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Prevalence and risk factors of dry eye symptoms in Jazan Province, Saudi Arabia: a cross-sectional study

Running title: Prevalence of symptomatic dry eye and its risk factors

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Abstract:

Background: Dry eye syndrome (DES) is a condition of tear film and ocular surface disruption. Symptomatic DES, one of the most common ocular diseases, reduces quality of life.

Objectives: This study aimed to evaluate the prevalence of Dry eye symptoms and its possible risk factors in the Jazan region of Saudi Arabia.

Design: This is an observational, cross-sectional study conducted between October 2018 and May 2023.

Methods: This study was conducted among 1061 participants using an online survey that included questions regarding sociodemographic characteristics, dry eye symptoms, possible factors related to dry eye, and chronic comorbidities. Dry eye symptoms was evaluated using the Ocular Surface Disease Index (OSDI).

Results: The overall prevalence of Dry eye symptoms was 59.9%, with 19.7% of the respondents having mild, 14.0% moderate, and 26.2% severe dry eye symptoms. A statistically significant difference in dry eye symptoms prevalence was observed between males and females ($X^2 = 54.167$; $p = 0.000$), with females (68.4%) being more commonly affected than males (52.2%). Female participants were 1.78 times more likely to develop DES (odds ratio [OR] = 1.78; 95% confidence interval [Cl]:1.37–2.31).

Conclusion: The prevalence of dry eye symptoms in the general population of Jazan, Saudi Arabia, was very high.

keywords: dry eye; prevalence; saudi arabia; ocular surface disease index.

Introduction:

Dry eye syndrome (DES) is a condition of tear film and ocular surface disruption, caused by multiple factors. It presents eye discomfort, ocular disturbance, and tear film instability. It occurs because of excessive tear evaporation or reduced tear production, which may eventually lead to ocular surface damage [1,2]. Although it rarely causes vision loss, symptomatic DES inevitably reduces quality of life [3-5].

DES is one of the most common ocular diseases and a major cause of visits to ophthalmological clinics [6,7]. Symptoms range from mild temporary irritation to severe persistent dryness, itching, burning sensation, pain, visual disturbance, and ocular fatigue [3,8]. Approximately 7–10 million Americans require artificial tears, with an estimated annual cost of over $100 million [9]. However, the annual costs for DES treatment have been found surprisingly very low in other countries, such as France, Italy, Germany, and Spain, possibly due to the increased self-treatment with over-the-counter medications [10]. Studies have reported diverse estimates of DES prevalence, ranging from 7.8% to 70.2% [3,11-13]. This variation can be attributed to the different case definitions used, different populations surveyed, or different methodologies [3,6,14,15]. For example, the prevalence was 15.3% in the Blue Mountain Study [12], 14.5% in the Beaver Dam Study [13], and 33.7% in the Shiphai

Eye Study [3]. Studies involving tear function tests to determine dry eye have generally reported lower DES rates. Tests used in these studies include Schirmer's test, fluorescein stain, tear break-up time, and rose bengal stain [16;17]. Only a few studies have reported the subtype-based prevalence of DES. The most common subtype in these studies was lipid anomaly, followed by aqueous tear deficiency, and mucin layer deficiency [11,18].

Several environmental and epidemiological risk factors for dry eye have been identified in the literature. Risk factors include female sex [13,17,19,20], advanced age [13,17,21], arthritis, gout, thyroid disease, diabetes, caffeine use, cigarette smoking [13,22], contact lens wear [23], and pterygium [3]. In the Jazan region, as in most Saudi regions, a hot desert climate can be a potential risk factor for dry eye. In fact, a study from the Alahsa region reported a high DES prevalence of 32.1% [6]. A hot climate and consequent increased use of air-conditioning among Saudis are known to increase the odds of developing dry eye [24,25].Therefore, this study aim was to evaluate dry eye symptoms prevalence and identify possible risk factors in the Jazan region of Saudi Arabia.

The study will evaluate dry eye symptoms using the Ocular Surface Disease Index (OSDI). The OSDI stands as a valuable and validated diagnostic scale that offers distinct advantages in evaluating DES prevalence. By incorporating the OSDI, researchers can gather comprehensive data on the impact of DES symptoms on individuals' quality of life.

Compared to other diagnostic scales, the OSDI provides a more comprehensive assessment of DES by considering the severity of symptoms, functional limitations, and their influence on daily activities. This multifaceted approach allows for a more accurate estimation of the overall burden of DES on individuals. Furthermore, the subjective nature of dry eye symptoms is well-captured by the OSDI through self-reported responses. By allowing individuals to express the frequency and intensity of their symptoms, the OSDI provides valuable insights into their lived experiences. Given the advantages of the OSDI, its utilization in estimating DES prevalence is crucial for a more holistic understanding of the condition. By incorporating the OSDI in research studies, researchers can obtain a comprehensive assessment of the impact of DES on individuals' lives, enhancing our understanding of the prevalence and severity of the disease. Therefore, this study aims to evaluate the prevalence of dry eye symptoms and identify potential risk factors in the Jazan region of Saudi Arabia, utilizing the OSDI as a valuable tool for assessing the impact of DES on individuals' quality of life.

Methods:

Study population and design:

An observational cross-sectional study was conducted between October 2018 and May 2023 to evaluate dry eye symptoms prevalence and identify possible risk factors in Jazan Province, Saudi Arabia.

The inclusion-exclusion criteria of this study were as follows:
Inclusion criteria

1. Male and female participants.
2. Saudi and non-Saudi individuals.
3. Aged 18 years or older.
4. Any individual in Jizan in the last 6 months.

Exclusion criteria

1. Participants below 18 years of age.
2. Any person from Jazan but stayed there for less than 6 months in the last 6 months.

These criteria were established to ensure that the study included a diverse range of participants within the targeted population while maintaining consistency and relevance to the objectives of evaluating the prevalence of dry eye symptoms and identifying potential risk factors in Jazan Province, Saudi Arabia.

Data collection:

An online link to the survey was sent to the participants through various social media websites and applications such as WhatsApp through Google Forms. The author translated the survey from English to simple Arabic using back translation. The authors translated the ODSI questionnaire with revalidating the Arabic version of the tool. Online survey consists of four main parts. The first part ensured participants' anonymity and stated the aims of the study. After providing their informed consent at the beginning of the survey as (Are you a resident of the Jazan region, and agree to participate in this survey) the participants were directed to the next part. The second part included demographic information such as age, sex, residence, and employment. The third part assessed dry eye symptoms prevalence using the Ocular Surface Disease Index (OSDI), a valid, reliable, and commonly used tool for detecting dry eye symptoms. It consists of 12 questions rated from 0 to 4, with a total score of 100 calculated using the following equation:

$$\text{OSDI} = \frac{(\textit{sum of scores}) \times 25}{\textit{number of questions answered}}$$

The OSDI scores were then categorized as normal (0–12), mild (13–22), moderate (23–32), and severe (33–100) ocular surface (12). The total OSDI was then divided by 100 to change the score from 0–100 to 0–1 to solve the possible problem of skewed distribution (26).

Finally, the fourth part asked about the potential risk factors for DES. The Arabic survey was pretested on a random sample of 10 participants (who were not included in the final analysis) for understandability and clarity.

As for the sampling method relevant to the study, a combination of Convenience sampling and random sampling was considered. Convenience sampling was employed as the author recruited participants through an online survey distributed via various social media websites and applications. This method involved selecting individuals who were readily available and accessible, specifically those who had access to the online survey through social media platforms.

Statistical Analysis:

Data analysis was performed using Statistical Package for the

Social Sciences (SPSS) version 21 (SPSS Inc., Chicago, IL). Qualitative and quantitative variables were measured as frequencies, mean, median, standard deviation (SD), and others. A t-test was performed to compare the different age groups. The level of significance was set at $p<0.05$.

Results:

Variables	*n* (%)
Gender	
Male	552 (52.0)
Female	509 (48.0)
Age (in years)	
≤20	157 (14.8)
21–40	769 (72.5)
>40	135 (12.7)
Nationality	
Saudi	1051 (99.1)
None-Saudi	10 (0.9)
Educational level	
Elementary school	9 (0.8)
Middle school	29 (2.7)
Secondary school	194 (18.3)
Bachelor or Diploma degree	783 (73.8)
Post graduate	46 (4.3)
Marital status	
Single	471 (44.4)
Married	562 (53.0)
Divorced/widow	28 (2.6)
Job status	
Student	338 (31.9)
Working	674 (63.5)
Retired	23 (2.2)
Self-employed	26 (2.5)
Monthly income (Saudi Riyals)	
< 5000	491 (46.3)
5000–1000	265 (25.0)
> 10000	305 (28.7)

Table 1: Sociodemographic characteristics of the study sample (*N*=1061)

A total of 1061 participants (552 males and 509 females) participated in this study, with a response rate of 95.4%. The average age (±SD) of respondents was 29.5 (±9.4) years, and the majority (72.5%) were in a 21–40 age group. The vast majority (99.1%) of the respondents were Saudis, and most of them (73.8%) had a bachelor's or diploma degree. Married respondents constituted 53.0% of the sample. The majority (63.5%) had a job; 46.3% had a monthly income of >5000 Saudi Riyals (Table 1).

Variables	*n* (%)
Smoking	166 (15.6)
Computer use (in hours)	
< 3	783 (73.8)
3–6	177 (16.7)
>6	101 (9.5)
Mobile phone use (in hours)	
< 3	138 (13.0)
3–6	400 (37.7)
>6	523 (49.3)
Refractive surgery	114 (10.7)
Role of Environmental Factors in Dry Eye Syndrome (DES)	
Hot and dry weather	420 (39.6)
Air pollution	285 (26.9)
Dust and sand particles in the air	321 (30.2)
Exposure to air conditioning or heaters	460 (43.3)
Lack of humidity	380 (35.8)
All of the above	150 (14.1)
None of the above	90 (8.5)
* Including many conditions with very low frequencies, such as sebaceous cyst.	

Table 2: Behavioral and health background characteristics of the study sample (*N*=1061)

Table 2 describes the respondents' behavioral and health background details. Of 1061 respondents, 15.6% were smokers; 73.8% used computers for >3 hours/day, and 49.3% used mobile phones for >6 hours/day. Regarding the health background, 10.7% had a history of refractive surgery.

Variable	Severity of DES (OSDI scores)				*p* value
	Normal (0–12)	Mild (13–22)	Moderate (23–32)	Severe (33–100)	
Sex *n* (%)					
Male	264 (47.8)	123 (22.3)	65 (11.8)	100 (18.1)	0.000
Female	161 (31.6)	86 (16.9)	84 (16.5)	178 (35.0)	
Total *N* (%)	425 (40.1)	209 (19.7)	149 (14.0)	278 (26.2)	1061 (100.0)
Age (in years)					
≤20	58 (36.9)	30 (19.1)	26 (16.6)	43 (27.4)	0.066
21–40	323 (42.0)	154 (20.0)	107 (13.9)	185 (24.1)	
>40	44 (32.6)	25 (18.5)	16 (11.9)	50 (37.0)	
Total *N* (%)	425 (40.1)	209 (19.7)	149 (14.0)	278 (26.2)	1061 (100.0)
DES: dry eye syndrome; OSDI: Ocular Surface Disease Index.					

Table 3: Prevalence of mild, moderate, and severe DES distributed by sex and age (n=1061)

As shown in Table 3, the overall prevalence of DES was 59.9%, with 19.7% of the respondents having mild, 14.0% moderate, and 26.2% severe DES. There was a statistically significant difference in DES prevalence between males and females (X^2=54.167; p= 0.000), with females (68.4%) being more commonly affected than males (52.2%).

Regarding the age distribution of dry eye symptoms prevalence, respondents aged >40 years (67.4%) were affected more frequently, followed by those aged ≤20 years (63.1%). No statistically significant difference in DES prevalence was observed between different age groups (X^2=11.812; p= 0.066).

Variable	Unadjusted			Adjusted		
	OR	95%CI	p value	OR	95% CI	p value
Sex						
Male	1			1		
Female	.198	1.54–2.55	0.000	1.78	1.37–2.31	0.000
Age (in years)						
≤20	1					
21–40	0.81	0.57–1.15	0.24			
>40	1.21	0.75–1.97	0.44			
Computer use (in hours)						
< 3	1					
3–6	.103	0.74–1.44	0.87			
>6	1.03	0.67–1.57	0.90			
Mobile phone use (in hours)						
< 3	1					
3-6	0.79	0.53–1.17	0.23			
>6	0.92	0.63–1.63	0.69			
Refractive surgery						
No	1			1		
Yes	2.22	1.42–3.46	0.000	1.53	0.95–2.47	0.08
Smoking						
No	1					
Yes	1.14	0.82–1.60	0.44			

DES: dry eye syndrome; OR: odds ratio; CI: Confidence interval.

Table 4: Evaluation of risk factors for DES by bivariate and multivariate logistic regression analyses

The potential risk factors for dry eye symptoms were examined separately using bivariate analysis, as shown in Table 4. Female sex (odds ratio [OR] = 0 .198; 95% confidence interval [Cl]: 1.54–2.55), and history of refractive surgery (OR = 2.22; 95%Cl: 1.42–3.46).

Discussion:

This study aimed to estimate the prevalence of DES in the general population of Jazan, Saudi Arabia. As expected, we found a high overall DES prevalence of 59.9% with 19.7% mild, 14.0% moderate, and 26.2% severe symptoms. Comparisons between studies evaluating DES prevalence are difficult due to differences in the questionnaires and clinical tests used, the definition of DES, and the population studied [6]. Overall, our findings are comparable to those of previous studies that used the same questionnaire. For mild and moderate DES, our values were similar to those found by Garza-León et al. among university students in Mexico (19.9% mild and 14.8% moderate DES) (26). The prevalence of severe DES in our sample was higher than that reported by Zhang et al. (23.7%) [27]. Possible explanations include a hot climate and the consequent increased use of air conditioning in homes and cars by Saudis (6). Both hot desert climates and air conditioning are known to increase the odds of developing dry eye [24,25].

Consistent with other studies of DES [28-30], the analysis revealed a higher prevalence of severe DES among females than among males (OR = 0 .198; 95%Cl: 1.54–2.55). This risk factor was significant even after controlling for history of refractive surgery.

Respondents who reported having had refractive surgery had a significantly higher OSDI than those without refractive surgery. This risk factor did not persist after controlling for sex. Dry eye is the most common complication of refractive surgery [31-33]. However, this association is time-dependent and usually lasts for >6 months [32]. The timing of surgery was not assessed, which is a limitation of this study.

Although other studies [6,13,26] have linked smoking to the development of DES, we found no significant difference in DES prevalence between smokers and non-smokers. This may be due to the small number of smokers in our sample (n = 166) and the overall high prevalence of DES. Finally, the analysis showed that the OSDI did not significantly differ according to the duration of computer and mobile phone use. Similar results have been reported in other studies [26,34].

The association between the prevalence of Dry Eye Syndrome (DES) and factors such as computer use, mobile phones, and eye surgery is an important area of investigation. While this study did not find a significant association between DES prevalence and the duration of computer and mobile phone use, it is crucial to acknowledge that the findings may differ from previous studies that reported a strong association. The absence of a significant association in this study could be attributed to various factors, including differences in study populations, methodologies, and sample sizes. It is possible that the unique characteristics of the Jazan population, such as lifestyle habits, environmental factors, or cultural practices, may contribute to the differing results. Additionally, variations in the definition and assessment of DES, as well as differences in the tools and questionnaires used, can impact the observed associations. To address this discrepancy, further investigation and a robust comparison with previous published studies are warranted. A comprehensive analysis that considers the specific characteristics of the study population, methodological differences, and potential confounding factors would be valuable in understanding the reasons behind the difference in findings. By conducting such comparisons, the

authors can gain insights into the factors contributing to the contrasting results and provide a more comprehensive explanation for the observed associations or lack thereof.

The role of environmental factors in Dry Eye Syndrome (DES) was explored in this study. Participants were asked to indicate the presence or absence of specific environmental factors related to DES. The results showed that a substantial proportion of participants reported experiencing certain environmental factors that could contribute to DES. Hot and dry weather was reported by 39.6% of participants, highlighting the potential impact of climatic conditions on DES. Air pollution was another significant factor, with 26.9% of participants indicating its presence. Dust and sand particles in the air were reported by 30.2% of participants, further emphasizing the potential irritants in the environment. Exposure to air conditioning or heaters, which can affect the humidity levels, was reported by 43.3% of participants. This finding suggests that artificial heating or cooling systems may contribute to DES symptoms. Lack of humidity, another environmental factor that can influence tear evaporation, was reported by 35.8% of participants. Interestingly, a notable proportion of participants (14.1%) reported experiencing all of the aforementioned environmental factors. This indicates a potential cumulative effect of multiple environmental factors on the development and severity of DES. On the other hand, a small percentage (8.5%) reported none of the environmental factors, suggesting that other factors or individual differences might contribute to DES symptoms in these cases.

This is the first study to evaluate dry eye symptoms prevalence and risk factors in a large population-based sample in the Jazan region and among a few populations in Saudi Arabia. Some limitations are noteworthy. Most importantly, this study used only a self-reported questionnaire for dry eye symptoms. As reported by some studies, the correlation between prevalence rates measured by questionnaires and objective clinical tests is poor [35,36], and combining both methods is recommended to confirm the diagnosis [2]. In addition, the Arabic version of the OSDI has been validated. We have not evaluated the time required for refractive surgery. Therefore, we could not determine a correlation between the timing of refractive surgery and the development of DES. Other environmental factors, such as contact lens wear [26,28], psychological factors, such as stress [37] and autoimmune diseases [37-39], have not been studied.

Conclusion:

In conclusion, this study provides valuable insights into the prevalence and risk factors associated with dry eye symptoms in the general population of Jazan, Saudi Arabia. The overall prevalence of dry eye symptoms was found to be very high, with a significant proportion of individuals experiencing mild, moderate, and severe symptoms. The study also revealed a higher prevalence of severe dry eye symptoms among females compared to males, which remained significant even after controlling for confounding factors. The findings from the survey strongly indicated that a substantial number of participants consistently reported experiencing symptoms indicative of eye dryness. These symptoms, such as redness and irritation, were prevalent among a significant portion of the surveyed population. Additionally, a considerable proportion of respondents reported feeling a recurring sensation of dryness or grittiness in their eye's multiple times per week. However, no significant association was observed between dry eye symptoms and factors such as the duration of computer and mobile phone use or smoking.

It is important to note that the findings of this study may differ from previous research due to variations in study populations, methodologies, and definitions of dry eye syndrome. Further investigations are warranted to conduct robust comparisons with previous studies and explore the underlying reasons for the observed differences. Additionally, incorporating objective clinical tests alongside self-reported questionnaires would enhance the accuracy of future studies. Evaluating the timing of refractive surgery and investigating other environmental and psychological factors associated with dry eye symptoms could provide a more comprehensive understanding of this condition.
Overall, this study contributes to the existing knowledge on dry eye symptoms prevalence and risk factors in the Jazan region. The findings emphasize the need for further research and tailored interventions to address this significant ocular health concern and improve the quality of life for individuals affected by dry eye syndrome in Saudi Arabia.

Declarations:

Ethics approval and consent to participate:

All participants were asked for their willingness to participate in the study, and the purpose of the study was thoroughly explained to them at the beginning of the interviews. Questions regarding the names and contact details were not included. Ethical approval (reference no.: 1842) was obtained from the Scientific Research Ethics Committee of Jazan Hospital, Ministry of Health, KSA on 17 January 2018.

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Competing interests:

The Authors declare that there is no conflict of interest.

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