific regions and periods is explained by the results.
- As we cannot have access to unpublished results, a publication bias cannot be excluded.
- The pooled analysis of some other risk factors was not produced due to insufficient data.

INTRODUCTION

Pterygium is a common fibrovascular proliferative disease affecting the ocular surface; it can result in ocular irritation, visual disturbances and so on.[1] Many previous reports have shown the prevalence of, and risk factors for, pterygium in population-based studies, but the prevalence of pterygium varies widely with geography, age and gender in different samples,[2] and the data remain limited and localised. Although the exact aetiology of pterygium is unknown, there seems to be an association between outdoor work and pterygium formation,[3] especially with ultraviolet (UV) radiation. Increasing geographical latitude was associated with a reduced pterygium OR.[4] Until now, there is no national, population-based study on the prevalence of pterygium in the world, and it would seem that a national, pooled estimate based on the global population is necessary. In this meta-analysis, we carried out a systematic review of previous population-based studies on the prevalence of, and risk factors for, pterygium in the world and investigated any differences among age groups, genders and geographical latitude.

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METHODS

Search strategy

We searched all English reports on population-based studies for the prevalence of, and risk factors for, pterygium using MEDLINE, EMBASE, Web of Science and Google (scholar), and all Chinese reports were searched manually and online using the Chinese Biochemical Literature on Disc (CBMDisc), Chongqing VIP database and China National Knowledge Infrastructure (CNKI) database. The search keywords were: pterygium, pterygia, prevalence, epidemiology and risk factor. Reference lists were checked and researchers contacted for additional literature. A total of 138 reports published in the period from January 2000 to May 2013 were identified.

Inclusion and exclusion criteria

The review and analysis were conducted using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) Statement as a guide.[5] Reports potentially eligible for inclusion in this systematic review and meta-analysis had to meet the following criteria: they had to be population-based studies, original, written in English or Chinese, and needed to provide sufficient information to estimate the pooled prevalence of, and risk factors for, pterygium. If more than one study was based on the same population sample, the study of the highest quality was included. We excluded studies that were on the duplicate population groups but were of lower quality, whose participants were drawn from a particular occupation or population, and that did not satisfy one or more inclusion criteria.

A total of 138 potentially relevant studies were identified and screened. After systematic review, only 20 of these were included in the meta-analysis. The progress for study inclusion is shown in figure 1.

Data extraction

Two researchers (LL and JG) independently searched the literature. Data were extracted from each article using a standardised form including first author, publication year and *et al*. The characteristics of the population-based studies included in this meta-analysis on the pooled prevalence of pterygium in the world are shown in table 1.

We systematically assessed several key points of study quality proposed by the MOOSE Collaboration[25] The quality of the included studies is shown in table 2.

Data analysis

OR was analysed using the RevMan V.5.0 (Review Manager, Copenhagen: the Nordic Cochrane Centre, the Cochrane Collaboration, 2010) statistical software package. Meta-analyst statistical software offered by http://tuftscaes.org/meta_analyst/ was used to analyse

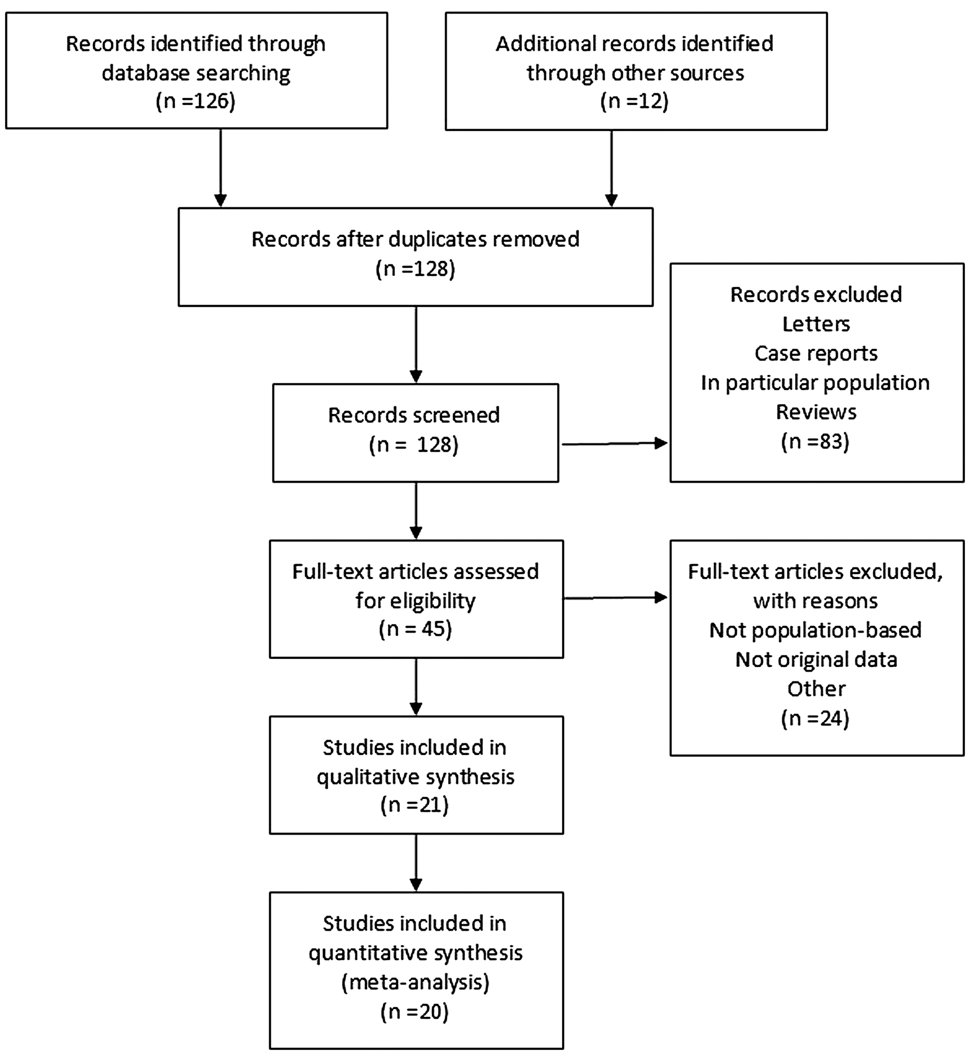

Figure 1 Flow chart demonstrating those studies that were processed for inclusion in the meta-analysis.

Table 1 Characteristics of population-based studies on the prevalence of pterygium

No.	First author	Publication year	Country	Regional	Area	Ethnic	Rural/ urban	Survey year	Age range (years)	Sample size (n)	Cases (n)
1	Cajucom-Uy *et al*[6]	2010	Singapore	1°09′-1°29N,103° 38′-104°6′E	South-western part of Singapore	Malay	NA	2004–2006	40–79	3280	508
2	Wu *et al*[7]	2002	China	22°12″N,113° 15″E	Doumen County	Chinese	Rural	1997	50 years or over	4214	1391
3	Paula *et al*[8]	2006	Brazil	0°9′S,68°54′W	Sao Gabriel da Cachoeira City	Indian	Rural	1997–1999	NA	624	115
4	Viso *et al*[9]	2011	Spain	42°N	O Salnes	Spanish	Urban	2005–2006	40–96	619	42
5	Fotouhi *et al*[10]	2009	Iran	35°N,50°E	Tehran	Persian	Urban	2002	All age	4564	66
6	Durkin *et al*[11]	2008	Myanmar	20°53′N,95°53′E	Meiktita	Burmese	Rural	2005	40 years and over	2076	NA
7	Wong *et al*[12]	2001	Singapore	1°16′N,103°51′E	Tanjong Pagar	Chinese	NA	1997–1998	40–79	1232	120
8	Lu *et al*[13]	2009	China	34°4′-55′N,100° 53′-102°15′E	Henan County	Mongolian	Rural	2006	40 years and over	2112	378
9	Tan *et al*[14]	2006	Indonesia	1°53′N,101°44′E	Pulau Jaloh	Indonesia	NA	NA	All age	477	81
10	Liang *et al*[15]	2010	China	39.6°-40.3°N	Beijing	Chinese	Rural	2008–2009	55–85	37 067	1395
11	Bueno-Gimeno *et al*[16]	2002	Algeria	27°42′N,8°10′W	Tindouf	Saharan	NA	1997	6–80	1322	138
12	Luthra *et al*[17]	2001	Barbados	13°11′N,60°27′W	Barbados	Barbadian	Urban	NA	40–84	2781	613
13	McCarty *et al*[18]	2000	Australia	38°53′S,144°45′E	Victoria	Victorians	Rural/ urban		40 years and over	5147	142
14	Shiroma *et al*[19]	2009	Japan	26°20′N,126°48′E	Kumejima	Japanese	NA	2005–2006	40 years and over	3747	1154
15	Ma *et al*[20]	2007	China	39°54′N,116°23′E	Beijing	Chinese	Rural/ urban	2001	40 years and over	4439	128
16	West and Muñoz[21]	2009	USA	31°-32°N,111° 3′-4′W	Nogales and Tucson	Hispanic	NA	NA	40 years and over	4774	NA
17	Liu *et al*[22]	2001	China	18°-19° N,108°-109°E	Hainan	Chinese	Rural	1999	12–88	7990	628
18	Gazzard *et al*[23]	2002	Indonesia	1°N	Riau province	Malay/ Indonesians	Rural	2001	21 years and over	1210	NA
19	Sherwin *et al*[24]	2013	Australia	29°2′S,167°56′E		NA	NA	2007	15 years and over	641	70
20	Lu *et al*[2]	2007	China	35°2′N,101°5′E	Zeku	Tibetan	Rural/ urban	2006	40 years and over	2229	323

E, east latitude; N, north latitude; NA, not available; S, south latitude; W, west latitude.

Table 2 Quality for the population-based studies on the prevalence of pterygium

No.	First author	Publication year	Sampling scheme	Population characteristics	Prevalence definition	Diagnostic criteria	Response rate	Total score
1	Cajucom-Uy *et al*[6]	2010	Yes	Yes	Yes	Yes	0.787%	5
2	Wu *et al*[7]	2002	Yes	Yes	Yes	Yes	88.49%	5
3	Paula *et al*[8]	2006	NA	Yes	NA	Yes	NA	2
4	Viso *et al*[9]	2011	Yes	Yes	Yes	Yes	66.10%	5
5	Fotouhi *et al*[10]	2009	Yes	Yes	Yes	Yes	70.30%	5
6	Durkin *et al*[11]	2008	Yes	Yes	Yes	Yes	83.70%	5
7	Wong *et al*[12]	2001	Yes	Yes	Yes	Yes	71.80%	5
8	Lu *et al*[13]	2009	Yes	Yes	Yes	Yes	84.90%	5
9	Tan *et al*[14]	2006	Yes	Yes	Yes	Yes	86.70%	5
10	Liang *et al*[15]	2010	Yes	Yes	Yes	Yes	84%	5
11	Bueno-Gimeno *et al*[16]	2002	Yes	Yes	Yes	Yes	NA	4
12	Luthra *et al*[17]	2001	Yes	Yes	Yes	Yes	93%	5
13	McCarty *et al*[18]	2000	Yes	Yes	Yes	Yes	NA	4
14	Shiroma *et al*[19]	2009	Yes	Yes	Yes	Yes	81.20%	5
15	Ma *et al*[20]	2007	Yes	Yes	Yes	Yes	NA	4
16	West and Muñoz B[21]	2009	Yes	Yes	Yes	Yes	NA	4
17	Liu *et al*[22]	2001	Yes	Yes	Yes	Yes	NA	4
18	Gazzard *et al*[23]	2002	Yes	Yes	Yes	Yes	96.70%	5
19	Sherwin et al[24]	2013	Yes	Yes	Yes	Yes	61.50%	5
20	Lu *et al*[2]	2007	Yes	Yes	Yes	Yes	84.69%	5

NA, not available.

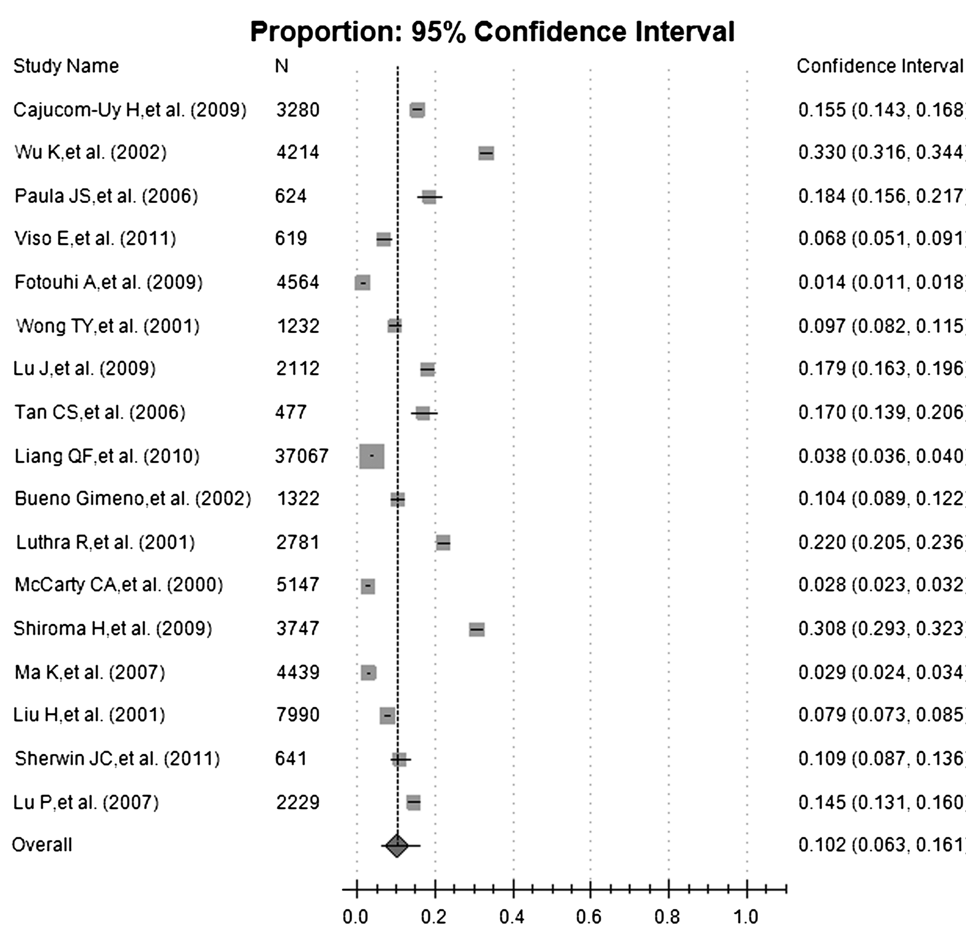

Figure 2 Forest plot displaying the pooled prevalence of pterygium in the population of the world.

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the data for the pooled prevalence. All meta-analyses were evaluated for heterogeneity using the χ^2-based I^2 test and Q test.[26] I^2 Test estimated the percentage of the total variance in all of the data under consideration that was related to heterogeneity. The authors suggested using 25%, 50% and 75% to indicate low-level, moderate-level or high-level heterogeneity. If there was moderate-level or high-level heterogeneity, a random-effects meta-analysis was performed by the DerSimonian and Laird method, except where fixed-effects models were used. Publication bias was assessed by visually inspecting a funnel plot. A p value less than 0.05 was considered statistically significant.[27 28]

RESULTS

The pooled prevalence rate of pterygium was 10.2% (95% CI 6.3% to 16.1%; I^2=49.9%, Q=1.00; p<0.001) in the overall population (figure 2). The maximum (33%) and minimum (2.8%) prevalence rates of pterygium appeared in the studies by Wu *et al*[7] and McCarty *et al*,[18] respectively. The pooled prevalence was 13.2% (95% CI 4.7% to 31.8%; I^2=50%, Q=1.00; p<0.001) for the rural population in five studies, and it was higher than the pooled prevalence of 6.3% (95% CI 0.9% to 32.3%; I^2=49.9%, Q=0.99; p<0.001) for the urban population in three studies. The pooled prevalence rates for pterygium were 14.5% (95% CI 9.1% to 22.2%; I^2=49.8%, Q=1.00; p<0.001) in men and 13.6% (95% CI 7.5% to 23.5%; I^2=49.9%, Q=1.00; p<0.001) in women, respectively. The pooled prevalence rate for participants with unilateral cases of pterygium was higher than that for those with bilateral pterygium (8% vs 6.2%). After removing other countries, we found that the pooled prevalence of pterygium in six studies from China was 9.9% (95% CI 4% to 22.7%; I^2=50%, Q=1.00; p<0.001), which was similar to the overall pooled prevalence of pterygium in the world.

There was a significant trend of greater prevalence for pterygium at older ages (40–49 vs 50–59 vs 60–69 years, 11% vs 15.6% vs 20.1%), and the trends were generally similar between the 60–69 and over 70 years age groups (20.1% vs 20.2%). This report presented trends in the pooled prevalence of pterygium varied with increasing geographical latitude. The pooled prevalence of

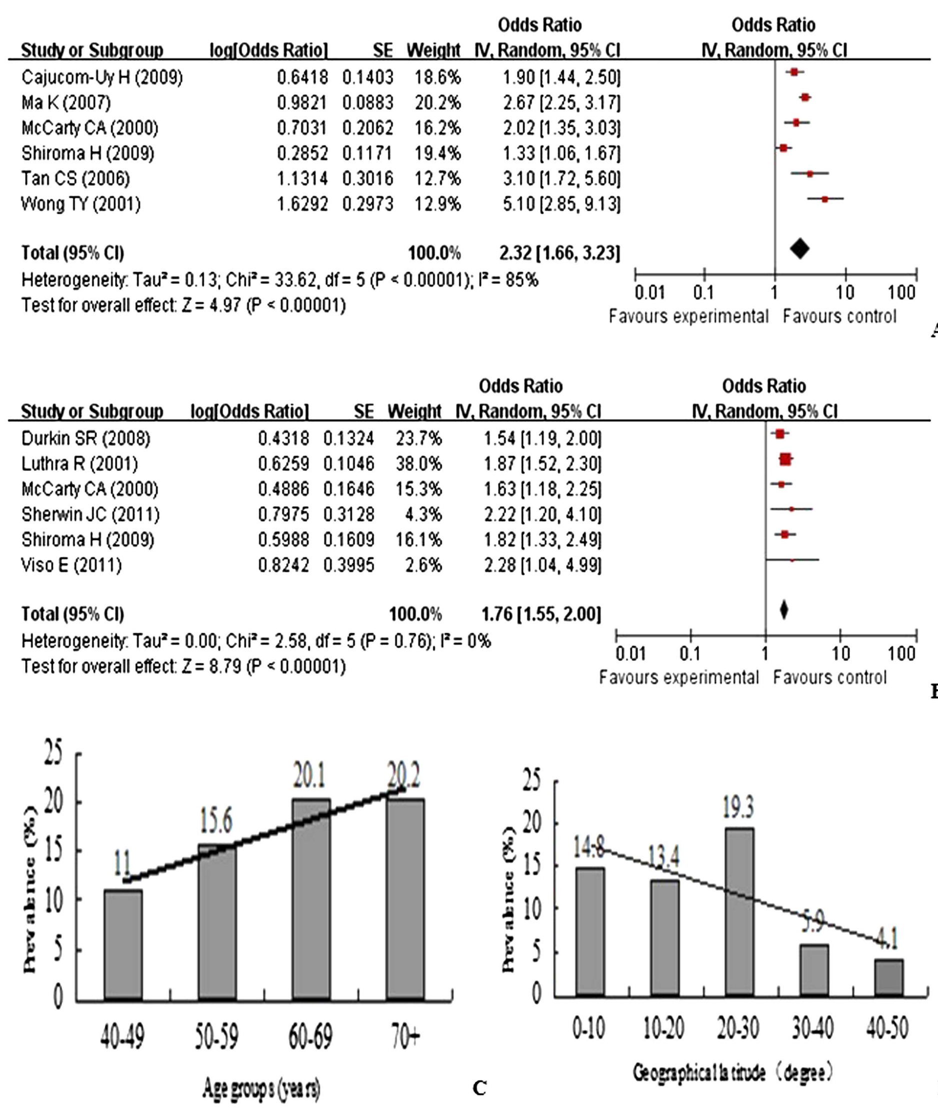

Figure 3 Forest plot displaying the pooled ORs and trends of pterygium: (A) OR for male gender; (B) OR for outdoor activity; (C) trend for age groups and prevalence of pterygium; and (D) trend for geographical latitude and prevalence of pterygium.

pterygium (19.3%, 95% CI 12.4% to 28.9%; I^2=49.8%, Q=0.99; p<0.001) whose stations were located in the latitude ranges of 20–30° was higher than for those in any other areas (figure 3). In addition, the prevalence rates comparing men and women, unilateral versus bilateral, Chinese articles, age and latitude are shown in table 3.

Six studies investigated the association between male gender and pterygium. The pooled OR was 2.32 (95% CI 1.66 to 3.23; I^2=85%, p<0.001) for the male gender. There were six articles which provided information on the relationship between outdoor sun exposure and pterygium, and the OR was 1.76 (95% CI 1.55 to 2; I^2=0%, p=0.76) for outdoor sun exposure (figure 3).

There were other risk factors for pterygium by logistic regression in the reviewed studies, but the pooled ORs could not be calculated because little information in estimating. The risk factors are shown in table 4.

All comparisons passed the test of heterogeneity, as previously defined random-effects models were used for meta-analyses. The funnel plot of the overall pooled prevalence of pterygium is shown in figure 4. The funnel plot had the expected funnel shape. There was no significant publication bias in this meta-analysis.

DISCUSSION

The prevalence of pterygium varied widely across studies. A simple meta-analysis to combine the findings of studies would be informative. To our knowledge, this is the first meta-analysis of prevalence rate and risk factors for pterygium in the world. In this meta-analysis, a total of 20 studies with 900 545 samples were included. We showed that the pooled prevalence rate of pterygium was 10.2% (95% CI 6.3% to 16.1%) in the general population. The eligible studies covered 12 countries. There was a similarity in prevalence of pterygium between China and the world, which might have resulted in the region of China being located mostly in the low-to-high latitude regions, but the prevalence of pterygium (33%) in the Doumen County of China was highest in this systematic review.[7] This indicates a strong requirement for prevention and treatment strategies to control pterygium disease.

Researches on whether gender is related to pterygium have been uncertain.[2 6–24] Many previous studies suggested that the prevalence of pterygium was higher in the male gender than in the female gender,[6 14 15 19 24] which is consistent with the results of this meta-analysis (men vs women, 14.5% vs 13.6%). The pooled OR was 2.32 (95% CI 1.66 to 3.23) for the male gender. Previous studies by Lu *et al*[2] reported that women were at higher risk than men (OR 1.6, 95% CI 1.2 to 2) after logistic regression, which involved in the lifestyle for Tibetan women who had much rural and outdoor work.

Results by this meta-analysis suggested that the prevalence of pterygium in the rural population was higher than that in the urban population, because rural people were often involved in much outdoor work. We found a significant positive trend between increasing age and the prevalence of pterygium, so the importance of organising healthcare for the elderly to prevent pterygium cannot be underestimated.

Epidemiological associations have been suggested between outdoor activity and the prevalence of pterygium,[9 11 17–19 24] and the pooled OR of outdoor activity for pterygium was 1.76 (95% CI 1.55 to 2). Adding even more outdoor activity makes it a great time to get more exposure to sunlight. A strong positive correlation between climatic UV radiation and the prevalence of pterygium[29] was found. It is also known that the low geographical latitude regions are exposed to higher sunlight. There was a trend between higher geographical latitude and lower prevalence of pterygium beside areas located in the latitude range of 20–30°. We are not aware of the reason why the prevalence of pterygium was a little higher in the latitude range of 20–30° than that in low latitude regions.

However, the findings had substantial heterogeneity (p<0.001), possibly due to the confounding effects of differences in age, distribution of participants and so on.

Although we have estimated the pooled prevalence of pterygium in the world, which is very important for preventative public health, there are some limitations in this meta-analysis. First, we only included studies written in English or Chinese and published from January 2000 to May 2013, so the pooled prevalence of pterygium in specific regions and periods is explained by the results. In addition, further evidence might have emerged subsequent to our original search, and the results of the

Table 3 Summary table of the data with the significance test results

Subgroups	The pooled prevalence rates of pterygium (%)	p Value
Gender		
Males	14.5	0.03
Females	13.6	
Unilateral or bilateral		
Unilateral pterygium cases	8	<0.01
Bilateral pterygium cases	6.2	
Area		
Pterygium in China	9.9	0.06
Pterygium in the world	10.2	
Age group, years		
40–49	11	<0.01
50–59	15.6	
60–69	20.1	
Old age group, years		
60–69	20.1	0.12
70–79	20.2	
Different parallel latitude		
0–10	14.8	0.01
10–20	13.4	
20–30	19.3	
30–40	5.9	
40–50	4.1	

Table 4 Risk factors of the population-based studies by logistic regression for prevalence of pterygium

First author	Publication year	Risk factors	OR	95% CI
Cajucom-Uy *et al*[6]	2010	Age	1.3	1.1 to 1.4
		Male gender	1.9	1.5 to 2.6
		High systolic blood pressure	1.6	1.2 to 2.1
Viso *et al*[9]	2011	Outer activity	2.28	1.04 to 4.98
		fluorescein staining	2.64	1.08 to 6.46
Fotouhi *et al*[10]	2009	Age (60+)	73.6	17.1 to 316.1
Durkin *et al*[11]	2008	Primarily outdoor	1.54	1.19 to 2
Wong *et al*[12]	2001	Male gender	5.1	2.9 to 9.3
		Age (50–59)	3.7	1.5 to 9.4
		Age (60–69)	6.3	2.6 to 15.1
		Age (70–81)	7.8	3.2 to 18.8
Lu *et al*[13]	2009	Age (70–79)	2	1.4 to 2.8
		Alcohol intake	1.5	1 to 2
		Education (<3 years)	2.1	1.4 to 3.2
		Dry eye symptoms	1.9	1.5 to 2.5
		Poor family situation	1.3	1 to 1.6
		Schirmer's test (≤5 mm)	2.4	1.9 to 3.1
		Tear break-up time (≤10 s)	2.3	1.8 to 2.9
		Seldom use of sunglasses	1.5	1.2 to 1.9
		Seldom use of hat	1.3	1.1 to 1.7
		Cataract	1.5	1.1 to 1.9
Tan *et al*[14]	2006	Male gender	3.1	1.72 to 5.61
Luthra *et al*[17]	2001	Age	1.01	1 to 1.02
		Education (<12 years)	1.43	1.01 to 2.03
		Outer activity	1.87	1.52 to 2.29
		Darker skin complexion	0.66	0.52 to 0.83
		Using sunglasses outdoor	0.18	0.06 to 0.59
		Use of prescription glasses	0.75	0.6 to 0.93
McCarty *et al*[18]	2000	Age group (10 year)	1.23	1.06 to 1.44
		Male gender	2.02	1.35 to 3.03
		Rural residence	5.28	3.56 to 7.84
		Lifetime ocular sun exposure	1.63	1.18 to 2.25
Shiroma *et al*[19]	2009	Male gender	1.33	1.03 to 1.63
		Age (years)	1.02	1.01 to 1.03
		Refractive error	1.08	1.03 to 1.13
		Experience of outdoor jobs	1.82	1.33 to 2.5
		Intraocular pressure	0.96	0.94 to 0.98
Ma *et al*[20]	2007	Male gender	2.67	2.25 to 3.18
West and Muñoz B[21]	2009	Education (<6 years)	2.81	2.18 to 3.62
		Income <20 000	1.24	1.03 to 1.51
		Smoking	0.75	0.59 to 0.94
		Bilateral cataract surgery	0.54	0.35 to 0.83
Gazzard *et al*[23]	2002	Age (51 and above)	7.31	2.36 to 22.7
		Smoking	0.46	0.24 to 0.9
Sherwin *et al*[24]	2013	Outdoor >3/4 day	2.22	1.2 to 4.09
		Ultraviolet autofluorescence (per 10 mm)	1.16	1.05 to 1.28
		Skin type (tans)	2.17	1.2 to 3.92
Lu *et al*[2]	2007	Age (70–79)	2	1.4 to 2.8
		Female gender	1.6	1.2 to 2
		Education (<3 years)	1.6	1.1 to 2.4
		Dry eye symptoms	1.3	1 to 1.7
		Use of sunglasses/stone glasses	0.3	0.1 to 0.8
		Use of hats	0.3	0.2 to 0.5
		Seldom use of sunglasses/stone glasses	4.6	1.9 to 11.3
		Seldom use of hats	3.6	2.4 to 5.4
		Low socioeconomic status	1.9	1.5 to 2.4

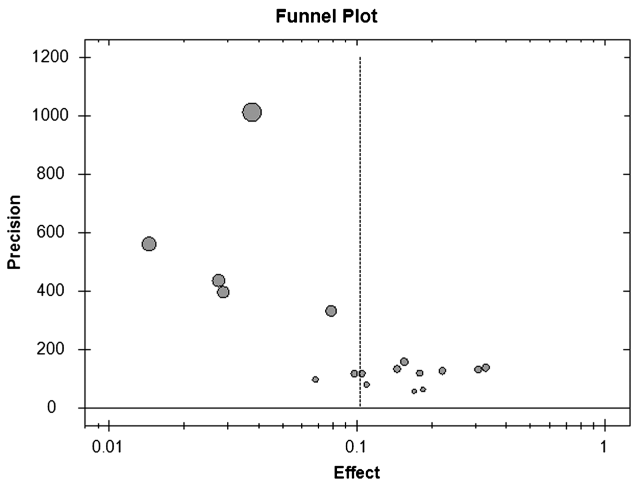

Figure 4 Funnel plot of studies conducted on the prevalence of pterygium in the world.

meta-analysis must be updated in time. Second, as we cannot have access to unpublished results, a publication bias cannot be excluded. Third, a pooled analysis of some other risk factors was not produced due to insufficient data.

Described as an 'ophthalmic enigma',[30] the prevalence of pterygium was 10.2% in the world. Healthcare providers should be aware of preventing pterygium, especially in the elderly and people in low latitude regions.

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Contributors LL and DH conceived and designed the experiments. LL, ZY and JW performed the experiments. DH, LL, JG and JW analysed the data. LL, JG and DH wrote the article.

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