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Research Article

# Prevalence of Symptomatic Dry Eye and its Risk Factors among Coastal Population in Eastern Province of Saudi Arabia

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## Abstract

**Background:** The prevalence of dry eyes is estimated to be between 7.4% and 33.7% depending on the type of studies, its diagnostic test used, or geographic area studied. Dry eye is a disorder of lacrimal film caused by increased tear evaporation and/or decreased tear production. There are numerous predisposing risk factors for dry eye such as age, gender, chronic diseases and environmental factors. One of the important environmental risk factor in coastal areas is humidity with high temperature climate, as it will make people resort to air-conditioning leading to increasing of dry eye prevalence.

**Objectives:** The aim of our study was to estimate the prevalence of symptomatic dry eye and to assess the most frequent risk factors for dry eye among the coastal population of the eastern province of Saudi Arabia.

**Methods:** An observational cross-sectional study was conducted from April to June 2018 in coastal population of eastern province in Saudi Arabia. The range of target participant was between 6 and 40 years. A valid electronic questionnaire which is Ocular Surface Disease Index (OSDI) was used to assess dry eye symptoms. In addition, demographic profile was created and data about the risk factors were collected. All the questions were closed ended.

**Result:** Out of 471 responses, 65.4% were female. Mean age 23.35 (SD ± 20.5) for male and 23.03 (SD ± 19.6) for female. We found out that the prevalence of symptomatic dry eye in the coastal population of eastern province is 62.4%. Most of participants considered to have severe dry eye which account to be 25.5%, followed by mild symptomatic dry eye that account to be 24.8%. Comparing OSDI with these factors: arthritis, diabetes, thyroid diseases, using Antidepressants drug and/or multivitamins supplements shown statistical significances differences. In addition, age and arthritis shown strong correlation with dry eye.

**Conclusion:** Dry eye is highly prevalent in the coastal population of the eastern province of Saudi Arabia. That clearly indicates that ophthalmologists, optometrists, and general practitioners provide essential information about who to avoid dry eye. However, further investigations and researches are required for better understanding of possible factors that might explain the increase of prevalence of dry eye among our target population for early intervention and management.

***Keywords:*** *Dry Eye; Coastal Population; Eastern Province; Saudi Arabia*

## Introduction

Dry eye is a multifactorial disorder of lacrimal film. The tear film is of vital importance in the eyes since they have the role of keeping the eyes' surface smooth and clear of foreign particles. A film of tears spreads over the eyes with each blink, and when that does not happen efficiently, the result is dry eyes [1].

For decades, it was thought that dry eye was strictly caused by a decrease in the aqueous phase of the tear film. However, later in 1995 it was defined as a complex, multifaceted group of medical and ocular diseases which could be due to either increased tear evaporation and/or decreased tear production [2].

This results in significant harm to the ocular surface, and it is largely accompanied by a rise in the osmolarity of the lacrimal film and an inflammation of the ocular surface [2]. This disorder is affected by multiple factors such as age, gender, diet, wearing contact lenses, and other environmental factors [3].

Dry eye is associated with symptoms of discomfort such as stinging, burning, vision disturbance, light sensitivity, eye fatigue, grittiness, foreign object sensation, and eye redness [4]. These symptoms will likely affect the quality of life in people suffering from this condition since it can affect their productivity at work, social life, reading, driving at night, as well as due to the cost of treating it [2].

Dry eye leads to an increase in the number of visitors to ophthalmology clinics because it is common in the field of ophthalmology [5,6]. Its prevalence varies between different studies, depending on a lot of factors like disease definition, the way of diagnosis, and type of population. It is estimated to be 7.4% - 33.7% around the world [2]. According to The Beaver Dam population-based study, it was found that the prevalence rate of dry eye is 14% in adults, and that it affects women more than men (16.7% versus 11.4%, respectively) [2].

Dry eye is highly prevalent in Saudi Arabia.In a study done in Al-Ahsa, 1858 Saudi adults with the mean age of 39.3 ± 14.1 years were examined. It was found that the age-adjusted prevalence of dry eye syndrome was 32.1% [3].

Another study was conducted to assess the prevalence of dry eye symptoms among patients of King Abdul-Aziz Specialist Hospital (Taif), Saudi Arabia. The result was out of 482 patients, only 116 patients were normal, and the rest had mild, moderate, to severe dry eye [7].

In Jeddah, Saudi Arabia, a Prospective systematic random sampling study of 251 subjects was conducted. It was reported that 234 (93.2%) out of the 251 subjects were diagnosed with dry eye [8,9]. Note that he prevalence and incidence of dry eye may be under-reported in the clinical setting, which could be due to not reporting the issue to the doctor, or the failure of patients to recognize the symptoms of dry eye [2].

The relative humidity and temperature play a vital role in the prevalence of dry eye. Many studies have shown that as the relative humidity increases, the prevalence of dry eye decreases [2]. However, in most Saudi areas, the coastal population has a weather with high temperatures reaching more than 52°C, especially in the summer season. The aims of this study were to assess the prevalence of dry eye among coastal population in the eastern province of Saudi Arabia and to define the most familiar risk factors of this disease.

## Methods

An observational cross-sectional study was conducted from April to June 2018 among coastal populations (whom living within 100 km from the sea) in the eastern province of Saudi Arabia. Determined by Google maps. The age range of target participants was between 6 and 40 years and People who have been living for a period that exceeds six months in coastal areas were included in this study. A well-structured questionnaire was designed in Arabic language and distributed to the participants electronically. The paper form was used to collect response the illiterate participants and who do not use Smartphones and later the response was transferred to the electronic form. A valid questionnaire which is Ocular Surface Disease Index (OSDI) was used to assess dry eye symptoms, The questionnaire includes questions about demographic profile, vision and ocular symptoms and risk factors related to dry eye disorder. The OSDI score includes 3 questions related to ocular symptoms, 6 questions about vision-related function and 3 questions about the environmental triggers. OSDI was calculated from 0 to 100 where 0 - 12 is normal, 13 - 22 mild, 23 - 32 moderate, and 33 - 100 is severe. Scores for each question range from 0 to 4 where 0 represent (none of the time) and 4 represent (all the time). The final score was calculated using the following formula [9]:

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

The invitation to participate in the study was sent to 500 individual.

Ethics was approved by the National Institute of Health. SPSS version 21.0 software package was used for statistical analysis. Qualitative and quantitative variables were measured frequencies, mean, median, standard deviation and others. In addition, the t-test was performed to compare between different age groups. A *p*-value for the test was set at 0.05.

## Results

The response rate of the study was 94.2% (471). the prevalence of symptomatic dry eye appeared in 62.4%. Including an age group from 6 - 40 years old. 65.4% Of the participants were females and 34.6% were males. The mean gender was 23.35 (SD ± 20.5) for male and 23.03 (SD ± 19.6) for female. The frequency of risk factors in order from maximum to minimum was 350 (74.3%) for caffeine drinking, 114 (24.2%) for Multivitamin use, 95 (20.2%) for contact lenses usage, 60 (12.7%) for Hypercholesterolemia, 50 (10%) for smoking, 46 (9.8%) for refractive surgery, 35 (7.4%) for Arthritis, 35 (7.4%) for Diabetes, 22 (4.7%) for Thyroid disease, 30 (6.4%) for Aspirin use and 8 (1.7%) for Antidepressant drug use (Table 1).

| Variable | | n | Percentage (%) |
|---|---|---|---|
| Age | More than 6 to 20 years | 64 | 13.6 |
| | More than 20 to 30 years | 221 | 46.9 |
| | More than 30 to 40 years | 75 | 15.9 |
| | More than 40 years | 111 | 23.6 |
| Gender | Male | 163 | 34.6 |
| | Female | 308 | 65.4 |
| Risk Factors | Smoking | 50 | 10.6 |
| | Arthritis | 35 | 7.4 |
| | Diabetes | 35 | 7.4 |
| | Thyroid disease | 22 | 4.7 |
| | Hypercholesterolemia | 60 | 12.7 |
| | Aspirin use | 30 | 6.4 |
| | Antidepressant | 8 | 1.7 |
| | Multivitamin | 114 | 24.2 |
| | Caffeine drinking | 350 | 74.3 |
| | Contact lenses use | 95 | 20.2 |
| | Refractive surgery | 46 | 9.8 |

***Table 1:*** *Demographic profile and risk factors of participants in OSDI questionnaire (n = 471).*

The normal participants represented 177 (37.6%), establishing an OSDI score between 0 and 12. For those with a score between 13 to 22 they were considered as having a mild dry eye disease and represented 117 (24.8%). While a score between 23 to 32 shows a moderate dry eye disease that represented 57 (12.1%) of participants. Finally, participants with a score of 33 or higher were considered to have severe dry eye disease and were 120 (25.5%) of the study population (Table 2), it means that the majority of the participants suffer from severe symptomatic dry eyes followed by mild symptomatic dry eye. Comparing the OSDI score between male and female participants, there was no significant difference in the score of OSDI between genders ($p$ = 0.868), showing that female mean was 23.03 (± SD 19.6) and male mean was 23.35 (± SD 20.5).

| Prevalence of dry eye symptoms | N (%) |
|---|---|
| Normal participants (OSDI* score 0 - 12) | 177 (37.6) |
| Participants with dry eye: | 294 (62.4) |
| Participants with mild dry eye (OSDI score 13 - 22) | 117 (24.8) |
| Participants with moderate dry eye (OSDI score 23 - 32) | 57 (12.1) |
| Participants with severe dry eye (OSDI score 33 - 100) | 120 (25.5) |
| Total | 471 (100) |

***Table 2:*** *The prevalence of mild, moderate, and severe dry eye test (n = 471).*
**OSDI: Ocular Surface Disease Index.*

The risk factors: smoking, aspirin, caffeine drinks, contact lenses and refractive surgery demonstrated no significant difference between the exposed and un-exposed groups (Table 3). In contrast, the difference was highly significant in the OSDI score for multivitamins use ($p$ = 0.000). Participants with multivitamins use had a higher score, mean score was29.64 (SD ± 21.03) compared to those with no multivitamins use for mean score of 21.07 (SD ± 19.08). For instance, participants who used antidepressant were also statistically significant ($p \leq 0.05$), with a higher mean score of 42.19 (SD ± 27.8) compared to participants with no antidepressants usage having a mean score of 22.8 (SD ± 19.6).Furthermore, arthritis disease participants had a higher mean score of 30.71 (SD ± 21.3) compared to those without arthritis for mean score of 22.53 (SD ± 19.7). Similarly, Hypercholesterolemia participant showed a statistical significance with a higher mean score of 30.38 (SD ± 22.1) compared to participants with no hypercholesterolemia having a mean score of 22.08 (SD ± 19.4). Finally, participants who had Thyroid Diseases and diabetes were also statistically significant ($p \leq 0.05$), given a higher mean score for those with the presence of these risk factors compared to those of an absence risk factors (Table 3).

| Variable | | n | Mean | SD | p-Value |
|---|---|---|---|---|---|
| Gender | Male | 163 | 23.35 | ± 20.5 | 0.868 |
| | Female | 308 | 23.03 | ± 19.6 | |
| Smoking | Yes | 50 | 26.42 | ± 21.1 | 0.219 |
| | No | 421 | 22.75 | ± 19.7 | |
| Arthritis | Yes | 35 | 30.71 | ± 21.3 | 0.019 |
| | No | 436 | 22.53 | ± 19.7 | |
| Diabetes | Yes | 35 | 32.38 | ± 23.6 | 0.004 |
| | No | 436 | 22.4 | ± 19.4 | |
| Thyroid Diseases | Yes | 22 | 32.29 | ± 21.8 | 0.027 |
| | No | 449 | 22.69 | ± 19.7 | |
| Hypercholesterolemia | Yes | 60 | 30.38 | ± 22.1 | 0.002 |
| | No | 411 | 22.08 | ± 19.4 | |
| Aspirin | Yes | 30 | 29.1 | ± 22.7 | 0.090 |
| | No | 441 | 22.74 | ± 19.6 | |
| Antidepressant | Yes | 8 | 42.19 | ± 27.8 | 0.006 |
| | No | 463 | 22.8 | ± 19.6 | |
| Multivitamins | Yes | 114 | 29.64 | ± 21.03 | 0.000 |
| | No | 357 | 21.07 | ± 19.08 | |
| Caffeine Drinks | Yes | 350 | 23.83 | ± 20.1 | 0.204 |
| | No | 121 | 21.16 | ± 19.3 | |
| Contact Lens | Yes | 95 | 24.80 | ± 20.2 | 0.363 |
| | No | 376 | 22.72 | ± 19.8 | |
| Refractive Surgery | Yes | 46 | 25.18 | ± 21.9 | 0.465 |
| | No | 425 | 22.92 | ± 19.7 | |

***Table 3:*** *A comparison of OSDI score in participants who have certain factor and those who don't have (n = 471).*

Using Pearson Correlation Coefficient, a strong positive correlation was found between age of participants and OSDI score for dry eye symptoms, with $p$ = 0.001 and a correlation coefficient of 1.150. Multivariate logistic regression analysis for the association between risk factors and dry eye symptoms, showed arthritis as the only significant factor ($p$ = 0.01) with an odd ratio (OR) = 0.22 (95% confidence interval [CI]: 0.07,0.67) (Table 4).

| Variable | p-Value | OR | 95% C.I. | |
|---|---|---|---|---|
| | | | Lower | Upper |
| Gender (Male) | 0.69 | 0.91 | 0.57 | 1.45 |
| Smoking (Yes) | 0.37 | 0.72 | 0.35 | 1.47 |
| Arthritis (Yes) | 0.01 | 0.22 | 0.07 | 0.67 |
| Diabetes (Yes) | 0.56 | 0.75 | 0.28 | 2.01 |
| Thyroid Diseases (Yes) | 0.36 | 0.57 | 0.17 | 1.88 |
| Hypercholesterolemia (Yes) | 0.38 | 0.73 | 0.36 | 1.48 |
| Aspirin (Yes) | 0.63 | 1.29 | 0.45 | 3.70 |
| Antidepressant (Yes) | 0.20 | 0.25 | 0.03 | 2.11 |
| Multivitamins (Yes) | 0.08 | 0.64 | 0.39 | 1.06 |
| Caffeine Drinks (Yes) | 0.30 | 0.78 | 0.50 | 1.24 |
| Contact Lens (Yes) | 0.09 | 0.63 | 0.37 | 1.07 |
| Refractive Surgery (Yes) | 0.80 | 0.92 | 0.48 | 1.77 |
| Constant | 0.66 | 1.10 | | |

***Table 4:*** *An association between risk factors and dry eye symptoms.*

*Logistic regression for the factors, the reference for the gender is female.*

*For all other factors, the reference value is (no) or absence of the factor.*

*OR: Odds Ratio; CI: Confidence interval.*

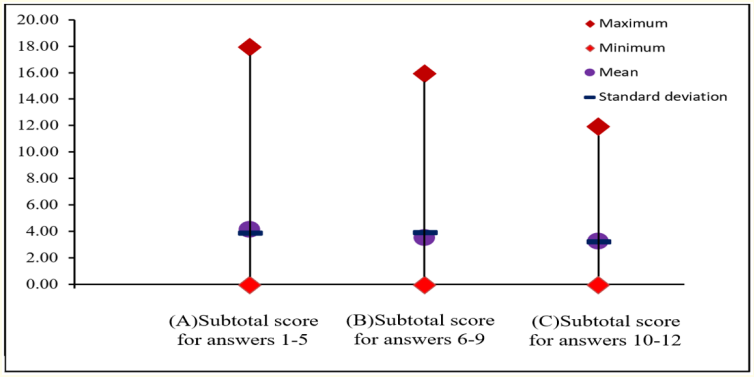


***Figure 1:*** *Ocular surface disease index score of different sections (n = 471).*

## Discussion

A cross sectional study was conducted in coastal population of eastern province in Saudi Arabia by using a valid and reliable questionnaire (OSDI), which is a subjective scale to assess the symptoms and the severity of symptomatic dryness in the eyes as normal, mild, moderate, or severe. Ocular surface disease index was measured, according to participants score out of 100. Four hundred and seventy-one people participated in this study. The prevalence of symptomatic dry eye in our study was 62.4%. Also, 65.4% of participant were female.

As OSDI scores increases, the incidence of dry eyes increased, this is associated with groups who have arthritis, diabetes, thyroid disease, and who are under antidepressant drugs and multivitamins supplements. There was a strong statistical significant correlation between OSDI scores with age and arthritis $p = 0.01$.

A similar cross-section hospital-based, observational study in north India by Titiyal., *et al.* showed that the prevalence of dry eye was 32%[10]. Their study is similar to our study in showing that gender and previous ocular surgery are not significant risk factors to symptomatic dry eyes [10]. In addition to that, this study found that hours of visual display terminal usage, smoking and contact lens usage are factors that increase the prevalence of symptomatic dry eye [10]. There are discrepancies between the two studies. Jeewan Singh Titiyal found that smoking and using contact lens were significantly associated with dry eye which is contrary to our study.

Also, prospective systematic random sampling study that was done in Jeddah by Amal Bukhari., *et al.* found that 93.2% of their participants were diagnosed with dry eyes. They concluded that blepharitis and smoking are the most common risk factors that have association with dry eyes [8]. In contrast, in our study, smoking was not significantly associated with dry eye symptoms. However, the study of Amal Bukhari showed that gender, history of eye surgery and contact lenses usage are insignificant risk factors[8]. These insignificant factors are similar to our study in the eastern province.

Andre and colleagues revealed, in their cross-sectional study conducted in China, a significant correlation between ocular surface disease index (OSDI) score and type 2 diabetes mellitus (T2DM), demonstrating that patients with dry eye symptoms are more likely to have high HbA1c levels [11]. A study conducted in Al-Ahsa also stated that dry eye disease is significantly associated with diabetic patients [3]. These two studies consolidated our findings that the association between diabetes mellitus (DM) and dry eye disease (DED) was significant.

Dieter Franz Rabensteiner and colleague found no significant relation between participants using contact lens and ocular surface damage among those with known aqueous tear deficiency (ATD) and evaporative dry eye (EDE) [12]. Similarly, in our study, the use of contact lenses was not significantly associated with dry eye symptoms. In contrast, another study conducted in Taif showed association between contact lenses usage and high OSDI score [7]. Dieter also stated that meibomian gland dysfunction (MGD), which is a disease seen in different age groups including young people, is associated with ocular surface dysfunction [12].

Another cross-sectional study conducted by Julia Silvestre de Castro in brazil found that being a female, people above the age of 60 years old, having a history of ocular surgery, wearing contact lens, undergoing cancer treatment, using computer use > 6 hours per day, taking antidepressants and/or Anti-allergy medications were significantly associated with dry eye [13]. In contrast, age and anti-depressant medications were the only significant risk factors. However, these variation of results on all previously studied may be attributed to different sample sizes, regional variations, genetic traits and environmental factors.

In addition to that, a cross-sectional study conducted in Pakistani population was done by Abdullah Ayub found that outdoor workers, people working in air conditioners and people exposed to excessive sunlight, wind, temperature were at higher risk of developing dry eye [14]. These factors may contribute to high prevalence of dry eyes in coastal population in eastern province comparing to other studies that used similar questionnaire. Although many studies concluded that humidity contributed in decreasing the prevalence of dry eye [2], coastal populations in Saudi Arabia were having high prevalence. Because the temperature could reach up to 50° in summer, people resort to air-conditioners. Therefore, these ecological risk factors rending the coastal population to have high prevalence of dry eyes disorders [3]. The summary of published data on prevalence of dry eye in a population-based study that we used in our study (Table 5).

To the best of found knowledge, there are insufficient studies conducted in the coastal population in Saudi Arabia. Although, a previous study in the eastern region regarding the same topic is found, it was specified to Al-Ahsa region of eastern province. However, our study is the first to target coastal population in the eastern province in Saudi Arabia.

Our study was online questionnaire-based, limited to people with the ability to access the questionnaire through internet. Moreover, neither clinical tests nor past diagnosis were included in the research, which can underestimate or overestimate dry eye by false positive or false negative results. Indeed, causality is not obtained from cross-sectional study design, only the association between variables can be provided. Finally, we recommend further researchers to take into consideration a study design that provide them with causes of dry eye disease, more risk factors, testing public awareness of dry eye disease, and/or increasing sample size.

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## Conflicts of Interest

None.

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