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Ocular Exposure to Particulate Matter and Development of Pterygium: A Case-Control Study

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Abstract

Background: Formation of pterygium has been mainly attributed to exposure to the ultraviolet (UV) radiation. Other factors such as dry weather, wind exposure and microtrauma with dust particles, have been linked to development of pterygium.

Objective: To determine the association between ocular exposure to particulate matter and development of pterygium.

Methods: This case-control study was conducted in a company dedicated to the production and marketing of toilets. We included a total of 90 cases identified in November 2013 and 184 controls. The diagnosis of pterygium was based on clinical examination. Variables studied included age and job tenure of the participants. Logistic regression analysis was used to assess the effect of exposure on developing pterygium.

Results: All study participants were male. The mean age of the cases and controls was 39.9 (SD 9.5) and 37.8 (SD 7.3) years, respectively. 115 (42%) of the participants had a job tenure of 5–8 years. The percentages of cases and controls exposed to particulate matter were 31.1% (n=28) and 30.4% (n=56), respectively (OR 1.08, 95% CI 0.61 to 1.91).

Conclusion: We could not observe any association between ocular exposure to particulate matter and development of pterygium.

Keywords: Pterygium; Particulate matter; Dust; Occupational exposure; Occupational medicine; Adult

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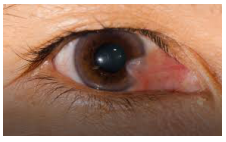

Introduction

Pterygium is one of the most common eye diseases.[1-3] It is an inflammatory process associated with cell proliferation, connective tissue remodelling, and angiogenesis leading to fibrovascular proliferation.[4,5]

Formation of pterygium has been linked to several factors. Exposure to the ultraviolet (UV) radiation is described as the most important risk factor. However, other factors such as dry weather, dust, rapid evaporation of the tear film, genetic factors, ametropia, exposure to wind and microtrauma with dust particles, and even exposure to harmful chemicals, have also been mentioned.[6-17] Nevertheless, there is no consensus on how important these factors are in the pathogenesis of pterygium.[18]

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Figure 1: A typical personnel during the execution and at the end of his work activities. A) A polisher with particulate matter sampling pump whose eyebrows become white by the dust generated by the polishing of the toilets. B) An enameller whose eyebrows and the ocular perimeter become white by the particulate matter. C) A polisher with particulate matter sampling pump. The polishing booth is seen behind the employee. D) An enameller doing the lavatories enamelling process. The enamelling cabin and the mist generated are observed.

In mild and non-inflamed cases, the pterygium is usually asymptomatic.[19-22] However, in advanced or recurrent forms, elevated areas can cause symptomatic epithelial keratopathy producing tearing reflex, photophobia and foreign body sensation.[2,3,23,24] If it grows, it can reduce the visual capacity, causing irregular astigmatism.[2,22,24]

The diagnosis of pterygium is based on a careful ophthalmological examination. We try to locate any pathological activities such as a fibrous and vascular proliferation on the conjunctiva (unilateral or bilateral) containing blood vessels arranged radially in relation to the eye vertex.[25]

In certain companies, such as those producing toilets and ceramics, some workers may have ocular exposure to particulate matter during work. This study was conducted to determine the association between ocular exposure to particulate matter and pterygium formation in workers of a factory dedicated to production and commercialization of toilets and ceramics.

Materials and Methods

The company where the study was conducted has more than 50 years of existence and is dedicated to the production and marketing of toilets and ceramics. Parts of their productive activities involve generation of particulate matter—for example, in preparation of the plaster, preparation of the frit, and polishing and enamelling of the sanitary ware. At the time the study was conducted, these activities were carried out in roofed spaces with no solar radiation exposure. The workers did not have any eye protection so that the ocular conjunctiva of the operators was in contact with particulate matter. The operators of the polishing and enamelling units finished their routine work with the upper two-thirds of the face covered with particulate matter, despite using the face respirator and the wimple.

This case-control study was carried out in November 2013. The company had 1301 workers and was dedicated to the production and marketing of toilets. The sample type was non-probabilistic. We conducted a pilot study including 11 cases and 22 controls chosen from the evaluated population, considering the same inclusion and exclusion criteria of the final sample. The minimum sample size was calculated assuming an estimated odds ratio (OR) of 2.5 and a case exposure frequency of 27% (obtained from the pilot study), an accept-

able type one error of 5%, a study power of 80%, and a case:control ratio of 1:2, based on which a minimum of 90 cases and 180 controls were needed for the study.

Cases included those workers diagnosed with pterygium; controls were those who did not have pterygium. Both cases and controls had a job tenure of ≥5 years at the company, and working in an environment with total/inhalable dust concentration of >10 mg/m^3 and respirable dust concentration of >3 mg/m^3.

Workers with a family history of pterygium, alcohol consumption of >40 g/day, and those with moderate smoking (6–15 cigarettes/day) were excluded from the study.[11,26-29] Those who worked in areas directly exposed to sunlight (UV radiation) were also excluded. For the same reason, those workers who had worked in fishing, masonry, public transportation, construction, and agriculture were excluded from the study.

We also excluded those who worked in environments that had high thermal stress and low relative humidity—both are considered risk factors for the development of pterygium. To identify these environments, we reviewed the measurements of the work areas based on the wet-bulb globe temperature index (WBGT, ISO 7243, 1989). The limit values of WBGT were established according to the American Conference on Governmental Industrial Hygienists (ACGIH) in 2012, using Quest Technologies equipment (QUESTEMP 36 and series TKI090009).

The main outcome variable was the presence of pterygium in the participants, determined by reviewing the occupational medical examinations of cases. Ocular exposure was defined as exposure for five years or more to particulate matter in an environment with dosimetry values of >10 mg/m^3 for total/inhalable dust and >3 mg/m^3 for respirable dust. The workers who fulfilled the definition were the polishing, enamelling, kilns and frit operators (Fig 1).

TAKE-HOME MESSAGE

- Pterygium is one of the most common ophthalmic diseases.
- So far, many conditions have been mentioned as factors contributing to the pathogenesis of pterygium. Those include exposure to the ultraviolet radiation, dry weather, wind, and particulate matter.
- We could not find any association between ocular exposure to particulate matter and pterygium formation in workers of a factory dedicated to production and commercialization of toilets and ceramics.

To objectify the ocular exposure to particulate matter, we had access to occupational hygiene monitoring and to the total/inhalable and respirable dust dosimetries, carried out in the company during five years prior to the study. These measurements were made with calibrated dosimeters, by certified environmental engineers with a minimum experience of three years in occupational hygiene monitoring.

We applied the 0500 and 0600 methodologies of the National Institute for Occupational Safety and Health (NIOSH) for the quantification of total/inhalable and respirable dust. Moreover, the maximum permissible values were established according to the ACGIH, 2012. We used calibrated constant flow pumps (Sensidyne brand and BDX II model) to collect air samples.

Ethics

The study protocol was reviewed and approved by the Institutional Review Board, of the Universidad Peruana Cayetano Heredia, Lima, Peru.

Statistical Analysis

We used the STATA ver 12.0 (Statacorp, Tx, USA) for data analysis. Continuous numeric variables were presented as mean

Table 1: Characteristics of the participants in case and control groups

Variables	n (%) Cases (n=90)	Controls (n=184)	p value
Age (yrs)			
<33	26 (29)	65 (35.3)	0.26
33–37	26 (29)	37 (20.1)	
38–42	16 (18)	43 (23.4)	
>42	22 (24)	39 (21.2)	
Job tenure (yrs)			
5–8	38 (42)	77 (41.8)	0.75
9–12	21 (23)	50 (27.2)	
>12	31 (35)	57 (31.0)	
Ocular exposure to particulate matter			
No	62 (69)	128 (69.6)	0.91
Yes	28 (31)	56 (30.4)	

and standard deviation (SD); the categorical variables were expressed as number and percentage. χ^2 test was used to compare characteristics of cases and controls. Binary logistic regression analysis was used to determine the independent risk factors for development of pterygium. The model was adjusted for age and job tenure.

Using the Mantel-Haenszel test, we also assessed the interaction between the participant's age (categorized in quartiles) and the ocular exposure to particulate matter. The interaction term was created by multiplying the age quartiles by the ocular exposure to particulate matter.[30] A p value <0.05 was considered statistically significant.

Results

A total of 90 cases and 184 controls were included in the study. All the participants were male. The mean age of the cases was 39.9 (SD 9.5) years; for controls, it was 37.8 (SD 7.3) years (p=0.28). The job tenure of 115 (42%) participants was 5–8 years (Table 1).

The prevalence of ocular exposure to particulate matter among the study participants was 31% (n=84)—31% (n=28) of cases and 30.4% (n=56) of controls exposed to particulate matter (p=0.91). There were no statistically significant differences between the cases and controls in terms of age (p=0.26) and job tenure (p=0.75) (Table 1).

No association was found between ocular exposure to particulate matter and presence of pterygium (crude OR 1.03, 95% CI 0.60 to 1.78). The result was the same after the model was adjusted for age and job tenure (adj. OR 1.08, 95% CI 0.61 to 1.91) (Table 2).

No significant association was also found between age quartiles and ocular exposure to particulate matter, and presence of pterygium in the logistic regression model with the multiplicative interaction term.

Discussion

In the present study, we could not find any association between ocular exposure to particulate matter and the presence of pterygium. A study carried out in Nigeria with 144 motorcyclists and a control group of 114 office workers from the same company also found no association between job tenure and the presence of pterygium. Use of sunglasses and hats was found to protect formation of pterygium.[25] In the other hand, another study, also conducted in Nigeria on 615 motorcyclists, found no association between the use of sunglasses and the prevalence of pterygium.[31]

A cross-sectional study in Nigeria was conducted on 553 sawmill workers of whom 449 and 104 performed technical and administrative tasks, respectively. The study reported that the likelihood a worker

with technical tasks develops pterygium is more than twice that a sawmill administrative worker does. Nevertheless, they did not adjust their analyses for potential confounders.[32]

A high prevalence of pterygium has been reported in welders. However, these workers are also exposed to smoke, whereas workers in our study were mainly exposed to particulate matter.[17] A Korean study conducted between 2006 and 2011 on 22 216 participants found an association between exposure to particulate matter with aerodynamic diameter <10 µm and development of primary pterygium. After adjusting for confounders, this study also found a significant association between development of pterygium and sun exposure, older age, and low educational level of participants.[33]

In literature review, we could not find any significant association between exposure to particulate matter and pterygium formation in various occupational groups. Nevertheless, some studies show that use of both hat and sunglasses reduces the presence of pterygium.[18,25] Therefore exposure to UV radiation could be the most important cause in the pathogenesis of pterygium. To corroborate this hypothesis, it is required to conduct studies offering protection against UV radiation to the occupational groups with the highest risk of pterygium and assess the impact of this intervention on the pterygium incidence.

In our study, the age of participants was not associated with the development of pterygium. Despite lack of statistical interaction between age quartiles and ocular exposure to particulate matter, and presence of pterygium, the prevalence of pterygium has been linked with older ages;[18,33] several studies has described a higher prevalence of pterygium among 20–50-year-old workers.[3,16,17,23]

Regardless of the negative results found in this study, it is important to use eye protective measures when carrying out work activities in contact with particulate matter. The lack of association observed in this study could be explained by the structure of the study population aged under 40 years and the fact that the risk of pterygium increases with age.[18,33] Therefore, conduction of a prospective studies with a follow-up of participants of more than 10 years seems necessary to determine whether exposure to particulate matter is a risk factor for the development of pterygium.

This study had certain limitations: the assessment of ocular exposure to particulate matter was performed through the measurement of total/inhalable and respirable dust. Unfortunately, in ophthalmological research, a validated criterion for this quantification has not yet been established. Despite this, we tried to objectify it, using the total/inhalable and respirable dust dosimetries performed with a validated methodology, by trained personnel,

Table 2: Logistic regression analysis (crude and adjusted) to evaluate the association between ocular exposure to particulate matter and the presence of pterygium.

	OR (95% CI)	
Variable	**Crude**	**Adjusted**
Ocular exposure to particulate matter		
No	1	1
Yes	1.03 (0.60 to 1.78)	1.08 (0.61 to 1.91)
Age (years)		
<33	1	1
33–37	1.75 (0.89 to 3.46)	1.80 (0.90 to 3.61)
38–42	0.93 (0.45 to 1.93)	0.86 (0.35 to 2.12)
>42	1.41 (0.70 to 2.82)	1.20 (0.44 to 3.26)
Job tenure (yrs)		
5–8	1	1
9–12	0.85 (0.45 to 1.62)	0.82 (0.42 to 1.62)
>12	1.10 (0.61 to 1.98)	1.21 (0.50 to 2.95)

with calibrated and certified monitoring equipment. Furthermore, pterygium was not diagnosed by an ophthalmologist; it was done by a primary care physician. Moreover, the study was carried out in a single sanitary factory, so the findings may not be generalized to the entire occupational group. Nevertheless, it was an advantage that both cases and the controls were selected from the same population. Finally, we could not measure the degree of exposure to UV radiation. However, we excluded all workers who did not perform their activities under roof protection. Equally, we tried to control other important confounders, such as thermal stress and low relative humidity, by excluding the participants working in such areas.

In conclusion, we could not find any association between ocular exposure to particulate matter and development of pterygium.

Conflicts of Interest: None declared.

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