Dry eye symptoms and associated risk factors among adults aged 50 or more years in Central Mexico

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Abstract

Objective. To determine the prevalence of dry eye symptoms (DES) and associated risk factors among adults in Tlaxcala, Mexico. **Materials and methods.** A cross-sectional population-based study that included 1 508 individuals aged ≥50 years who answered the Dry Eye Questionnaire (DEQ-5), with a score ranging between 0 and 22; the following categories were defined: no DES (<6); mild-moderate DES (6 to 11) and severe DES (≥12). **Results.** The prevalence of DES was 41.1% (95%CI 38.6-43.6), and was higher in women (OR=2.26, 95%IC 1.70-3.00), in individuals with smoking index of <10 (OR=1.40, 95%CI 1.05-1.87) and ≥10 pack-years (OR=2.29, 95%CI 1.44-3.63), subjects with history of ever consuming alcohol (OR=1.31, 95%CI 1.02-1.70), and those receiving antihypertensive treatment (OR=1.29, 95%CI 1.00-1.65). **Conclusion.** Dry eye symptoms were highly prevalent in the study population and were associated with sex, smoking, alcohol consumption, and antihypertensive medications.

Keywords: dry eye symptoms; 5-item Dry Eye Questionnaire; prevalence

Resumen

Objetivo. Determinar la prevalencia de síntomas de ojo seco y factores de riesgo asociados en población adulta de Tlaxcala, México. **Material y métodos.** Se realizó un estudio de base poblacional con 1 508 individuos ≥50 años que respondieron el *Dry Eye Questionnaire* (DEQ-5) y se definieron las siguientes categorías: sin síntomas (<6); síntomas leve-moderado (6 a11) y síntomas severos (≥12). **Resultados.** La prevalencia de síntomas de ojo seco fue de 41.1% (IC95% 38.6-43.6); fue mayor en mujeres (OR=2.26, IC95% 1.70-3.00), en individuos con índice de tabaquismo <10 (OR=1.40, IC95% 1.05-1.87) y ≥10 paquetes-año (OR=2.29, IC95% 1.44-3.63), en sujetos con historia de consumo de alcohol (OR=1.31, IC95%1.02-1.70) y en aquellos con tratamiento antihipertensivo (OR=1.29, IC95% 1.00-1.65). **Conclusión.** La frecuencia de síntomas de ojo seco fue altamente prevalente en la población de estudio y se asoció con sexo, tabaquismo, consumo de alcohol y medicamentos antihipertensivos.

Palabras clave: síntomas de ojo seco; cuestionario de ojo seco de 5 ítems; prevalencia

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Dry eye is defined by the 2007 International Dry Eye Workshop as a multifactorial disease of the tears and ocular surface, which results in symptoms of discomfort,[1] visual disturbance, increased tear film osmolarity, and inflammation of the ocular surface. Dry eye is regarded as an important public health issue due to its impact on the quality of life of those with the pathology.[2] The prevalence of this condition ranges from 5 to 30%, depending on the characteristics of the studied population and the method of assessment.[2,3] Among the risk factors related to dry eye are older age, female sex, ethnicity, decreased androgen levels, exogenous estrogen use, imbalance of the essential fatty acids, autoimmune disorders, and use of certain drugs (i.e. antihypertensive and antianxiety drugs).[1-3] Several dry eye symptoms questionnaires have been developed for epidemiological research as well as clinical diagnosis and monitoring of treatment response. The 5-item Dry Eye Questionnaire (DEQ-5) explores the frequency and intensity of eye dryness and discomfort together with the frequency of watery eye.[4,5] The DEQ-5 is a simple, inexpensive instrument for screening dry eye symptoms that can be applied to large cohorts of patients. The aim of this study was to determine the prevalence of dry eye symptoms and the risk factors associated to this condition among the adult population of the State of Tlaxcala, Mexico.

Materials and methods

Study population

A cross-sectional population-based study was carried out from July to September 2013 in order to determine the prevalence of visual impairment and blindness in people aged ≥50 years in the State of Tlaxcala, Mexico. The prevalence of dry eye was also evaluated. A multistage sampling design in keeping with the Rapid Assessment of Avoidable Blindness (RAAB) methodology was used. A total of 39 municipalities were chosen, comprising 4 282 households with 2 574 individuals aged ≥50 years (INEGI, National Institute of Statistics and Geography of Mexico). Of these potentially eligible people, 1 617 accepted to participate in the study, and 1 508 completed the DEQ-5. The evaluation included also several health questionnaires and assessment of visual acuity by trained interviewers at the homes of the participants. People with any visual impairment or general health problems were referred for medical attention with their usual health care provider. This study was performed in accordance with the guidelines of the Declarations of Helsinki. The Institutional Review Boards of Research, Ethics, and Biosecurity of the Conde de Valenciana Institute of Ophthalmology approved the study protocol. Before the interview and blood sampling, all participants signed an informed consent form.

General evaluation and visual acuity

A general questionnaire including sociodemographic information, smoking (age at first cigarette, duration of smoking, and average of cigarettes per day), alcohol consumption (age at first use, duration of alcohol consumption, and average of drinks per day), and chronic comorbidities (such as diabetes, hypertension, and obesity) was administered. Both smoking and alcohol consumption statuses were categorized into never, former, and current use. The intensity of smoking was evaluated by calculating the smoking index:

$$\left(\frac{\text{average of cigarettes per day X duration of smoking in years}}{20} \right)$$

which quantifies the number of pack-years a person has smoked. Due to the small number of participants with ≥15 pack-years of smoking (4.4%), we categorized the score as follows: never-smoker, <10 pack-years of smoking (low exposure), and ≥10 pack-years of smoking (medium/high exposure). Systolic (SBP) and diastolic (DBP) blood pressure was measured three times using a digital sphygmomanometer, and the average of the last two measurements was used. Hypertension was defined as SBP≥140 mmHg, DBP≥90 mmHg, or intake of antihypertensive drugs regardless of blood pressure values. Diabetes was defined according to the Expert Committee on Diagnosis and Classification of Diabetes Mellitus 2003, as fasting serum glucose >7.0 mmol/l (126 mg/dl) or previous physician's diagnosis.

Visual acuity and pinhole visual acuity were measured using the Snellen tumbling E chart. Individuals were categorized according to visual acuity in the better eye as normal (better than or equal to 20/60), moderately impaired (worse than 20/60 and equal to 20/200), severely impaired (worse than 20/200 and equal to 20/400), and blind (worse than 20/400)**.** Fasting plasma glucose, total cholesterol, triglycerides, HDL-cholesterol, LDL-cholesterol, and creatinine and albumin levels were determined. All analytical measurements were performed at the Clinical Laboratory at the Conde de Valenciana Institute of Ophthalmology in Mexico City.

Five-item dry eye questionnaire (DEQ-5)

For this study, a previously validated Spanish version of the DEQ-5 questionnaire was used.[6] The DEQ-5 is a five-item questionnaire that measures a number of

symptoms along four dimensions: frequency, intensity in the morning, intensity late in the day, and degree of bother.[5] The questionnaire score ranges from 0 to 22 points, and the sum of points is categorized as follows: <6, no dry eye symptoms; 6 to 11, mild-moderate dry eye symptoms; and ≥12, severe dry eye symptoms. Persons in the last category must be also examined for the presence of Sjögren's syndrome (SS), an autoimmune disease that combines dry eyes, dry mouth, and other diseases of the connective tissues.[5]

Statistical analysis

Unadjusted and sex-adjusted prevalence and their respective 95% confidence intervals (95%CI) for dry eye symptoms, both overall and by degree of severity, were estimated by logistic regression analysis. Comparisons between individuals with and without dry eye symptoms were carried out when appropriate, using Pearson chi-square test for categorical variables and analysis of variance (ANOVA) or the Kruskal-Wallis test for continuous variables. The magnitude of the association between dry eye symptoms and various risk factors across severity categories was examined by logistic and multinomial logistic regression models, using the DEQ-5 score, with the participants without dry eye as reference group, and calculating odds ratios (OR) and their 95%CI. Some of the risk factors for dry eye symptoms were age (continuous and dichotomous variable), sex, smoking status (as nominal variable [never, former, and current]), smoking index (never-smokers, <10 pack-years, and ≥10 pack-years), ever alcohol consumption (as dichotomous [yes/no] and nominal variable [never, former, and current]), diabetes (yes/no), antihypertensive treatment (yes/no), visual impairment (none, mild/moderate, and severe), and wearing glasses (yes/no). In a model for individuals with diabetes, duration of diabetes (continuous variable) was added. The fit of the models was tested with the Hosmer-Lemeshow deciles of risk. Also, the outliers and influence statistics were evaluated. All analyses were performed with STATA 14.0 (Stata Corporation, College Station, Tex.).

Results

Description of the study population

The study population included 1 508 individuals (900 women [59.6%] and 608 men [40.3%]; the mean age was 64.7 years [s.d. 10.6]). According to the classification of the degree of severity of dry eye symptoms, 887 (58.8%) participants did not have the condition, 455 (30.2%) had

mild/moderate symptoms, and 166 (11.0%) had severe dry eye symptoms. Comparison of participants across DEQ-5 categories showed significant differences by sex, occupation, wearing of glasses, visual acuity in the better eye, and visual function (table I). Although no significant differences between dry eye symptoms groups by smoking status or smoking index were observed, the smoking index of ≥10 pack-years was more prevalent in current than in former smokers with mild/moderate (36.9 *vs.* 13.4%, respectively) or severe dry eye symptoms (36.8 *vs.* 11.8%, respectively).

Prevalence of mild/moderate and severe dry eye symptoms

The overall prevalence of any degree of severity of dry eye symptoms was 41.1% (95%CI 38.6-43.6). The prevalence of any severity of dry eye symptoms was significantly higher in women than in men (45.3% [95%CI 42.1-48.6] *vs.* 35.0% [95%CI 31.3-38.9], respectively), as well as in individuals with ≥10 pack-years of smoking (58.4% [95%CI 48.5-67.7]) and in those with<10 pack years of smoking (46.3% [95%CI 41.4-51.2]), compared to never-smokers (36.1% [95%CI 32.6-39.8]). The prevalence of any severity of dry eye symptoms was also higher in current (42.6% [95%CI 38.7-46.5]) and former (45.0% [95%CI 40.3-49.8]) alcohol consumers than in never-consumers (35.1% [95%CI 30.6-39.8]), as well as in individuals with moderate visual impairment (59.4% [95%CI 46.8-70.9]) and severe visual impairment/blindness (68.6% [95%CI 56.4-78.6]), compared to those with normal visual acuity (38.9% [95%CI 36.4-41.6]). A similar trend was observed in the prevalence of mild/moderate and severe dry eye symptoms (table II). Additionally, the prevalence of any degree of dry eye symptoms increased significantly with worsened visual acuity in those who did not wear glasses (normal vision, 34.6%; moderate visual impairment, 54.3%; and severe visual impairment/blindness, 75.8%; *p*<0.001). No significant trend due to visual impairment was observed in participants who wore glasses.

Risk factors associated with the prevalence of dry eye symptoms

In a multiple logistic regression analysis, the odds for any severity of dry eye symptoms were higher in women (OR=2.26, 95%CI 1.70-3.00), in individuals with a smoking index of <10 pack-years (OR=1.40, 95%CI 1.05-1.87) and ≥10 pack-years (OR=1.29, 95%CI 1.44-3.63), subjects with a history of ever alcohol consumption (OR=1.31, 95%CI 1.02-1.70), and those receiving antihypertensive treatment (OR=1.29, 95%CI 1.00-1.65) (table III). In ad-

Table I

SOCIODEMOGRAPHIC AND CLINICAL CHARACTERISTICS OF MEXICAN ADULTS AGED 50 OR MORE YEARS BY SEVERITY OF DRY EYE SYMPTOMS. TLAXCALA STUDY, 2013

	No dry eye symptoms N=887	Mild/moderate dry eye symptoms N=455	Severe dry eye symptoms N=166	P value
Age (years), mean (s.d.)	64.8 (10.5)	64.6 (10.8)	64.1 (10.6)	0.706
Sex				
Women	492 (55.5)	293 (64.4)	115 (69.3)	<0.001
Men	395 (44.5)	162 (35.6)	51 (30.7)	
Level of education				
Less than elementary school	148 (16.7)	68 (15.0)	37 (22.3)	0.095
Elementary school or higher	739 (83.3)	387 (85.0)	129 (77.7)	
Occupation				
Housewife	404 (45.6)	242 (53.2)	94 (56.6)	0.019
Farmer/trader	197 (22.2)	84 (18.4)	26 (15.7)	
Other	286 (32.2)	129 (28.4)	46 (27.7)	
Type of locality				
Rural	191 (21.5)	108 (23.7)	35 (21.1)	0.616
Urban	696 (78.5)	347 (76.3)	131 (78.9)	
Smoking status				
Never	516 (58.2)	261 (57.4)	96 (57.8)	0.698
Former	237 (26.7)	128 (28.1)	51 (30.7)	
Current	134 (15.1)	66 (14.5)	19 (11.5)	
Smoking index (pack-years)				
Never-smokers	516 (58.8)	261 (57.6)	96 (57.8)	0.518
<10 pack-years	306 (34.8)	151 (33.3)	57 (34.4)	
≥10 pack-years	56 (6.4)	41 (9.1)	13 (7.8)	
Alcohol consumption				
Never	269 (30.3)	132 (29.0)	37 (22.3)	0.067
Former	247 (27.9)	126 (27.7)	63 (37.9)	
Current	371 (41.8)	197 (43.3)	66 (39.8)	
Diabetes Mellitus				
Yes	285 (32.1)	162 (35.6)	54 (32.5)	0.433
No	602 (67.9)	293 (64.4)	112 (67.5)	
Hypoglycemic treatment*	97 (34.0)	56 (34.6)	17 (31.5)	0.916
Hypertension				
Yes	411 (46.3)	234 (51.4)	89 (53.6)	0.084
No	476 (53.7)	211 (48.6)	77 (46.4)	
Antihypertensive treatment*	127 (30.9)	91 (38.9)	33 (37.1)	0.100
Visual acuity in the better eye‡				
Normal	841 (94.8)	393 (86.4)	146 (88.0)	<0.001
Moderate	25 (2.8)	29 (6.4)	8 (4.8)	
Severe/blindness	21 (2.4)	33 (7.2)	12 (7.2)	
Visual function score (VF-14), median (IQR)	94.0 (78.5-100)	86.0 (62.0-96.0)	70.0 (41.5-91.0)	<0.0001
Wearing of glasses				
Yes	376 (42.4)	219 (48.1)	91 (54.8)	0.005
No	511 (57.6)	236 (51.9)	75 (45.2)	
Cataract surgery history				
Yes	40 (4.5)	21 (4.6)	12 (7.2)	0.314
No	847 (95.5)	434 (95.4)	154 (92.8)	

All values are presented as frequency and percentages except when noted
ANOVA or Kruskal-Wallis test for means and medians comparisons, respectively and Pearson chi-square test for proportions comparison were applied when appropriate

* Treatment for subjects with diabetes and hypertension, respectively
‡ Pinhole visual acuity in the better eye was defined as follows: normal, equal to or better than 20/60; moderate impairment, worse than 20/60 and equal to 20/200; severe impairment, worse than 20/200 and equal to 20/400; and blindness, worse than 20/400

Missing values for smoking index by DEQ-5: <6, 9; 6 to 11, 2; and ≥12, 0; for visual function score by DEQ-5: <6, 50; 6 to 11, 34; and ≥12, 9

Table II
Prevalence (%) of severity of dry eye symptoms among Mexican adults aged 50 or more years. Tlaxcala Study, 2013

Variables	Mild/moderate dry eye symptoms Prevalence (95%CI)	Severe dry eye symptoms Prevalence (95%CI)	Any severity of dry eye symptoms Prevalence (95%CI)
Sex			
Men*	26.6 (23.3-30.3)	8.4 (6.4-10.9)	35.0 (31.3-38.9)
Women	32.6 (29.6-35.7)	12.8 (10.8-15.1)	45.3 (42.1-48.6)
P value	0.014	0.008	<0.001
Smoking status*			
Never	27.4 (24.2-30.8)	9.2 (7.3-11.5)	36.5 (33.0-40.2)
Current	33.9 (27.4-41.1)	10.7 (6.9-16.3)	45.2 (38.1-52.5)
Former	34.0 (29.1-39.2)	14.5 (11.1-18.7)	48.6 (43.3-54.0)
P_{trend} value	0.060	0.249	0.013
Smoking index (pack-years)‡			
Never-smokers	27.1 (23.9-30.5)	9.1 (7.2-11.4)	36.1 (32.6-39.8)
<10 pack-years	32.7 (28.3-37.4)	13.2 (10.2-16.9)	46.3 (41.4-51.2)
≥10 pack-years	43.3 (33.6-53.6)	16.0 (9.4-25.9)	58.4 (48.5-67.7)
P_{trend} value	0.003	0.024	<0.001
Alcohol consumption*			
Never	28.3 (24.2-32.9)	7.1 (5.0-9.8)	35.1 (30.6-39.8)
Current	31.6 (28.1-35.4)	10.6 (8.4-13.3)	42.6 (38.7-46.5)
Former	29.7 (25.5-34.2)	15.1 (11.9-18.8)	45.0 (40.3-49.8)
P_{trend} value	0.256	0.126	0.040
Visual acuity in the better eye‡			
Normal	28.4 (26.1-30.8)	10.4 (8.9-12.1)	38.9 (36.4-41.6)
Moderate	46.5 (34.5-58.9)	12.5 (6.4-23.2)	59.4 (46.8-70.9)
Severe/blindness	50.2 (38.3-62.0)	18.1 (10.5-29.3)	68.6 (56.4-78.6)
P_{trend} value	<0.001	0.051	<0.001
Overall prevalence	30.1 (27.8-32.5)	10.8 (9.3-12.5)	41.1 (37.6-42.6)

Sex-adjusted prevalence and its 95%CI by smoking status, smoking index, alcohol consumption, and visual acuity in the better eye were calculated by logistic regression analysis
* chi-square test, ‡chi-square test for trend
Visual acuity in the better eye was defined as follows: normal, better than or equal to 20/60; moderate impairment, worse than 20/60 and equal to 20/200; severe impairment, worse than 20/200 and equal to 20/400; and blindness, worse than 20/400

Table III
Risk factors associated with severity of dry eye symptoms among Mexican adults aged 50 or more years. Tlaxcala Study, 2013

Variables	Mild/moderate dry eye symptoms‡		Severe dry eye symptoms‡		Any severity of dry eye symptoms§	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Sex (women)	2.04 (1.50-2.79)	<0.001	2.94 (1.87-4.63)	<0.001	2.26 (1.70-3.00)	<0.001
Smoking index <10 pack-years*	1.37 (1.00-1.88)	0.050	1.49 (0.96-2.31)	0.078	1.40 (1.05-1.87)	0.021
Smoking index ≥10 pack-years*	2.29 (1.39-3.78)	0.001	2.27 (1.09-4.76)	0.029	2.29 (1.44-3.63)	<0.001
Ever alcohol consumption	1.17 (0.89-1.55)	0.260	1.80 (1.18-2.75)	0.007	1.31 (1.02-1.70)	0.036
Antihypertensive treatment	1.35 (1.03-1.78)	0.028	1.11 (0.74-1.66)	0.600	1.29 (1.00-1.65)	0.047

* Never-smoker as reference category
‡ Multiple multinomial regression analysis, n=1470
§ Multiple logistic regression analysis, n=1470

dition, when the association between mild/moderate and severe dry eye symptoms and a smoking index of ≥10 pack-years was evaluated by multinomial logistic regression, the odds remained largely unchanged (OR=2.29, 95%CI 1.39-3.78 and OR=2.27, 95%CI 1.09-4.76, respectively).

In a multiple logistic regression analysis in individuals with diabetes, the likelihood of dry eye symptoms was higher in women (OR=2.28, 95%CI 1.30-3.97), in individuals with a smoking index of ≥10 pack-years (OR=2.75, 95%CI 1.12-6.73), and in those with longer diabetes duration (OR per 5 yrs. =1.14, 95%CI 1.03-1.25). No difference was observed in those taking antihypertensive medication (table IV). We were not able to estimate the association between smoking index categories and moderate and severe dry eye symptoms, because of the small number of participants with a high smoking index (≥10 pack-years).

Discussion

Dry eye disease is the most frequent ocular complaint among the aging population and represents an economic burden for healthcare systems.[7] The diagnosis of this condition is often complex, because signs and symptoms of dry eye disease do not always correlate. Despite the development of many questionnaires and diagnostic tools, there is no gold standard. Tear film osmolarity is recognized as a better marker of disease severity compared to other methods, such as Schirmer's test, tear breakup time, corneal staining, and meibomian gland dysfunction testing.[8] However, the measurement of tear osmolarity or the use of other biochemical or tear composition markers (MMP-9, interleukins) is expensive and impractical in both routine clinical practice and population-based studies.

Table IV

RISK FACTORS ASSOCIATED WITH ANY SEVERITY OF DRY EYE SYMPTOMS AMONG MEXICAN ADULTS AGED 50 OR MORE YEARS WITH DIABETES. TLAXCALA STUDY, 2013

Variables	Any severity of dry eye symptoms[‡]	
	OR (95%CI)	P value
Sex (women)	2.28 (1.30-3.97)	0.004
Smoking index <10 pack-years*	1.30 (0.74-2.28)	0.364
Smoking index ≥10 pack-years*	2.75 (1.12-6.73)	0.027
Diabetes duration (per 5 yrs.)	1.14 (1.03-1.25)	0.012
Antihypertensive treatment	1.15 (0.77-1.72)	0.505

* Never-smoker as reference category
‡ Multiple logistic regression analysis, n=407

The DEQ-5 is a valuable, inexpensive and simple instrument, useful for screening dry eye symptoms in large populations, as it accurately detects more severe forms of the disease.[5,9] In the present study, the sex-adjusted overall prevalence of dry eye symptoms was 41.1%. The prevalence of dry eye reported in several population-based studies shows a wide variability, which may be explained by differences in measuring methods as well as differences in individual and environmental risk factors between the studied populations.[9–15] Prevalence ranges between 6%, in a population of Melbourne, Australia, and 50%, among Mongolian people in China.[11,12] As for the Hispanic population, a population-based study found a prevalence of 18%, whereas hospital-based studies have reported a prevalence of 25% in Hispanic Americans, and 34% in Mexicans.[9,13,14] Compared to recent studies in Caucasian populations, studies in Asian populations showed a consistently higher prevalence, following adjustment for age and gender.[12,16,17] Given the high prevalence reported here, Hispanic ethnicity may be considered as a specific risk factor.

Several population-based studies have reported an increase in the prevalence of dry eye among older people.[3,10] Our study, however, did not find any differences by age, maybe because we included individuals aged more than 50 years, of whom 20% were older than 80 years, potentially reducing thereby the age effect. We found that women (45.3%) had both a higher prevalence of dry eye (35.0%) and a more severe condition of the disease than men. Likewise, many studies have reported that women have a higher likelihood of dry eye symptoms than men, particularly women receiving estrogen replacement therapy.[15] Also, women tend to report more intense, frequent, and longer-duration pain, which may predispose a higher report of pain related to dry eye.[18] Differences between the sexes could thus be explained by the interaction of biological dissimilarities together with psychological and sociocultural determinants.[1,19]

With regard to smoking, we found a significant trend in the prevalence of mild/moderate and severe dry eye according to the smoking index (pack-years) categories that we evaluated. The relation between smoking and dry eye has not yet been extensively researched. Some studies suggest that both passive and active exposure increase the risk of dry eye, and for people with this condition, smoking is a significant irritant that worsens their symptoms.[14] The effect of smoking-induced lipid peroxidation on the outer layer of the precorneal tear film is the most probable cause of tear film breakdown leading to dry eye symptoms; smoking reduces the blood flow and adds to the formation of clots within ocular capillaries.[20]

Alcohol consumption is another risk factor associated with the likelihood of more severe dry eye syndrome (in our study, OR=1.31, 95%CI 1.02-1.70). Not enough information on the effect of ethanol on tear film and ocular surface is available to suggest that alcohol contributes to the development of chronic ocular surface diseases.[21] Ethanol can act both as a hyperosmolar agent and an organic solvent for the lipid layer, which may also disturb cytokine production through various pathways, such as the thromboxane pathway, ultimately leading to subclinical or even overt inflammation of the ocular surface.[21]

On the other hand, dry eye was more frequent in participants with visual impairment who did not wear glasses compared to those who wore them. A study suggest that wearing glasses significantly increases the humidity of both normal and dry eye by 17% to 14%, respectively.[22] Also, environmental factors such as air pollution and atmospheric pressure play a significant role in both the prevalence and the pathogenesis of the dry eye syndrome.[23] However, air pollution was not of concern in the sample area. Previous studies have clearly demonstrated that people living in heavily urbanized areas have a higher likelihood of dry eye syndrome than those who live in rural areas.[23] The state of Tlaxcala is located in East-Central Mexico. It is the smallest and one of the most densely populated states of the country; 78% of the population lives in urban areas and 22% in rural zones. It is estimated that its capital city,Tlaxcala, is one of the ten most polluted cities in the country.

Our data show an increased likelihood of dry eye symptoms linked to duration of diabetes (14% for severe dry eye symptoms per each 5 years) and to individuals with ≥10 pack-years of smoking. Dry eye symptoms in people with diabetes are known to occur because diabetic neuropathy results in reduced corneal sensitivity, which decreases both the reflex-induced lacrimal secretion and the blink rate while increasing evaporative tear loss.[24] In general, individuals with longer duration of diabetes may report fewer dry eye symptoms, even with increased tear osmolarity.[25]

Among the limitations of our study was the type of design, which did not allow us to determine a causal association between the evaluated risk factors and dry eye symptoms. Another limitation relates to self-report of dry eye symptoms; nevertheless, several studies have underscored the use of self-report as a screening tool applicable to the general population that reflects the magnitude of dry eye symptoms and therefore the importance of this condition as a public health concern. For diabetic subjects, we were not able to estimate the effect of metabolic control on dry eye symptoms due to the lack of information on HbA1c. Finally, we did not include information about dry eye biomarkers and environmental exposure, which may have caused some residual confounding.

In short, dry eye symptoms were common among adults aged 50 or more years in a specific Mexican population and are related to certain risk factors, such as smoking and alcohol consumption, which are potentially modifiable with appropriate public health interventions. Further studies will help determine the variability in the prevalence of dry eye symptoms in Mexican population as well as assess the impact of this condition on the quality of vision and, consequently, of life.

References

1. Lemp MA, Baudouin C, Baum J, Dogru M, Foulks GN, Kinoshita S,*et al.* The definition and classification of dry eye disease: report of the definition and classification subcommittee of the International Dry Eye WorkShop (2007). Ocul Surf. 2007;5(2):75-92.https://doi.org/10.1016/S1542-0124(12)70081-2
2. Lin PY, Cheng CY, Hsu WM, Tsai SY, Lin MW, Liu JH, Chou P. Association between symptoms and signs of dry eye among an elderly Chinese population in Taiwan: The Shihpai Eye Study. Investig Ophthalmol Vis Sci. 2005;46(5):1593-8.https://doi.org/10.1167/iovs.04-0864
3. Ottobelli L, Fogagnolo P, Guerini M, Rossetti L. Age-related changes of the ocular surface: A hospital setting-based retrospective study. J Ophthalmol. 2014;(2014):532378. https://doi.org/10.1155/2014/532378
4. Gulati A, Sullivan R, Buring JE, Sullivan DA, Dana R, Schaumberg DA. Validation and repeatability of a short questionnaire for dry eye syndrome. Am J Ophthalmol. 2006;142(1):125-31. https://doi.org/10.1016/j.ajo.2006.02.038
5. Chalmers RL, Begley CG, Caffery B. Validation of the 5-Item Dry Eye Questionnaire (DEQ-5): Discrimination across self-assessed severity and

aqueous tear deficient dry eye diagnoses. Contact Lens Anterior Eye. 2010;33(2):55-60. https://doi.org/10.1016/j.clae.2009.12.010

6. Hernández-Quintela E, Martínez J, Santacruz-Valdés C, Beltrán F, Ramírez-Assad C, Mora-Juárez E, et al. Transcultural validation of the 5-Item Dry Eye Questionnaire (DEQ-5) for Mexican population. Invest Ophthalmol Vis Sci. 2013;54(15):4362 [cited May 5, 2017]. Available from: http://iovs.arvojournals.org/article.aspx?articleid=2149216

7. McDonald M, Patel DA, Keith MS, Snedecor SJ. Economic and humanistic burden of dry eye disease in Europe, North America, and Asia: A systematic literature review. Ocul Surf. 2016;14(2):144-67. https://doi.org/10.1016/j.jtos.2015.11.002

8. Sullivan BD, Whitmer D, Nichols KK, Tomlinson A, Foulks GN, Geerling G, et al. An objective approach to dry eye disease severity. Invest Ophthalmol Vis Sci. 2010;51(12):6125-30. https://doi.org/10.1167/iovs.10-5390

9. Martinez JD, Galor A, Ramos-Betancourt N, Lisker-Cervantes A, Beltran F, Ozorno-Zarate J, et al. Frequency and risk factors associated with dry eye in patients attending a tertiary care ophthalmology center in Mexico City. Clin Ophthalmol. 2016;10:1335-42. https://doi.org/10.2147/OPTH.S106451

10. Liu NN, Liu L, Li J, Sun YZ. Prevalence of and risk factors for dry eye symptom in mainland china: a systematic review and meta-analysis. J Ophthalmol. 2014;2014:748654. https://doi.org/10.1155/2014/748654

11. McCarty CA, Bansal AK, Livingston PM, Stanislavsky YL, Taylor HR. The epidemiology of dry eye in Melbourne, Australia. Ophthalmology. 1998;105(6):1114-9. https://doi.org/10.1016/S0161-6420(98)96016-X

12. Guo B, Lu P, Chen X, Zhang W, Chen R. Prevalence of dry eye disease in Mongolians at high altitude in China: the Henan eye study. Ophthalmic Epidemiol. 2010;17(4):234-41. https://doi.org/10.3109/09286586.2010.498659

13. Viso E, Rodriguez-Ares MT, Gude F. Prevalence of and associated factors for dry eye in a Spanish adult population (the Salnes Eye Study). Ophthalmic Epidemiol. 2009;16(1):15-21. https://doi.org/10.1080/09286580802228509

14. Hom M, De Land P. Prevalence and severity of symptomatic dry eyes in Hispanics. Optom Vis Sci. 2005;82(3):206-8. https://doi.org/10.1097/01.OPX.0000156310.45736.FA

15. Schaumberg DA, Sullivan DA, Buring JE, Dana MR. Prevalence of dry eye syndrome among US women. Am J Ophthalmol. 2003;136(2):318-26. https://doi.org/10.1016/S0002-9394(03)00218-6

16. Paulsen AJ, Cruickshanks KJ, Fischer ME, Huang GH, Klein BE, Klein R, Dalton D. Dry eye in the beaver dam offspring study: prevalence, risk factors, and health-related quality of life. Am J Ophthalmol. 2014;157(4):799-806. https://doi.org/10.1016/j.ajo.2013.12.023

17. Jie Y, Xu L, Wu YY, Jonas J. Prevalence of dry eye among adult Chinese in the Beijing Eye Study. Eye. 2009;23(3):688-93. https://doi.org/10.1038/sj.eye.6703101

18. Popescu A, Leresche L, Truelove EL, Drangsholt MT. Gender differences in pain modulation by diffuse noxious inhibitory controls: A systematic review. Pain. 2010;150(2):309-18. https://doi.org/10.1016/j.pain.2010.05.013

19. Le Q, Zhou X, Ge L, Wu L, Hong J, Xu J. Impact of dry eye syndrome on vision-related quality of life in a non-clinic-based general population. BMC Ophthalmol. 2012;12:22. https://doi.org/10.1186/1471-2415-12-22

20. Rummenie VT, Matsumoto Y, Dogru M, Wang Y, Hu Y, Ward SK, et al. Tear cytokine and ocular surface alterations following brief passive cigarette smoke exposure. Cytokine. 2008;43(2):200-8. https://doi.org/10.1016/j.cyto.2008.05.011

21. Kim JH, Kim JH, Nam WH, Yi K, Choi DG, Hyon JY, et al. Oral alcohol administration disturbs tear film and ocular surface. Ophthalmology. 2012;119(5):965-71. https://doi.org/10.1016/j.ophtha.2011.11.015

22. Tsubota K. The effect of wearing spectacles on the humidity of the eye. Am J Ophthalmol. 1989;108(1):92-3. https://doi.org/10.1016/S0002-9394(14)73274-X

23. Galor A, Kumar N, Feuer W, Lee D. Environmental factors affect the risk of dry eye syndrome in a United States veteran population. Ophthalmology. 2014;121(4):972-3. https://doi.org/10.1016/j.ophtha.2013.11.036

24. Zhang X, Zhao L, Deng S, Sun X, Wang N. Dry eye syndrome in patients with Diabetes Mellitus: Prevalence, etiology, and clinical characteristics. J Ophthalmol. 2016;2016:8201053. https://doi.org/10.1155/2016/8201053

25. Kaiserman I, Kaiserman N, Nakar S, Vinker S. Dry eye in diabetic patients. Am J Ophthalmol. 2005;139(3):498-503. https://doi.org/10.1016/j.ajo.2004.10.022