

# Prevalence and Risk Factors for Symptomatic Dry Eye Disease Based on McMonnies Questionnaire Among Medical Students, Saudi Arabia; a Cross-Sectional Study

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**Purpose:** Dry eye disease (DED) is a common ocular problem that worsens patients' quality of life. This study aimed to assess DED prevalence and risk factors among medical students at the University of Tabuk.

**Patients and Methods:** This is an analytical, cross-sectional, survey-based study. An online questionnaire was distributed by email to all medical students at the University of Tabuk. A self-administered McMonnies questionnaire was used in the assessment.

**Results:** We included 247 medical students who completed the questionnaire. Most participants were females (71.3%) and were <25 years old (85.8%). DED prevalence rate was 18.2% (95% CI=13.61% to 23.61%). Furthermore, DED was found to be significantly associated with the presence of irritation of eyes when waking up from sleep (OR=19.315), sleeping with partially opened eyes (OR=19.105), redness and irritation of the eyes when swimming in chlorinated fresh water (OR=7.863), and having prescription eyedrops or other dry eye treatments (OR=3.083).

**Conclusion:** Our study at the University of Tabuk found that 18.2% of medical students had dry eye disease and identified the associated risk factors. Early diagnosis and treatment are crucial to prevent complications due to the high prevalence of DED.

**Keywords:** eye dryness, survey, DED, observational study

## Introduction

Dry eye disease (DED) is a disorder of tears and the ocular surface that leads to visual disturbance, symptoms of discomfort, and hyperosmolarity of tear film that results in inflammation and damage to the ocular surface.<sup>1,2</sup> Etiologically, DED is a multifactorial disorder characterized by excessive tear evaporation, decreased tear production, and poor tear quality.<sup>3</sup>

The affected individuals suffer various symptoms, such as redness, itchiness, burning, irritation, photophobia, dryness, foreign body sensation, and visual disturbances. There is no severe visual impairment or blindness, though DED interferes with daily activities and impacts the vision-related quality of life. In severe cases, there is an increased risk of ocular infection, surface damage, or corneal ulceration.<sup>4</sup> A recent study documented the negative impact of DED on the productivity of Saudi workers, especially among those having a severe degree of DED.<sup>5</sup>

Dry eye disease is one of the most prevalent ocular diseases worldwide and is a frequently encountered ocular problem in daily ophthalmological practice. The reported prevalence of DED varies from 5% to 50% worldwide.<sup>6</sup> In

Saudi Arabia, according to a recent study, the prevalence of DED is 17.5%.<sup>7</sup> Additionally, the new lifestyles with increased use of electronic/media devices increased the risk of DED in the younger population.<sup>8</sup>

Many risk factors for DED have been identified, including older age, female gender, and use of estrogen hormone.<sup>9</sup> Furthermore, some studies have found an association between dry eyes and smoking, wearing contact lenses, and daily screen time.<sup>10,11</sup> Lifestyle, medical and environmental factors, such as low humidity and Asian race, have also been suggested as risk factors for DED.<sup>12,13</sup> A study discussed using a smartphone application “DryEyeRhythm” and revealed that several risk factors, including female gender, using contact lenses, smoking, prolonged periods in front of screens, having collagen disease, hay fever, and depression, can all lead to severe DED-type symptoms.<sup>14</sup>

Several questionnaires have been created to evaluate a patient’s personal perception of dry eye symptoms. This is done to generate more reliable and consistent data, which can help improve the management and treatment of patients suffering from dry eye disease. Some of these questionnaires are the National Eye Institute Visual Function Questionnaire-25, Ocular Surface Disease Index, Standard Patient Evaluation of Eye Dryness Questionnaire, Canadian Dry Eye Epidemiology Study, McMonnies questionnaire, and many more.<sup>15–18</sup>

It is essential to determine the risk factors associated with increased DED prevalence for possible interventions to control the condition. Therefore, this study aimed to assess the prevalence and risk factors of dry eye disease among medical students at the University of Tabuk using the McMonnies questionnaire, one of the earliest and most widely used questionnaires as a screening instrument for DED with sensitivity reportedly varying between 87% and 98% and specificity between 87% and 97%.<sup>19–21</sup>

## Materials and Methods

### Ethical Considerations

The study protocol was approved by the Faculty of Medicine Ethics Committee, University of Tabuk, Tabuk, Saudi Arabia. Approval number (UT-246-84-2023). Our study complies with the Declaration of Helsinki.

The electronic survey starts with information about the study and “written” consent of participation. First, participants were informed about the study objectives, methodology, risks, and benefits. Participants who agreed to complete the questionnaire implied they decided to participate in the study. The study conserved participants’ privacy. Investigators were responsible for keeping the security of the data. Each subject was given a unique identifier code.

### Study Design and Setting

This cross-sectional survey study was conducted at the Faculty of Medicine, University of Tabuk, Saudi Arabia, in January 2023. After obtaining the students’ emails list from the Faculty of Medicine administration, an email was sent by the researchers to all medical students and interns showing the study’s aims and objectives. If they agree to participate, they can use the provided link to fill out the electronic self-administered survey.

### Study Population

The duration of medical schools in Saudi Arabia is six years, with an additional internship year that must be completed in order for the students to be considered graduates and obtain their degrees.

The inclusion criteria were to enroll medical students of all six years and the interns at the University of Tabuk aged 18 years and older, both genders, who received the invitation email and replied with an agreement to participate in this study and complete the questionnaire. We excluded the medical students and interns who did not consent to participate in the study. To minimize selection bias, we attempted to include medical students of both genders in all academic grades (from the first to the sixth years, and house officers “interns”).

### Sample Size

The sample size was calculated using “The Raosoft program”. With a 5% margin of error, 95% confidence level, and 550 students and interns as the total population, the required sample size was 227, to be recruited randomly from all male and female medical students at the University of Tabuk.

## Data Collection Tool

We collected data from medical students using the validated self-administered McMonnies questionnaire, which was adopted according to our study objectives.<sup>19–23</sup> It included information regarding socio-demographics (age, gender, and grade), behavior (contact lens wearing, daily hours in front of screens), medical history (symptoms “such as soreness, scratchiness, dryness, grittiness, burning” and treatment of dry eye, the effect of different irritants on the eye “cigarette smoke, smog, air conditioning, central heating, chlorinated fresh water, drinking alcohol” and medications “antihistamines, diuretics, tranquilizers, oral contraceptives, antihypertensives”, dryness of other mucus membranes “nose, mouth, throat, chest, or vagina”, relation to sleep and other medical disorders “arthritis and thyroid diseases”), history of allergy or previous refractive surgery, and family history of eye dryness or use of eye drops or other treatment for dry eye.

## Statistical Analysis

The data were imported into SPSS Ver 22 (IBM Corp. USA). Categorical data were expressed as numbers and percentages. Subjects considered in our study as “Dry eye disease patients” are those who stated having at least one of the five self-reported symptoms (soreness, scratchiness, dryness, grittiness, burning) reported as often or constantly. Subjects considered as “having no DED” were those with no reported symptoms, or they reported symptoms as “sometimes present”. Univariate analysis was performed using Chi-Square or Fisher’s Exact tests as appropriate. Variables that showed significant association with DED in the univariate analysis were entered in a multivariate logistic regression analysis to show the significant risk factors for DED.  $P < 0.05$  was considered statistically significant.

## Results

### Demography

After emailing all medical students and interns at the University of Tabuk (550 students), 247 replied to the sent email that they agreed to participate in the study, and the remaining (303 students) either did not respond to the invitation email or did not agree to participate were all excluded from the study. So, our study included 247 medical students and house officers from the University of Tabuk, Saudi Arabia, who completed a self-administered questionnaire for dry eye disease. The highest percentage of the participants were females ( $n=176$ , 71.3%) (Table 1).

**Table 1** Demographic Characteristics of the Study Participants (N=247)

Variables		N=247	%
Age (years)	<25	212	85.8
	≥25	35	14.2
Sex	Female	176	71.3
	Male	71	28.7
Grade	First	37	15.0
	Second	11	4.5
	Third	61	24.8
	Fourth	42	17.1
	Fifth	27	11.0
	Sixth	34	13.8
	House officer	34	13.8

## Prevalence of DED Among the Medical Students at the University of Tabuk

The prevalence of DED among the medical students at the University of Tabuk was 18.2%, with a 95% CI of 13.61% to 23.61%. The diagnosis of DED was based on constantly or often experiencing at least one symptom of the disease, according to the validated McMonnies questionnaire. The prevalence of each symptom alone or in association with other symptoms is illustrated in Table 2.

## Symptomatic Features of DED Among the Medical Students at the University of Tabuk

The most commonly reported symptom of DED was dryness (63.1%), followed by scratchiness (59.5%) and soreness (51.4%). Alternatively, less frequent symptoms included burning (44.1%) and grittiness (22.7%).

## Risk Factors for DED Among the Medical Students at the University of Tabuk

Univariate analysis revealed that a significantly higher percentage of subjects with DED reported wearing soft lenses than those not having the disease (17.8% versus 5.4%,  $p=0.027$ ). However, other variables, including age, gender, family history of DED, the number of hours in front of the screen, and history of corrective eye surgery, did not show a significant association with the presence of DED ( $p>0.05$ ), as shown in Table 3.

**Table 2** Prevalence of Self-Reported Symptoms of Dry Eye Disease

Symptoms		N=247	%
Dry eye disease	No	202	81.8
	Yes	45	18.2
Experiencing burning constantly or often	Alone	1	3.4
	Combined with other symptoms	28	96.6
Experiencing dryness constantly or often	Alone	5	12.2
	Combined with other symptoms	36	87.8
Experiencing Scratchiness constantly or often	Alone	1	2.8
	Combined with other symptoms	35	97.2
Experiencing Soreness constantly or often	Combined with other symptoms	30	100
Experiencing Grittiness constantly or often	Combined with other symptoms	13	100

**Table 3** Demographic Factors Associated with Dry Eye Disease (N=247)

Demographic Factors		Dry Eye Disease				P value
		No N=202 (81.8%)		Yes N=45 (18.2%)		
		N	%	N	%	
Age (years)	<25	173	85.6	39	86.7	0.859
	≥25	29	14.4	6	13.3	
Sex	Female	139	68.8	37	82.2	0.072
	Male	63	31.2	8	17.8	

(Continued)

Table 3 (Continued).

Demographic Factors		Dry Eye Disease				P value
		No N=202 (81.8%)		Yes N=45 (18.2%)		
		N	%	N	%	
Family history	Uncertain	49	24.3	9	20.0	0.830
	No	60	29.7	14	31.1	
	Yes	93	46.0	22	48.9	
Wearing eye lenses	Hard lenses	4	2.0	0	0.0	0.027*
	Soft lenses	11	5.4	8	17.8	
	No	187	92.6	37	82.2	
Hours Infront of screens	> 12	49	24.3	11	24.4	0.280
	9–12	67	33.2	22	48.9	
	6–9	63	31.2	10	22.2	
	3–6	16	7.9	1	2.2	
	1–3	7	3.5	1	2.2	
Corrective eye surgery	Uncertain	2	1.0	0	0.0	0.722
	No	179	88.6	42	93.3	
	Yes	21	10.4	3	6.7	

Note: \*Significant at  $p < 0.05$ .

Furthermore, a history of taking sleeping antihistamine tablets, antihistamine drops, or tranquilizers was frequently reported by the subjects having DED ( $p=0.018$ ). High percentages of individuals with DED stated having previous prescriptions of eyedrops or other treatments for dry eyes than their counterparts (75.6% and 46.0%, respectively,  $p < 0.001$ ). When swimming in chlorinated fresh water, redness and irritation of the eyes were more significantly described by those having DED (35.6%) than the healthy ones (14.4%),  $p=0.005$ . Sleeping with partially opened eyes was significantly detected in subjects with DED (17.8%),  $p < 0.001$ . Reporting eye irritation when waking up from sleeping was more frequent among the diseased than the healthy subjects (8.9% versus 1.0%,  $p < 0.001$ ). The univariate analysis revealed non-significant relation between the prevalence of DED and arthritis, thyroid abnormalities, dryness of the nose, mouth, throat, chest, or vagina, history of allergic diseases, eye dryness and irritation the day after drinking alcohol, eye sensitivity to cigarette smoking, smog, air conditioning, or heating ( $p > 0.05$ ) (Table 4).

Binary logistic regression analysis revealed that irritation of the eyes when waking up from sleeping (OR=19.315), sleeping with partially opened eyes (OR=19.105), redness and irritation of the eyes when swimming in chlorinated fresh water (OR=7.863), and having previous prescriptions of drops or other treatment for dry eyes (OR=3.083) were significant risk factors for the DED (Table 5).

## Discussion

This study revealed a DED prevalence rate of 18.2% among the medical students at the University of Tabuk using a validated McMonnies questionnaire of ocular symptoms related to dry eye. Furthermore, DED was found to be significantly associated with the presence of irritation of eyes when waking up from sleeping, sleeping with partially opened eyes, redness and irritation of the eyes when swimming in chlorinated fresh water, and having previous

**Table 4** Clinical Factors Associated with Dry Eye Disease (N=247)

Clinical Factors		Dry Eye Disease				P value
		No N=202 (81.8%)		Yes N=45 (18.2%)		
		N	%	N	%	
Do you take drugs?	Medication for digestive problems	4	2.0	0	0.0	0.018*
	Sleeping tablets / antihistamine tablets / antihistamine drops / or tranquilizers	24	11.9	13	28.9	
	No	174	86.1	32	71.1	
Have you ever had drops prescribed or other treatments for dry eyes?	Uncertain	8	4.0	3	6.7	<0.001*
	No	101	50.0	8	17.8	
	Yes	93	46.0	34	75.6	
Do you regard your eyes as being especially sensitive to cigarette smoke, smog, air conditioning, or heating?	Sometimes	71	35.1	18	40.0	0.230
	No	98	48.5	16	35.6	
	Yes	33	16.3	11	24.4	
Do your eyes easily become red and irritated when swimming in chlorinated fresh water?	Sometimes	65	32.2	13	28.9	0.005*
	No	78	38.6	9	20.0	
	Not applicable	30	14.9	7	15.6	
	Yes	29	14.4	16	35.6	
Are your eyes dry and irritated the day after drinking alcohol?	Sometimes	3	1.5	0	0.0	0.186
	No	49	24.3	6	13.3	
	Not applicable	149	73.8	38	84.4	
	Yes	1	0.5	1	2.2	
Do you suffer from arthritis?	Uncertain	15	7.4	1	2.2	0.363
	No	184	91.1	43	95.6	
	Yes	3	1.5	1	2.2	
Do you experience dryness of the nose, mouth, throat, chest, or vagina?	Never	163	80.7	36	80.0	0.621
	Sometimes	32	15.8	7	15.6	
	Constantly	1	0.5	1	2.2	
	Often	6	3.0	1	2.2	
Do you suffer from thyroid abnormality?	Uncertain	44	21.8	5	11.1	0.151
	No	154	76.2	38	84.4	
	Yes	4	2.0	2	4.4	

(Continued)

**Table 4** (Continued).

Clinical Factors		Dry Eye Disease				P value
		No N=202 (81.8%)		Yes N=45 (18.2%)		
		N	%	N	%	
Are you known to sleep with your eyes partly open?	Uncertain	16	7.9	12	26.7	<0.001*
	No	180	89.1	25	55.6	
	Yes	6	3.0	8	17.8	
Do you have eye irritation when you wake up from sleeping?	Sometimes	35	17.3	22	48.9	<0.001*
	Uncertain	7	3.5	1	2.2	
	No	158	78.2	18	40.0	
	Yes	2	1.0	4	8.9	
Do you have an allergy?	No	137	67.8	25	55.6	0.117
	Yes	65	32.2	20	44.4	

**Note:** \*Significant at  $p < 0.05$ .

**Table 5** Binary Logistic Regression for Risk Factors of Dry Eye Disease

	OR	95% CI of OR	P value	Sensitivity %	Specificity %	Accuracy %	P value
Having drops or other treatment prescribed for dry eyes	3.083	1.078–8.813	0.036*	51.1	96.0	87.9	<0.001*
Redness and irritation of the eyes when swimming in chlorinated fresh water	7.863	2.263–27.316	0.001*				
Sleeping with partially opened eyes	19.105	4.425–82.479	<0.001*				
Irritation of eyes when waking up from sleep	19.315	2.242–166.404	0.007*				

**Note:** \*Significant at  $p < 0.05$ .

**Abbreviations:** OR, odds ratio; CI, confidence interval.

prescriptions of drops or other treatment for dry eyes. Early detection of dry eyes is important because it can indicate the presence of systemic diseases, such as systemic lupus erythematosus, rheumatoid arthritis, and Sjogren's syndrome.<sup>24</sup> However, in the present study, there was no significant association between a history of rheumatoid arthritis or thyroid abnormalities and the presence of DED. This might be attributed to the young ages of the involved participants.

A history of taking sleeping antihistamine tablets, antihistamine drops, or tranquilizers was frequently reported by the subjects having DED. This is in line with previous researchers who stated that antihistamines and psychotropics might be associated with dry eye.<sup>25</sup> Also, a higher percentage of individuals with DED stated having previous prescriptions of eyedrops or other treatments for dry eyes than their counterparts (75.6% and 46.0%, respectively,  $p < 0.001$ ). This suggests high awareness of the studied medical students about the disease.

Patient education is essential in managing DED, and avoiding exacerbating factors is an integral part of the treatment plan.<sup>3</sup> Therefore, this study investigated the risk factors significantly associated with DED among the studied medical students.

The diagnosis of dry eye is based on subjective self-reported symptoms questionnaires and objective clinical tests. Though there is no "gold standard" for the diagnosis, no single clinical test is universally accepted as a standard criterion



for the diagnosis.<sup>26</sup> One of the methods used to diagnose DED is measuring central corneal thickness (CCT) and thinnest corneal thickness (TCT) using various investigative methods, including Pentacam and anterior segment coherence optical tomography (ASCOT), which were found to be significantly different in assessing the corneal morphology.<sup>27</sup> Additionally, a study utilized the smartphone app “DryEyeRhythm” to create a reliable system for categorizing and displaying individual and diverse subjective symptoms of dry eye disease (DED). This system aims to establish a basis for future predictive, preventive, personalized, and participatory medicine in managing DED.<sup>28</sup>

In the current study, the diagnosis of DED was based on the often or constant presence of at least one of the DED symptoms listed in the McMonnies questionnaire. Symptoms-based diagnosis has been very effective as a screening tool that can discriminate the presence of DED.<sup>29</sup> Additionally, several studies have reported that the McMonnies questionnaire is effective in accurately detecting Dry Eye Disease (DED) with high levels of sensitivity and specificity.<sup>30–32</sup> The questionnaire-based diagnosis is also more applicable and a favorable option for diagnosing dry eye in research based on large populations. Nonetheless, some studies reported a poor and inconsistent relation between patient-reported symptoms and clinical signs, with higher prevalence rates of symptom-based diagnosis than for both symptoms and signs-based diagnosis.<sup>33,34</sup>

Concerning the prevalence of DED, wide variations have been found among different population-based studies. The observed discrepancy is related to different factors, including the selected population, the etiological factors, the definition, and the methods used for DED diagnosis.<sup>35</sup>

Several studies have assessed the accuracy of the McMonnies questionnaire in identifying DED among ophthalmic outpatients. In one study conducted in China, the questionnaire revealed a DED prevalence rate of over 90% among outpatients, which is significantly higher than the rate documented in our study. This differentiation might be attributed to the difference in the studied populations, as the Chinese study included approximately 28,000 patients with dry eye symptoms.<sup>30</sup>

A population-based study from Al-Ahsa, Saudi Arabia, estimated a prevalence of dry eye symptoms of 32.1% among Saudi adults, with older females (>56 years), current smoking, and a history of diabetes mellitus significantly associated with dry eye.<sup>36</sup> A more recent study involving the coastal population of the eastern province of Saudi Arabia found a higher prevalence of 65.4%.<sup>37</sup> A study in Jeddah, Saudi Arabia, found that 93.2% of healthy people have dry eyes. Those with autoimmune diseases or on long-term medications should see an ophthalmologist. People should be educated that dry eyes could be a sign of chronic diseases.<sup>38</sup> There was also a high prevalence (59%) among the Jordanian population.<sup>35</sup>

The Ocular Surface Disease Index survey of students, staff, and faculty members of Mohammed Bin Rashid University and the staff at Mediclinic City and Parkview Hospitals in Dubai, United Arab Emirates, revealed a high prevalence of 62.6%. Female gender, daily screen time of more than six hours, and the use of contact lenses were found to be associated with dry eyes.<sup>39</sup>

A large hospital-based study included 3128 adult patients recruited from the Ophthalmology Outpatient Clinic of the Sohag University Hospital, Egypt, and reported a prevalence of 22.8% depending on both symptoms and signs.<sup>40</sup> Another corresponding study from Singapore detected a 12.3% prevalence of DED among participants aged 15 to 83 years based on McMonnies' dry eye questionnaire. Further, there were significant associations between DED and female gender, contact lens wearing, previous treatment for dry eye (OR=2.09), taking medication (OR=1.84), unusual sensitivity of eyes (OR=3.04), and irritation on waking (OR=2.38).<sup>41</sup>

In China, DED prevalence among senior high school students was 23.7%, depending on a previous clinical diagnosis of DED or severe symptoms (both dryness and irritation constantly or often). In addition, inadequate refractive correction, frequent self-administered topical ophthalmic medications, and poor sleep quality were significant risk factors.<sup>42</sup> Alternatively, another study included Chinese people aged 5–89 years showed a prevalence of 13.55%.<sup>43</sup>

A study of the residents of a rural area in Japan reported a prevalence of 21.6% in women and 12.5% in men, with a significant difference. The DED in this study depended on a composite of clinically diagnosed DED or severe symptoms of dryness and irritation, either constantly or often. Contact lenses were a common dry eye risk factor in both genders.<sup>44</sup> Furthermore, a population-based study in Sumatra, Indonesia, detected a 27.5% prevalence of one or



more of the six dry eye symptoms often or all the time adjusted for age, and pterygium was a possible independent risk factor.<sup>13</sup>

A study that investigated the overall prevalence of DED among a representative population of the United States has explored a rate of 5.28%. The annual prevalence from 2005 to 2012 was increasing, highlighting a growing health problem that necessitates continued research and therapeutic development.<sup>45</sup>

Our study could be limited by the self-reported responses, which could result in misclassification or recall bias. Also, the responses were not validated by performing the ophthalmic examination, which may affect the observed prevalence of dry eye disease among medical students at the University of Tabuk.

## Conclusion

Our study was conducted among medical students at the University of Tabuk, it was discovered that a significant proportion of 18.2% suffered from dry eye disease (DED). Furthermore, the study also unveiled various risk factors that are associated with the development of DED. Given the relatively high prevalence of DED, it is imperative to emphasize the significance of early diagnosis and prompt treatment to prevent further complications. Therefore, it is crucial that individuals remain vigilant and seek medical attention if they experience any symptoms of DED.

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## Disclosure

The authors declare that there are no conflicts of interest.

## References

1. Craig JP, Nichols KK, Akpek EK, et al. TFOS DEWS II definition and classification report. *Ocul Surf*. 2017;15(3):276–283. doi:10.1016/j.jtos.2017.05.008
2. Lemp MA, Foulks GN. 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. doi:10.1016/S1542-0124(12)70081-2
3. Messmer EM. The pathophysiology, diagnosis, and treatment of dry eye disease. *Dtsch Arztebl Int*. 2015;112(5):71–82. doi:10.3238/arztebl.2015.0071
4. Srinivasan S, Manoj V. A decade of effective dry eye disease management with systane ultra (polyethylene glycol/propylene glycol with hydroxypropyl guar) lubricant eye drops. *Clin Ophthalmol*. 2021;15:2421–2435. doi:10.2147/OPTH.S294427
5. Binyousef FH, Alruwaili SA, Altammami AF, Alharbi AA, Alrakaf FA, Almazrou AA. Impact of dry eye disease on work productivity among Saudi workers in Saudi Arabia. *Clin Ophthalmol*. 2021;15:2675–2681. doi:10.2147/OPTH.S313158
6. Stapleton F, Alves M, Bunya VY, et al. TFOS DEWS II epidemiology report. *Ocul Surf*. 2017;15(3):334–365. doi:10.1016/j.jtos.2017.05.003
7. Dossari SK, Alkhars AZ, Albaqshi AA, et al. Prevalence of dry eye disease and its risk factors among the general population of Saudi Arabia: a cross-sectional survey. *Cureus*. 2022;14(12):e32552. doi:10.7759/cureus.32552
8. Moon JH, Kim KW, Moon NJ. Smartphone use is a risk factor for pediatric dry eye disease according to region and age: a case control study. *BMC Ophthalmol*. 2016;16(1):188. doi:10.1186/s12886-016-0364-4
9. AlAwlaqi A, Hammadeh M. Examining the relationship between hormone therapy and dry-eye syndrome in postmenopausal women: a cross-sectional comparison study. *Menopause*. 2016;23(5):550–555. doi:10.1097/GME.0000000000000570
10. Markoulli M, Kolanu S. Contact lens wear and dry eyes: challenges and solutions. *Clin Optim*. 2017;9:41–48. doi:10.2147/OPTO.S111130
11. Titiyal JS, Falera RC, Kaur M, Sharma V, Sharma N. Prevalence and risk factors of dry eye disease in North India: ocular surface disease index-based cross-sectional hospital study. *Indian J Ophthalmol*. 2018;66(2):207–211. doi:10.4103/ijo.IJO\_698\_17
12. Shanti Y, Shehada R, Bakkar MM, Qaddumi J. Prevalence and associated risk factors of dry eye disease in 16 northern West bank towns in Palestine: a cross-sectional study. *BMC Ophthalmol*. 2020;20(1):26. doi:10.1186/s12886-019-1290-z
13. Lee AJ, Lee J, Saw SM, et al. Prevalence and risk factors associated with dry eye symptoms: a population based study in Indonesia. *Br J Ophthalmol*. 2002;86(12):1347–1351. doi:10.1136/bjo.86.12.1347
14. Inomata T, Nakamura M, Iwagami M, et al. Risk factors for severe dry eye disease: crowdsourced research using DryEyeRhythm. *Ophthalmology*. 2019;126(5):766–768. doi:10.1016/j.ophtha.2018.12.013
15. Nichols KK, Mitchell GL, Zadnik K. Performance and repeatability of the NEI-VFQ-25 in patients with dry eye. *Cornea*. 2002;21(6):578–583. doi:10.1097/00003226-200208000-00009
16. Schiffman RM. Reliability and validity of the ocular surface disease index. *Arch Ophthalmol*. 2000;118(5):615–621. doi:10.1001/archophth.118.5.615
17. Blackie C, Albou-Ganem C, Korb D. *Questionnaire Assists in Dry Eye Disease Diagnosis. Four-Question Survey Helps Evaluate Patients' Dry Eye Symptoms to Improve Screening*. Europe ed. Ocular Surgery News; 2012.

18. Doughty MJ, Fonn D, Richter D, Simpson T, Caffery B, Gordon K. A patient questionnaire approach to estimating the prevalence of dry eye symptoms in patients presenting to optometric practices across Canada. *Optomet Vision Sci.* 1997;74(8):624–631. doi:10.1097/00006324-199708000-00023
19. McMonnies C, Ho A. Marginal dry eye diagnosis. In: Holly F, editor. *The Preocular Tear Film in Health, Disease and Contact Lens Wear*. Lubbock: Dry Eye Institute Inc; 1986:32–38.
20. McMonnies CW, Ho A. Patient history in screening for dry eye conditions. *J Am Optom Assoc.* 1987;58(4):296–301.
21. McMonnies CW, Ho A. Responses to a dry eye questionnaire from a normal population. *J Am Optom Assoc.* 1987;58(7):588–591.
22. Guillemin I, Begley C, Chalmers R, Baudouin C, Arnould B. Appraisal of patient-reported outcome instruments available for randomized clinical trials in dry eye: revisiting the standards. *Ocul Surf.* 2012;10(2):84–99. doi:10.1016/j.jtos.2012.01.007
23. Gothwal VK, Pesudovs K, Wright TA, McMonnies CW. McMonnies questionnaire: enhancing screening for dry eye syndromes with Rasch analysis. *Invest Ophthalmol Vis Sci.* 2010;51(3):1401–1407. doi:10.1167/iovs.09-4180
24. Findlay Q, Reid K. Dry eye disease: when to treat and when to refer. *Aust Prescr.* 2018;41(5):160–163. doi:10.18773/austprescr.2018.048
25. Javadi MA, Feizi S. Dry eye syndrome. *J Ophthalmic Vis Res.* 2011;6(3):192–198.
26. Rentka A, Nagy A, Harsfalvi J, et al. Association between objective signs and subjective symptoms of dry eye disease in patients with systemic sclerosis. *Rheumatol Int.* 2017;37(11):1835–1845. doi:10.1007/s00296-017-3794-2
27. Fujimoto K, Inomata T, Okumura Y, et al. Comparison of corneal thickness in patients with dry eye disease using the Pentacam rotating Scheimpflug camera and anterior segment optical coherence tomography. *PLoS One.* 2020;15(2):e0228567. doi:10.1371/journal.pone.0228567
28. Inomata T, Nakamura M, Sung J, et al. Smartphone-based digital phenotyping for dry eye toward P4 medicine: a crowdsourced cross-sectional study. *NPJ Digit Med.* 2021;4(1):171. doi:10.1038/s41746-021-00540-2
29. Korb DR. Survey of preferred tests for diagnosis of the tear film and dry eye. *Cornea.* 2000;19(4):483–486. doi:10.1097/00003226-200007000-00016
30. Tang F, Wang J, Tang Z, Kang M, Deng Q, Yu J. Accuracy of McMonnies questionnaire as a screening tool for Chinese ophthalmic outpatients. *PLoS One.* 2016;11(4):e0153047. doi:10.1371/journal.pone.0153047
31. McMonnies C, Ho A, Wakefield D. Optimum dry eye classification using questionnaire responses. *Adv Exp Med Biol.* 1998;438:835–838.
32. Schaumborg DA, Sullivan DA, Buring JE, Dana MR. Prevalence of dry eye syndrome among US women. *Am J Ophthalmol.* 2003;136(2):318–326. doi:10.1016/S0002-9394(03)00218-6
33. Begley CG, Chalmers RL, Abetz L, et al. The relationship between habitual patient-reported symptoms and clinical signs among patients with dry eye of varying severity. *Invest Ophthalmol Vis Sci.* 2003;44(11):4753–4761. doi:10.1167/iovs.03-0270
34. Bartlett JD, Keith MS, Sudharshan L, Snedecor SJ. Associations between signs and symptoms of dry eye disease: a systematic review. *Clin Ophthalmol.* 2015;9:1719–1730. doi:10.2147/OPHT.S89700
35. Bakkar MM, Shihadeh WA, Haddad MF, Khader YS. Epidemiology of symptoms of dry eye disease (DED) in Jordan: a cross-sectional non-clinical population-based study. *Cont Lens Anterior Eye.* 2016;39(3):197–202. doi:10.1016/j.clae.2016.01.003
36. Alshamrani AA, Almousa AS, Almulhim AA, et al. Prevalence and risk factors of dry eye symptoms in a Saudi Arabian population. *Middle East Afr J Ophthalmol.* 2017;24(2):67–73. doi:10.4103/meajo.MEAJO\_281\_16
37. Alharbi A, Alanazi N, Alhamad J, et al. Prevalence of symptomatic dry eye and its risk factors among coastal population in Eastern Province of Saudi Arabia. *J Clin Exp Ophthalmol.* 2018;9:34.
38. Bukhari A, Ajlan R, Alsagoff H. Prevalence of dry eye in the normal population in Jeddah, Saudi Arabia. *Orbit.* 2009;28(6):392–397. doi:10.3109/01676830903074095
39. Alkabbani S, Jeyaseelan L, Rao AP, Thakur SP, Warhekar PT. The prevalence, severity, and risk factors for dry eye disease in Dubai - a cross sectional study. *BMC Ophthalmol.* 2021;21(1):219. doi:10.1186/s12886-021-01978-4
40. Mostafa EM. Prevalence of dry eye disease in southern Egypt: a hospital-based outpatient clinic study. *J Egypt Ophthalmol Soc.* 2016;109:32–40. doi:10.4103/2090-0686.192749
41. Tan LL, Morgan P, Cai ZQ, Straughan RA. Prevalence of and risk factors for symptomatic dry eye disease in Singapore. *Clin Exp Optom.* 2015;98(1):45–53. doi:10.1111/cxo.12210
42. Zhang Y, Chen H, Wu X. Prevalence and risk factors associated with dry eye syndrome among senior high school students in a county of Shandong Province, China. *Ophthalmic Epidemiol.* 2012;19(4):226–230. doi:10.3109/09286586.2012.670742
43. Song P, Xia W, Wang M, et al. Variations of dry eye disease prevalence by age, sex and geographic characteristics in China: a systematic review and meta-analysis. *J Glob Health.* 2018;8(2):020503. doi:10.7189/jogh.08.020503
44. Uchino M, Nishiwaki Y, Michikawa T, et al. Prevalence and risk factors of dry eye disease in Japan: koumi study. *Ophthalmology.* 2011;118(12):2361–2367. doi:10.1016/j.ophtha.2011.05.029
45. Dana R, Bradley JL, Guerin A, et al. Estimated prevalence and incidence of dry eye disease based on coding analysis of a large, all-age United States health care system. *Am J Ophthalmol.* 2019;202:47–54. doi:10.1016/j.ajo.2019.01.026