Frequency and Risk Factors for Pterygium in the Barbados Eye Study

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**Objective:** To describe the distribution and risk factors for pterygium in the predominantly black population of the Barbados Eye Study, which was based on a random sample of Barbadian-born citizens between the ages of 40 and 84 years.

**Methods:** The standardized protocol included ophthalmic and other measurements, automated perimetry, lens gradings, fundus photography, and a detailed interview. A 10% systematic sample of participants and those meeting specific criteria also received a comprehensive ophthalmologic evaluation.

**Results:** The Barbados Eye Study included 4709 participants, of whom 2978 were referred for an ophthalmologic evaluation and 2781 (93%) completed the examination. Cases of pterygium were found among 23.4% of 2617 black, 23.7% of 97 mixed (black and white), and 10.2% of 59 white participants examined. In addition to African ancestry, logistic regression analyses indicated a positive association between pterygium and age (odds ratio [OR], 1.01; 95% confidence interval [CI], 1.00-1.02), fewer years of education (OR, 1.43; 95% CI, 1.01-2.03), and an outdoor job location (OR, 1.87; 95% CI, 1.52-2.29). Having a darker skin complexion (OR, 0.66; 95% CI, 0.52-0.83), always using sunglasses outdoors (OR, 0.18; 95% CI, 0.06-0.59), and the use of prescription glasses (OR, 0.75; 95% CI, 0.60-0.93) were protective factors.

**Conclusions:** Approximately one quarter of the black participants examined had pterygia, a frequency that was 2.5 to 3 times higher than among whites in the Barbados Eye Study and elsewhere. Pterygium was almost twice as frequent among persons who worked outdoors but was only one fifth as likely among those who always used sunglasses outdoors. Educational interventions to modify these potential exposures may assist in preventing pterygium.


During the last several decades, numerous theories have been suggested for the pathogenesis and formation of pterygia. These include excessive exposure to ultraviolet light,1 chronic infection and thrombosis of conjunctival veins,2,3 invasion of the cornea by subconjunctival fibroblasts,4 and the presence of a pterygium angiogenesis factor that causes new vessels to proliferate on the cornea.5 Pinkerton et al6 proposed an immunologic mechanism, based on the finding of infiltration of small lymphocytes and plasma cells in the pterygium. More recently, the focus on the pathogenesis of pterygium has changed from a degenerative process to a proliferative condition. This theory is supported by a report on the abnormal expression of the p53 tumor suppressor gene in the conjunctiva of patients with pterygia.7 Whatever the exact pathogenesis, pterygia occur more commonly in tropical regions of the world8,8 and specifically seem to be related to ultraviolet light exposure.9,10 Several studies have attempted to obtain prevalence rates for pterygium in different populations during the last several decades. The earliest estimates were from a survey in New South Wales, Australia,11 which reported a 9.6% prevalence in persons aged 10 years and older. More recent studies from several countries report rates that vary widely,1,2,9,10,12-21 with higher rates of pterygium generally reported in adult populations. To our knowledge, there have been no population-based studies on risk factors for pterygia among black populations in tropical regions. This article presents such findings, based on the Barbados Eye Study (BES) population.22

**RESULTS**

Of the 4631 study participants examined at the study site, 2978 (64%) were referred for an ophthalmologic evaluation.
METHODS

The BES was conducted to determine prevalence rates and risk factors for eye diseases in the predominantly black population of Barbados, West Indies, the easternmost island in the Caribbean region. Details of sample selection and methods for the BES have been described previously. In summary, a simple random sample of Barbadian-born citizens aged 40 to 84 years was drawn by the Barbados Statistical Service (Bridgetown) and 4709 (84%) of those eligible took part in the study. Of these, 4631 completed examinations at the study site and the rest were examined at home. The protocol included automated refraction and best-corrected visual acuity (Ferris-Bailey chart), applanation tonometry, Humphrey automated perimetry, blood pressure and anthropometric measurements, lens gradings (Lens Opacities Classification System II [LOCS II]23), stereo color photography of the disc and macula, and an interview to obtain demographic, medical, environmental, and other risk factor information. A 10% systematic sample, as well as a subset of participants meeting specific criteria, also received comprehensive eye examinations by an ophthalmologist. These criteria were intraocular pressure higher than 21 mm Hg; abnormal visual fields; best-corrected visual acuity worse than 20/30 in either eye; a personal or family history of major eye diseases; diabetes history; and inability to complete the fundus photography, perimetry, or lens grading protocol. This report is mainly based on those participants who had ophthalmologic examinations. Additional analyses were also conducted for the 10% sample.

Pterygium was defined as the presence of a raised fleshy growth that crosses the limbus and encroaches onto the clear cornea or having a history of pterygium surgery. The risk factors evaluated were as follows: (1) personal characteristics included age, sex, iris color and skin complexion (each graded in 4 ordinal categories), years of education, lifetime occupation (agricultural, forestry, water-related occupation vs others), cigarette smoking, and alcohol use; (2) environmental variables included job location (outdoors or at sea vs indoors), hat or umbrella use, and the use of sunglasses and prescription glasses; (3) medical factors included medical history, use of oral steroids, vitamin supplements, aspirin, and glycated hemoglobin levels; (4) ocular factors included the presence of cataract, glaucoma, or macular degeneration, and the use of any eye drops. Lens opacities were defined by a score of 2 or greater in the LOCS II grading scheme as described elsewhere. Open-angle glaucoma was defined by the presence of both optic disc damage and visual field defects after ophthalmologic exclusion of other possible causes. Age-related macular changes were defined as the presence of early (medium or large drusen [≥63 µm] or ≥20 small drusen [<63 µm] with retinal pigment epithelium atrophy and/or pigment) or late (fluid, lipid, hemorrhage, geographic atrophy, or discliform scar) macular changes in at least 1 eye.

Risk factors were evaluated first by Mantel-Haenszel age- and sex-adjusted analyses. Statistically significant variables (P < .05) from bivariate analyses were retained for multivariate logistic regression analyses. Odds ratios (ORs) and 95% confidence intervals (CIs) for associations with pterygium were based on results from the logistic regression model.

Table 1. Demographic and Other Variables Among Black Participants in the BES With Ophthalmologic Examination by Pterygium Status

<table>
<thead>
<tr>
<th>Variable</th>
<th>No Pterygium (n = 2004)</th>
<th>Pterygium (n = 613)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>62.0 ± 12.2</td>
<td>64.0 ± 11.1</td>
</tr>
<tr>
<td>Male, %</td>
<td>63</td>
<td>65</td>
</tr>
<tr>
<td>Marital status, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>41</td>
<td>42</td>
</tr>
<tr>
<td>Widowed</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Other</td>
<td>39</td>
<td>35</td>
</tr>
<tr>
<td>Religion, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anglican</td>
<td>43</td>
<td>46</td>
</tr>
<tr>
<td>Pentecostal</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Other</td>
<td>44</td>
<td>37</td>
</tr>
<tr>
<td>Education, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>9.9 ± 3.0</td>
<td>9.1 ± 2.6</td>
</tr>
<tr>
<td>Median</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

*BES indicates Barbados Eye Study.

Table 1 compares demographic characteristics of the black BES participants with ophthalmologic examinations according to the presence or absence of pterygium. The mean age of participants with pterygia was 64 years; 42% were male and had a mean of 9.1 years of education. There were no statistically significant differences in these or other demographic variables between participants with and without a pterygium. Table 2 presents frequencies in percentage and age-and sex-adjusted ORs of variables significantly (P < .05) associated with pterygium from the Mantel-Haenszel analysis. Darker iris color, darker skin complexion, and smoking were more frequent in participants without pterygium, while having 12 years of education or fewer and an occupation of agriculture, fishing, or forestry were more
frequent in participants with pterygia. Among environmental variables, marked differences were observed in the use of sunglasses while being outdoors (“always” vs “sometimes,” “occasional,” or “never”), which was reported by 3.1% of persons without pterygia and by only 0.7% of those with pterygia. Hat or umbrella use while outdoors (“always” vs “sometimes,” “occasional,” or “never”), which may be an indicator for sun exposure, was positively associated with the presence of pterygium. Similarly, more participants with pterygia had a lifetime job location classified as “outdoors” or “at sea,” ie, 53.9% vs 38.5% of those without pterygia. Of the ocular variables, the use of prescription glasses, a diagnosis of glaucoma, and a nuclear color grading of 2 or higher (as defined by the LOCS II classification system) were more frequent in persons without pterygia, while soft and hard drusen were associated with an increased presence of pterygium.

Table 3 presents the factors independently associated with pterygium in logistic regression analyses. When all of the variables listed in Table 2 were placed in the same model, positively associated factors were age (OR, 1.01), job locations classified as “mostly outdoors and at sea” (OR, 1.87), and having an education less than or equal to 12 years (OR, 1.43). Factors related to a lower frequency of pterygium were darker skin complexion (OR, 0.66), a history of always using sunglasses outdoors (OR, 0.18), using prescription glasses (OR, 0.75), and current cigarette smoking (OR, 0.50).

Because visual acuity loss was one of the specific referral criteria for an ophthalmologic examination, it was commonly found in those examined. Overall, 33% of the 613 participants with pterygia had a visual acuity worse than 20/40 in the affected eye (the worse eye if both eyes were affected), compared with 31% of those without pterygia (worse eye). However, only 5 persons (0.2%) had visual acuity loss (worse than 20/40) attributed to pterygium.

Finally, we estimated the prevalence of pterygium in the total BES population regardless of referral for an ophthalmologic examination. Since every tenth BES participant was systematically referred for this examination, it was possible to estimate total prevalence from this 10% sample (384 black participants). The prevalence of pterygium in this subgroup was 21.6% (95% CI, 17.6%-26.1%). This slightly lower rate was expected since those in the 10% sample were younger than those referred for an ophthalmologic examination; however, it was still similar to the 23.4% found among the referred participants. This supports the validity of the findings on pterygium frequency. Similarly, multivariate analyses based on the 10% sample corroborated the associations identified in Table 3 (data not shown).

**COMMENT**

This is the largest study to assess risk factors for pterygium in a tropical region, based on a predominantly black population, as far as we know. We found a high occurrence of pterygium, which affected one fourth to one fifth of the participants of African origin. These results are of relevance, since pterygia can pose a significant problem in these regions either cosmetically or by affecting vision, thus requiring surgery. The study de-
scribed demographic characteristics of persons with pterygia (Table 1) and identified several potentially modifiable risk factors (Tables 2 and 3). This information can be used to plan and implement possible preventive strategies.

Much research regarding pterygia has been conducted worldwide during the past 4 decades, with some reports resulting from small, hospital or clinic-based settings, and others originating from larger population-based studies. Interpretation of the hospital/clinic studies is difficult since those patients are not usually representative of the general population and true prevalence estimates are not possible to obtain. Population-based studies may be difficult to compare as well owing to the varying age structures, diverse methods of ascertainment of study participants, and differences in overall study design and protocols. Nonetheless, some of these larger studies have reported comparable findings.

Among studies that included populations of all ages, similar prevalences of pterygium were found in South Africa (0.5%; n=1519); the Solomon Islands (0.3%; n=512); and Copenhagen, Denmark (0.7%; n=810). Slightly higher rates were reported by the National Trachoma and Eye Health Program, in which 1.1% and 3.4% of the nonaboriginal and aboriginal populations, respectively, were found to have pterygium. In contrast, a higher prevalence of 8.6% was reported among 659 Eskimos in Greenland.

Studies that were based on adult populations, which are more comparable with the BES, confirm the higher prevalence of pterygium with increasing age. In the National Trachoma and Eye Health Program, prevalence among nonaboriginal men increased from 9.9% at age 40 to 59 years to 12.0% at 60 years or older. A similar trend was noted among women, with rates of 4.9% and 6.1% for the respective age groups. These age-specific findings were consistent with those reported by the Blue Mountain Eye Study, in which the prevalence of pterygium was 7.3% for participants aged 49 years or older, and for the Chesapeake Bay watermen, with a prevalence of 8.3% in those aged 30 years or older. Prevalence was lower in the Australian state of Victoria, where 2.8% of 5147 participants older than 40 years had pterygium. However, prevalence tended to increase with age in this population as well, with 6.4% of those aged 80 to 89 years found to have pterygium.

In the BES, the frequency of pterygium among black participants was several times higher than the rates reported by all of the studies of adult populations, even while accounting for underlying age differences. Whereas inconsistencies in design and method can explain the varying prevalences among studies, it seems likely that real differences exist among populations. This variability is supported by the results of the BES, which indicate an approximately 3-fold higher frequency of pterygium in participants of African descent than in whites. Although the number of white BES participants was small, the prevalence among whites of 10.2% was consistent with rates reported by other studies. Among black participants, however, the frequency of pterygium was 23.4%, representing the highest rate reported for any group in a population-based study. This difference in rates within the same study may be caused by several factors, including lifestyle or occupational differences in environmental exposures (eg, to ultraviolet light or differences in genetic susceptibility). Several studies have investigated the possible role of heredity in the development of pterygium and have provided evidence to support the hypothesis that genetic influences do exist. However, the exact mechanism and extent of these influences is still unclear.

Besides age and race, the multivariate logistic regression analysis identified several other factors associated with pterygium. Several studies have reported an increased risk of pterygium associated with increases in UV radiation and sun exposure, as well as geographic location (with respect to sun intensity and proximity to the equator). As such, individuals working outdoors would be expected to have higher rates of pterygium than those working indoors. A case-control study of 278 patients in Brisbane (Australia) indicated that persons working outside environments were 4 to 11 times more likely to have pterygia than those working indoors. These estimates were somewhat higher than the almost 2-fold risk found in the BES; however, the differences are likely owing to the varying study design, geographic location, and other factors. Nonetheless, spending time outdoors has been reported to increase the risk of pterygium, with cumulative exposure to UV radiation playing a significant role.

Fewer years of education (≤12 years), possibly representing lower socioeconomic status, was also associated with pterygium in the BES. To our knowledge, the study by Taylor et al represents the only other investigation reporting on the association between education and pterygium. In bivariate analyses, more than 8 years of education was found to be protective (OR, 0.42; 95% CI, 0.28-0.62) among the Chesapeake Bay watermen. While this result is in the same direction as our findings, education was not a statistically significant factor in the subsequent logistic regression analyses in that study.

In the BES, darker iris color and darker skin complexion among black participants were found to be protective characteristics against pterygium in the bivariate analyses (Table 2), with darker skin pigmentation remaining significant in the multivariate analysis (Table 3). These findings were consistent with those reported by Mackenzie et al in a case-control study conducted in Brisbane. Because both studies had different designs, the magnitude of the ORs from the BES may not be directly comparable with the relative risks (RRs) estimated from the conditional logistic regression analysis in the Brisbane study; however, the latter study found that lighter eye color (hazel-green) was associated with an increased risk of pterygium (RR, 4.0; 95% CI, 2.4-6.7), which is consistent with our findings. Although not statistically significant, they also found a higher risk among those with fair skin as opposed to those with a black or olive tone (RR, 1.5; 95% CI, 0.9-2.6), also corroborating the BES findings. However, these results are not consistent with those reported by the Blue Mountains Eye Study in which no association was found with iris color and an increased risk was associated with darker skin (OR,
opacities. Similarly, in the Australian study by McCarty et al, associations of lens opacities and pterygium were not maintained in the multivariate analysis of that study. The mechanism for protection, if any, is not understood and the result could be spurious.

Reports on whether sex is related to pterygium have been inconsistent. The Blue Mountains Eye Study found that men were at higher risk than women (OR, 2.63; 95% CI, 2.03-3.42), a finding corroborated by McCarty et al (OR, 2.02; 95% CI, 1.35-3.03) and Moran and Hol lows, among the nonaboriginal population of Australia. However, the BES found no differences in pterygia between men and women (Table 2), which is consistent with reports from a study of the aboriginal population and a South African study. These findings may be attributable to differences in occupational or environmental exposures or lifestyle factors.

In the BES, pterygium was not associated with lens opacities, glaucoma, or macular findings in multivariate analyses. Pterygium was associated with posterior subcapsular opacities in the Blue Mountains Eye Study (OR, 1.90; 95% CI, 1.19-3.04) but not with cortical or nuclear opacities. Similarly, in the Australian study by McCarty et al, associations of lens opacities and pterygia were not maintained in the multivariate analysis.

This report was the first to include a large number of individuals of African ancestry in a tropical region and assess their risk factors for pterygium. The limitations of the study, however, should be pointed out. First, not all participants received a comprehensive eye examination by an ophthalmologist. Nevertheless, it was possible to estimate the total prevalence based on the results of the 10% sample of participants who were systematically referred for such examination, with results that support the validity of the findings. Second, certain risk factors, such as the use of sunglasses, were obtained through self-report and are subject to recall biases. However, since there is no reason to expect differential recall in persons with and without pterygium, such biases are unlikely to affect the results. Third, we were unable to compare the risk factors of pterygia between black and white participants because of the small sample in the latter group. Despite these limitations, the study provided valuable information about pterygia in people of African descent, not only identifying a very high prevalence, but also the opportunity for preventive interventions.

Several potentially modifiable factors may be protective against pterygium, thus suggesting the importance of educational interventions. These interventions are similar to those advocated for skin cancer, since the development of pterygium is probably related, to some extent, to increased UV light or environmental exposure. Although more than one third of participants without pterygia and one half of those with pterygia reported an outdoor job location, only 3% or less of the study population reported habitual use of sunglasses. Interventions to encourage the use of sunglasses and/or spectacles and to recommend the use of protective measures, such as wide-brimmed hats, may be effective to prevent or retard the development of pterygium in this and similar populations. Effective dispersion of educational messages advocating these simple and inexpensive measures seems to be a cost-effective approach to control the development of pterygium. Adoption of these recommendations would have public health relevance by reducing the financial and other burdens of surgery and other costs related to impaired vision, as well as having positive visual and cosmetic effects for the individual.

Our study found a high occurrence of pterygium in the population of African descent and identified potentially modifiable factors. Efforts should be made to reduce the risk of pterygium by changing the modifiable risk factors, such as increasing the use of sunglasses among people living in tropical climates, especially for those with outdoor occupations.

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