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ORIGINAL RESEARCH

Symptomatic Dry Eye Disease and Associated Factors Among Adult Diabetic Patients in Adare General Hospital, Hawassa City, Southern Ethiopia, 2023

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Introduction: Symptomatic dry eye disease is a multifactorial ocular surface condition caused by disruption of the precorneal tear film and is a common clinical finding in diabetic patients. However, there was no study on the prevalence and associated factors of symptomatic dry eye disease among diabetic patients in Ethiopia or in the study area.

Purpose: This study aimed to investigate the prevalence and associated factors of symptomatic dry eye disease among adult diabetic patients in Adare General Hospital, Hawassa City, Southern Ethiopia, in 2023.

Methods: A hospital-based cross-sectional study design was conducted on 493 adult diabetic patients who were selected using systematic random sampling, from April 23 to June 8, 2023. Data were collected through a face-to-face interview using an ocular surface disease index questionnaire. Binary logistic regression was performed to identify factors potentially associated with symptomatic dry eye disease. Variable with a P value of <0.05 was considered statistically significant.

Results: A total of 488 subjects participated in this study with a response rate of 99%. The prevalence of symptomatic dry eye disease was 34.8% (95% CI = 30.6–39.1). College and university educational status (AOR = 5.88, 95% CI = 2.25–15.38), government employed (AOR = 2.22, 95% CI = 1.05–4.68), use of visual display unit >5 hours (AOR = 4.41, 95% CI = 1.51–12.87), duration of diabetes ≥11 years (AOR = 3.57, 95% CI = 1.28–9.90), poor glycemic control (AOR = 2.13, 95% CI = 1.21–3.75), allergic conjunctivitis (AOR = 1.99, 95% CI = 1.12–3.54), and debris in the tear film (AOR = 3.63, 95% CI = 1.53–8.61) were positively associated with symptomatic dry eye disease.

Conclusion: The study revealed a high prevalence of symptomatic dry eye disease. Higher educational status, government employed, use of visual display unit, longer duration of diabetes, poor glycemic control, allergic conjunctivitis, and tear film debris were significantly associated with symptomatic dry eye disease. Breaks in screen use, good glycemic control, and treatment of ocular morbidities such as allergic conjunctivitis and debris in the tear film were recommended for all diabetic patients.

Keywords: symptomatic dry eye disease, Hawassa City, diabetic patients, Southern Ethiopia

Introduction

Dry eye disease (DED) is a multifactorial ocular surface disease due to tear film instability and hyperosmolarity, ocular surface inflammation, damage, and neurosensory abnormalities.[1] DED is classified as aqueous-deficient dry eye, when dryness is caused by decreased tear production, and evaporative dry eye, which results from increased evaporation of the precorneal tear film; however, clinically, mixed forms of dry eye are very common.[2]

Symptomatic dry eye disease (SDED) is a severe form of dry eye that is characterized by common symptoms such as dryness, ocular pain, burning sensation, ocular fatigue, grittiness, photophobia, soreness, irritation, tearing, and visual disturbances or limitations.[3]

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Diabetes mellitus (DM) is a global health problem that causes ocular surface disorder (dry eye disease).[4] DM-associated dry eye disease is caused by altered enzyme metabolism and decreased mucin secretion, dysfunction of the lacrimal gland and tear fluid due to diabetic neuropathy, and dysfunction of the meibomian glands, which leads to tear film instability by reducing the quantity and quality of the lipid layer of the precorneal tear film.[5]

Evidence has shown that the increasing number of diabetic patients worldwide is one of the contributing factors to increase the prevalence of symptomatic dry eye,[6] and the prevalence of dry eye disease in diabetics ranges from 20.6% to 54.3%.[7–10] In Ethiopia, the prevalence of symptomatic dry eye was 50.5% on postgraduate students in University of Gondar,[11] 49.5% on undergraduate students in Hawassa University[12] and 43% on Glaucoma patients in Menelik II tertiary hospital.[13] Although the prevalence of diabetes mellitus in Ethiopia was 6.5%,[14] there was no study that showed the prevalence of symptomatic dry eye among diabetic patients.

Reports showed that older age,[5] female sex,[6] poor glycemic control,[15–21] long duration of diabetes,[5,6,15,20–23] peripheral diabetic neuropathy,[5,24] use of artificial tears,[25] diabetic retinopathy,[15,23,24,26,27] and a history of cataract surgery[5] were significantly associated with dry eye disease in diabetic patients.

Early untreated DED in diabetics can be complicated by persistent corneal epithelial defects, corneal erosions, and microbial or trophic corneal ulcers, leading to ocular discomfort and visual disturbance or limitation.[23] People with dry eye are less efficient in daily life and lose their productivity at work because they suffer from severe eye discomfort and visual disturbances, which affects the patient's overall quality of life.[28,29]

Although dry eye disease is one of the most common eye diseases worldwide and is common in diabetic patients in clinical practice in Ethiopia, the actual extent and associated factors of DED in Ethiopia and the study area are not known. Since the Adare General Hospital in Hawassa City is one of the largest diabetic centers in Southern Ethiopia with an integrated eye care service, providing up-to-date information is important for formulating health policies and allocating adequate resources to address this problem in the study area as well in the country (Ethiopia). Therefore, the aim of this study was to determine the prevalence and associated factors of symptomatic dry eye disease among adult diabetic patients in Adare General Hospital, Hawassa City, Southern Ethiopia in 2023.

Methods and Materials

Study Design, Setting, and Period

A hospital-based cross-sectional study design was conducted at Adare General Hospital from April 23 to June 8, 2023. Adare General Hospital is located in Hawassa City, the capital of Sidama Regional State, which is found 275 km away from Addis Ababa. According to the hospital's planning and information office, Adare General Hospital provides both preventive and curative health care treatments, including eye care, to nearly three million people. With 1 ophthalmologist, 5 optometrists, and 1 ophthalmic nurse, the Department of Ophthalmology at Adare General Hospital provides comprehensive eye care to the surrounding community. Adare General Hospital is also providing care for at least 600 diabetic patients per month over five working days. Clinical care for diabetic patients has been provided by internists, general practitioners, and nurses.

Study Population and Eligible Criteria

All adult patients aged ≥18 years with type I or type II diabetes who were receiving diabetologic care at Adare General Hospital during the survey period. However, adult diabetic patients who were unable to answer the questionnaire because of speech or mental health problem, patients who were admitted to the inpatient unit seriously ill, patients with media opacities such as corneal and vitreous opacities, and patients with a shallow anterior chamber angle, uveitis, and keratitis were excluded.

Sample Size Determination

Sample Size Determination for Objective One

The sample size was determined using a single population proportion formula that $n = \frac{(Z_{\alpha/2})^2 p(1-P)}{d^2}$ is with the following assumptions (n = Sample size, Z = the value of z statistic at 95% confidence level = 1.96, P = the expected proportion of

symptomatic dry eye disease was 49.8%, which was taken from a similar study in Kenya,[30] and d – maximum allowable error (5%). The calculated sample size was 384.

Sample Size Determination for Objective Two

Female sex was the consistent factor for symptomatic dry eye disease[31] used to calculate the sample size for the second objective using the software EPI INFO version 7, considering a confidence level of 95%, power of 80%, a ratio of unexposed to exposed patients of 1.4, an odds ratio of 1.80, and the proportion of case in exposed and unexposed groups were 72.5% and 59.3%, respectively. So that the computer-generated sample size was 448. The sample size determined for the second objective was chosen because it was large and sufficient to meet both objectives. Adding a non-response rate of 10%, the final required sample size was 493.

Sampling Technique and Procedures

Study participants were selected using a systematic random sampling procedure with an interval of 2. To select the first study participant, a single number was drawn by a lottery method, and then continued with every K^{th} interval. An interval was calculated by dividing the expected number of diabetic patients who visited the diabetes clinic during the data collection period by the calculated sample size (K = N/n, N = 1024, n = 493).

Operational Definitions

Symptomatic dry eye: was defined as those participants who had a score of 13 and above points based on the OSDI questionnaire.[32,33]

Blood glucose control: was classified as good if the recorded current fasting blood glucose (FBS) level was less than 152 mg/dl and poor if the current FBS level was 152 mg/dl and above.[34]

Smokers: participants who had smoked at least 100 cigarettes during their lifetime and currently smoked either every day or every other day per week.[35]

Body Mass Index (BMI) (kg/m^2): was classified based on the World Health Organization categorization and calculated as weight in kilograms divided by height in square meters (m^2). A BMI of <18.5 was considered underweight, a BMI of 18.5–24.9 kg/m^2 was considered normal, a BMI of 25–29.9 kg/m^2 was considered overweight, and a BMI of ≥30 kg/m^2 was considered obese.[36]

Visual impairment: was defined as a present visual acuity of less than 6/12 in the better eye based on 11th the International Classification of Diseases definition of visual impairment.[37]

Duration of diabetes: was categorized as 1–5, 6–10, and ≥11 years.[21]

Diabetic retinopathy: was diagnosed and classified based on the Early Treatment of Diabetic Retinopathy Study.[38]

Meibomian gland dysfunction: was diagnosed based on the presence of at least one of the following clinical findings: excessive and abnormal secretion of the meibomian glands, telangiectasia at the posterior lid margin, frothy discharge at the lid margin or in the inner Canthi area, and pouting or obstruction of the meibomian gland orifices.[39]

Allergic conjunctivitis: was diagnosed based on the following clinical findings: Itching, lacrimation, mucoid discharge, conjunctival hyperemia or papillary reaction, variable chemosis, and eyelid edema.[39]

Age: was categorized as 18–40, 40–49, 50–59, and ≥60 years.[31]

Data Collection Tools and Procedure

Data were collected by personal interview, review of medical records, and an eye examination. The personal interview, review of medical records, and measurement of height and weight of study participants were performed by two trained nurses, whereas the eye examination was performed by two experienced optometrists.

The nurses conducted a face-to-face interview using a pretested and structured questionnaire that included information on socio-demographic characteristics such as age, sex, marital status, residence, educational and occupational status, and monthly income; behavioral data such as cigarette smoking, use of visual display devices, sleep duration, and sunlight exposure, ocular history such as use of artificial tears, intravitreal injections, history of cataract surgery, history of eye examination, history of medication use in the form of eye drops and use of eyeglasses, systemic comorbidities

such as asthma, sinusitis, antidepressant medications, and the Ocular Surface Disease Index (OSDI) questionnaire. The OSDI questionnaire contained 12 questions assessing dry eye disease symptoms. The response to each question was scored from 0 to 4, in which 0 represents none of the time, 1 some of the time, 2 half of the time, 3 most of the time, 4 all of the time.[32,33] The reliability of the items was checked by calculating Cronbach's alpha value (0.94). Clinical data such as type of diabetes, fasting blood glucose level, duration of DM, type of treatment, and systemic comorbidities such as hypertension, heart disease, dyslipidemia, diabetic neuropathy, vitamin A deficiency, dermatitis, arthritis, thyroid disease, Parkinson's disease, and use of diuretics were recorded in the medical records of the study participants. Weight was measured with a balance-beam scale and height with a wall-mounted stadiometer, and participants appeared in their underwear and without shoes. After completion of the interview, all study participants underwent a comprehensive eye examination. The presenting visual acuity of the study participants was measured in each eye using a Snellen chart at a distance of 6 meters under good room lighting. A slit-lamp biomicroscope with a 90-diopter Volk lens was used to examine the anterior and posterior portions of the eyes with the pupil dilated with 1% tropicamide eye drops to obtain clinical data such as meibomian gland dysfunction, allergic conjunctivitis, debris in the tear film, diabetic retinopathy, panretinal photocoagulation, and vitrectomy.

Data Quality Control

At Hawassa University Comprehensive Specialized Hospital, 5% of the sample size was used to pretest a structured questionnaire in Amharic, which was used to control for data quality. Two nurses and optometrists who collected the data were trained in it and their work was supervised, which helped to maintain the quality of the data. In addition, the collected data were checked for completeness at the end of the day to ensure data quality.

Data Processing and Analysis

After checking the completeness and consistency of the data, data were entered into the Epidemiological Information (EPI INFO) 7 program and then exported to the Statistical Package for Social Sciences (SPSS) version 25 for analysis. Multicollinearity was checked using the variance inflation factor and tolerance for controlling the effects of confounding variables on final results. Proportions and summary statistics such as mean, median and standard deviation were calculated for the descriptive data. Bivariable binary logistic regression followed by a multivariable binary logistic regression was performed to identify possible factors associated with symptomatic dry eye disease. The strength of the association between dependent and independent variables was expressed by an adjusted odds ratio (AOR) with a 95% confidence interval (CI). The model fitness was ensured by the Hosmer and Lemeshow goodness of fit. A variable with a P value of less than 0.05 was considered statistically significant.

Ethical Consideration

This study adhered to the tenets of the Declaration of Helsinki. Ethical approval was obtained from the Ethical Review Committee of University of Gondar, College of Medicine and Health Sciences, School of Medicine. Besides, a formal permission letter was also obtained from the medical director of Adare General Hospital. After a full explanation of the purpose of the study, written informed consent was obtained from all study participants. All study participants were informed of their right to withdraw from the study at any time during the interview and eye examination. Confidentiality was ensured by avoiding any personal identifiers from the data collection tool. Finally, patients with sight-threatening diabetic eye complications were referred to an eye clinic for further examination and follow-up.

Results

Socio-Demographic Characteristics of the Study Participants

A total of 488 participants were involved in this study, with a response rate of 99.0%. The median age of the participants was 56 years (IQR: 47–65). Of the 488 study participants, 260 (53.3%) were male, 293 (60.0%) were urban dwellers, and 289 (59.2%) had attended primary school or lower educational status (Table 1).

Table 1 Socio-Demographic Characteristics of the Study Participants in Adare General Hospital, Hawassa City, South Ethiopia, 2023 (n = 488)

Variables	Categories	Frequency	Percent
Age (in years)	18–39	67	13.7
	40–49	74	15.2
	50–59	158	32.4
	≥60	189	38.7
Sex	Female	228	46.7
	Male	260	53.3
Residency	Rural	195	40.0
	Urban	293	60.0
Marital status	Currently married	421	86.3
	Currently single	67	13.7
Educational status	Primary school or lower	289	59.2
	Secondary school	121	24.8
	College and University	78	16.0
Occupational status	Employed	148	30.3
	Farmer	42	8.6
	Housewife	114	23.4
	Private business	184	37.7
Monthly income (Ethiopian birr)	≤2000	147	30.1
	2001–4000	107	21.9
	4001–7500	116	23.8
	>7500	118	24.2

Note: n-sample size, and monthly income was categorized based on interquartile range.

Behavioral Factors and Past Ocular History of the Study Participants

Of all study participants, nearly three-quarters (73.8%) used a visual display unit for less than or equal to 2 hours per day, and 353 (72.3%) slept less than 8 hours per day. Nearly half (48.6%) of the participants had no history of eye examination. In addition, only 158 (32.4%) of the participants had a history of wearing spectacles (Table 2).

Table 2 Behavioral Factors and Past Ocular History of Diabetic Patients in Adare General Hospital, Hawassa City, South Ethiopia, 2023 (n = 488)

Variables	Categories	Frequency	Percent
Visual display unit use (in hours)	≤2	360	73.8
	3–5	91	18.6
	>5	37	7.6
Sleeping duration (in hours)	<8	353	72.3
	≥8	135	27.7
Sunlight exposure (in hours)	<3	422	86.5
	3–4	22	4.5
	5–6	38	7.8
	>6	6	1.2

(*Continued*)

Table 2 (Continued).

Variables	Categories	Frequency	Percent
Smoking cigarette	Yes No	10 478	2.0 98.0
History of an eye examination	Yes No	251 237	51.4 48.6
Spectacle use	Yes No	158 330	32.1 67.9
History of using eye drops	Yes No	157 331	32.2 67.8
History of using artificial tears	Yes No	61 427	12.5 87.5
History of Cataract Surgery	Yes No	67 421	13.7 86.3
History of taking Intravitreal injection	Yes No	13 475	2.7 97.3
History of Vitrectomy	Yes No	6 482	1.2 98.8
History of Pan-retinalphotoagulation	Yes No	15 473	3.1 96.9

Note: Sunlight exposure was categorized based on interquartile range, and sleeping duration was categorized based on the median value.

Clinical Characteristics of the Study Participants

Of the total 488 participants, 352 (72.1%) had type II diabetes. The median duration of diabetes was 7 years (IQR: 4–10), and the median value for FBS was 150 mg/dl (IQR: 125–182 mg/dl). Of the 488 participants, 188 (38.5%) and 120 (24.6%) had allergic conjunctivitis and tear film debris, respectively (Table 3).

Table 3 Clinical Data of Diabetic Patients in Adare General Hospital, Hawassa City, South Ethiopia, 2023 (n = 488)

Variables	Categories	Frequency	Percent
Type of DM	Type I Type II	136 352	27.9 72.1
Duration of DM (in years)	≤5 6–10 ≥11	187 189 112	38.3 38.7 23.0
Glycemic control	Good Poor	263 225	53.9 46.1
Treatment mode	Tablet Insulin Both	312 136 40	63.9 27.9 8.2
Visual impairment	Yes No	150 338	30.7 69.3

(*Continued*)

Table 3 (Continued).

Variables	Categories	Frequency	Percent
Meibomian gland dysfunction	Yes No	133 355	27.3 72.7
Allergic conjunctivitis	Yes No	188 300	38.5 61.5
Debris in the tear film	Yes No	120 368	24.6 75.4
Diabetic retinopathy (DR)	No Mild NPDR Moderate NPDR Severe NPDR Proliferative DR	282 79 72 33 22	57.8 16.2 14.8 6.8 4.4
BMI (kg/m^2)	Normal Underweight Overweight and obese	311 30 147	63.7 6.2 30.1
Vitamin A deficiency	Yes No	8 480	1.6 98.4

Abbreviations: NPDR, non-proliferative diabetic retinopathy; BMI, body mass index.

Systemic Co-Morbidities of the Study Participants

Out of 488 study participants, 146 (29.9%), 55 (11.3%), and 75 (15.4%) had a history of hypertension, dyslipidemia, and diabetic neuropathy, respectively (Table 4).

Table 4 Systemic Comorbidities of Diabetic Patients in Adare General Hospital, Hawassa City, South Ethiopia, 2023 (n = 488)

Variables	Categories	Frequency	Percent
Hypertension	Yes No	146 342	29.9 70.1
Heart disease	Yes No	50 438	10.2 89.8
Dyslipidemia	Yes No	55 433	11.3 88.7
Diabetic neuropathy	Yes No	75 413	15.4 84.6
Asthma	Yes No	39 449	8.0 92.0
Sinusitis	Yes No	20 468	4.1 95.9
Dermatitis	Yes No	13 475	2.7 97.3
Arthritis	Yes No	63 425	12.9 87.1

(*Continued*)

Table 4 (Continued).

Variables	Categories	Frequency	Percent
Thyroid disease	Yes No	6 482	1.2 98.8
Parkinson disease	Yes No	5 483	1.0 99.0
Antidepressant medication	Yes No	9 479	1.8 98.2
Diuretic use	Yes No	6 482	1.2 98.8

Prevalence of Symptomatic Dry Eye Disease

The prevalence of symptomatic dry eye disease in this study was 34.8% (95% CI = 30.6–39.1), of whom 63.5% were found in type 2 diabetic patients.

Factors Associated with Symptomatic Dry Eye Disease

Using bivariable binary logistic regression analysis, educational status, occupational status, monthly income, visual display unit (VDU) use, duration of sleep, history of eye examination, spectacle use, history of using eye drops, history of using artificial tears, arthritis, type of DM, duration of DM, glycemic control, treatment mode, dyslipidemia, heart disease, hypertension, diabetic neuropathy, history of cataract surgery, meibomian gland dysfunction, allergic conjunctivitis, debris in the tear film, diabetic retinopathy, and BMI were independently associated with symptomatic dry eye disease. However, in multivariable binary logistic regression analysis, educational status, occupational status, use of visual display unit, duration of DM, glycemic control, debris in the tear film, and allergic conjunctivitis were significantly associated with symptomatic dry eye disease.

Participants with an educational status of College and University were 5.88 times (AOR = 5.88, 95% CI = 2.25–15.38) more likely to have symptomatic dry eye disease than those with an educational status of primary school or lower. Participants who were government employed were 2.22 times (AOR = 2.22, 95% CI = 1.05–4.68) more likely to have symptomatic dry eye disease than those who were employed in the private business.

The odds of symptomatic dry eye disease were 4.41 times higher (AOR = 4.41, 95% CI = 1.51–12.87) in participants who used a VDU > 5 hours than in participants who used a VDU ≤ 2 hours. The odds of developing symptomatic dry eye disease were 3.57 times (AOR = 3.57, 95% CI = 1.28–9.90) higher in participants with diabetes duration since diagnosis ≥11 years than in participants with diabetes duration ≤5 years.

Participants with poor glycemic control were 2.13 times (AOR = 2.13,95% CI = 1.21–3.75) more likely to have symptomatic dry eye disease than participants with good glycemic control. Participants with allergic conjunctivitis were 1.99 times (AOR = 1.99,95% CI = 1.12–3.54) more prone to symptomatic dry eye disease than participants without allergic conjunctivitis. Individuals with debris in the tear film were 3.63 times (AOR = 3.63, 95% CI = 1.53–8.61) more likely to have symptomatic dry eye disease than those without debris in the tear film (Table 5).

Discussion

In this study, the prevalence of symptomatic dry eye disease (SDED) was 34.8% (95% CI = 30.6–39.1). This result is consistent with the studies conducted in Berhampur 37.2%,[24] and India 32.8%.[40]

On the other hand, the result of this study was higher than that of the study conducted in Iran 17.7%.[41] The difference might be due to differences in inclusion and exclusion of the study population. For example, in a study conducted in Iran, only type 2 diabetes was included and the use of medication or history of any other ocular or systemic disease that may affect tear production was excluded.

Table 5 Factors Associated with Symptomatic Dry Eye Disease Among Adult Diabetic Patients in Adare General Hospital, Hawassa City, South Ethiopia, 2023 (n = 488)

Variables	Symptomatic Dry Eye Disease				
	Yes	No	COR (95% CI)	AOR (95% CI)	P-value
Educational status					
Primary school or lower	64	225	1.00	1.00	
Secondary school	52	69	2.65(1.68–4.17)	2.69(1.38–5.27)	0.004
College and University	54	24	7.91(4.54–13.78)	5.88(2.25–15.38)	<0.0001
Occupational status					0.195
Government employed	80	68	3.07(1.94–4.85)	2.22(1.05–4.68)	0.032
Farmer	7	35	0.52(0.22–1.25)	1.44(0.44–4.73)	0.469
Housewife	32	82	1.02(0.61–1.71)	1.47(0.67–3.23)	0.335
Private business	51	133	1.00	1.00	
Monthly income (Ethiopian Birr)					0.785
≤2000	30	117	1.00	1.00	
2001–4000	26	81	1.25(0.69–2.27)	0.91(0.43–1.99)	
4001–7500	46	70	2.56(1.48–4.43)	0.69(0.30–1.62)	
>7500	68	50	5.30(3.08–9.12)	0.95(0.38–2.38)	
VDU use(hours)					
≤2	87	273	1.00	1.00	
3–5	56	35	5.02(3.09–8.17)	3.03(1.38–6.67)	0.006
>5	27	10	8.47(3.94–18.20)	4.41(1.51–12.87)	0.007
Sleeping duration(hours)					0.334
<8	133	220	1.60(1.04–2.47)	1.38(0.72–2.67)	
≥8	37	98	1.00	1.00	
History of eye examination					0.266
Yes	125	126	1.00	1.00	
No	45	192	0.24(0.16–0.36)	0.64(0.29–1.40)	
Spectacle use					0.554
Yes	81	77	1.00	1.00	
No	89	241	0.35(0.24–0.52)	0.79(0.37–1.69)	
History of using an eye drop					0.215
Yes	78	79	2.57(1.73–3.81)	0.64(0.32–1.29)	
No	92	239	1.00	1.00	
History of using artificial tears					0.187
Yes	43	18	5.64(3.13–10.16)	1.85(0.74–4.62)	
No	127	300	1.00	1.00	
History of Cataract Surgery					0.691
Yes	35	32	2.32(1.38–3.90)	1.18(0.53–2.64)	
No	135	286	1.00	1.00	
Type of DM					
Type I	62	74	1.89(1.26–2.84)	1.50(0.81–2.76)	0.195
Type II	108	244	1.00	1.00	
Duration of DM (in years)					
≤5	34	153	1.00	1.00	
6–10	60	129	2.09(1.29–3.39)	2.33(1.19–4.55)	0.013
≥11	76	36	9.50(5.52–16.36)	3.57(1.28–9.90)	0.015

(*Continued*)

Table 5 (Continued).

Variables	Symptomatic Dry Eye Disease				
	Yes	No	COR (95% CI)	AOR (95% CI)	P-value
Glycemic control					0.008
Good	53	210	1.00		
Poor	117	108	4.29(2.88–6.40)	2.13(1.21–3.75)	
Treatment mode					0.433
Tablet	83	229	1.00	1.00	
Insulin	62	74	2.31(1.52–3.52)	1.50(0.81–2.75)	
Both	25	15	4.60(2.31–9.15)	1.11(0.38–3.22)	
Meibomian gland dysfunction					0.595
Yes	92	41	7.97(5.10–12.44)	1.23(0.57–2.68)	
No	78	277	1.00	1.00	
Allergic conjunctivitis					0.019
Yes	102	86	4.05(2.73–6.00)	1.99(1.12–3.54)	
No	68	232	1.00	1.00	
Debris in the tear film					0.003
Yes	85	35	8.09(5.09–12.84)	3.63(1.53–8.61)	
No	85	283	1.00	1.00	
Diabetic retinopathy (DR)					0.379
No	67	215	1.00	1.00	
Mild non-proliferative	31	48	2.07(1.22–3.52)	0.57(0.25–1.28)	
Moderate non-proliferative	39	33	3.79(2.21–6.50)	0.48(0.18–1.25)	
Severe non-proliferative	21	12	5.62(2.63–12.01)	0.29(0.07–1.15)	
Proliferative	12	10	3.85(1.59–9.31)	0.88(0.17–4.66)	
BMI (kg/m^2)					0.079
Normal	97	214	1.00	1.00	
Underweight	18	12	3.31(1.53–7.14)	1.56(0.48–5.08)	
Overweight and obese	55	92	1.32(0.87–1.99)	0.55(0.30–1.00)	
Hypertension					0.550
Yes	66	80	1.89(1.27–2.81)	1.21(0.65–2.24)	
No	104	238	1.00	1.00	
Diabetic neuropathy					0.117
Yes	55	20	7.13(4.09–12.42)	1.97(0.84–4.60)	
No	115	298	1.00	1.00	
Dyslipidemia					0.658
Yes	28	27	2.13(1.21–3.74)	1.28(0.51–2.90)	
No	142	291	1.00	1.00	
Heart disease					0.304
Yes	24	26	1.85(1.02–3.33)	0.62(0.25–1.54)	
No	146	292	1.00	1.00	
Arthritis					0.183
Yes	34	29	2.49(1.46–4.26)	1.70(0.78–3.70)	
No	136	289	1.00	1.00	

Abbreviations: VDU, visual display unit; COR, crude odds ratio; AOR, adjusted odds ratio.

In contrast, the outcome of this study was lower than previous studies conducted in the United Kingdom 44%,[42] Albania 52.9%,[17] Iran 54.3%,[23] Saudi Arabia 51.7%,[25] Erbil, Iraq 41.5%,[43] Hoskote, Bangalore 55.7%,[26] India 68%,[44] Ghana 72.3%,[45] and Nairobi, Kenya 49.8%.[30] The discrepancy could be due to differences in the socio-demographic characteristics of the study participants, the study setting, and the measurement tool (diagnosis) for the outcome variable. For example, in the studies conducted in Iran, Hoskote, Bangalore, Ghana, and Kenya, tear break-up time, Schirmer test, and ocular surface disease index questionnaire were used to diagnose dry eye, whereas in this study, only OSDI questionnaire was used to diagnose dry eye.

Participants with an educational status of secondary school, college, and university were 2.69 and 5.88 times more likely to have symptomatic dry eye disease, respectively, than those with an educational status of primary school or lower. This result was confirmed by a study conducted in France.[46] This could be because as education levels increase, so does the likelihood of coming into contact with visual display devices such as computers, smartphones, and tablets. So, spending more time with screens while blinking less leads to dry eye disease.[47]

Participants who worked 3–5 and >5 hours at a VDU had a 3.03- and 4.41-fold higher risk of symptomatic dry eye disease, respectively, than participants who worked ≤2 hours per day at a VDU. Studies conducted on Japanese at VDU users,[47] Turkey lecturer,[48] and Chinese medical students[49] reached similar conclusions. The possible reason for this association could be that individuals working at a VDU for a long period of time are exposed to a low blink rate and evaporation of the precorneal tear film contributes to the development of SDED.[47]

Participants with allergic conjunctivitis were 1.99 times more prone to symptomatic dry eye disease than participants without allergic conjunctivitis. A study conducted in Ethiopia among postgraduate students[11] reached a similar conclusion. Allergic conjunctivitis is an inflammatory disorder of the conjunctiva that decreases goblet cell density, alters the lipid layer of the pre-corneal tear film, and increases meibomian gland duct distortion. Those conditions can increase the probability of developing dry eye disease.[50,51] Besides, individuals who have used medications such as antihistamines for the treatment of allergic conjunctivitis were more likely to develop dry eye disease than their counterparts.[52]

The odds of symptomatic dry eye disease for those participants with a duration of diabetes since diagnosis of 6–10 years and ≥11 years were 2.33 and 3.57 times higher than those participants with a duration of diabetes ≤5 years, respectively. This result was in line with the studies conducted in China,[5,6] Albania,[17] Iran,[23] India,[18–21,40] Pakistan,[22] and Egypt.[15] The impact of diabetes on the ocular surface is directly proportional to the duration of DM; that means as the duration of diabetes increases, diabetes could damage the accessory lacrimal gland, which leads to a reduction of basic tear secretion and instability of tear film, which facilitate the occurrence of dry eye disease in diabetic patients.[53]

Participants who had poor glycemic control were 2.13 times more likely to have symptomatic dry eye disease than participants with good glycemic control. This finding was consistent with the studies conducted in China,[16] Albania,[17] India,[18–21] and Egypt.[15] Uncontrolled high blood glucose damages the microvasculature of the lacrimal gland, causes autonomic neuropathy that affects the tear gland, and also disrupts the normal chemical composition and quality of the tear film by increasing the concentration of glucose in the tear film.[17,53]

Individuals with debris in the tear film were 3.63 times more likely to have symptomatic dry eye disease than those without debris in the tear film, which was similar finding in a study conducted in Egypt.[15] The possible explanation for this association is that debris can cause blurring of vision and a foreign body sensation in the eye since the debris is the collection or accumulation of the lipid and mucin of the tear film that is found on the cornea and moves with each blink.

Participants who were government employed were 2.22 times more likely to have symptomatic dry eye disease than those who were employed in the private business. This is due to the fact that employed individuals spent more time on visual display units with a reduced blinking rate.

Limitations of the Study

Because the study design was cross-sectional, it does not show the actual cause and effect relationship. The result of this study might be underestimated because the data were collected using only the OSDI questionnaire instead of using a combination of OSDI tools with other objective tests such as the tear break-up time, Schirmer test, and tear osmolarity test. Current fasting blood sugar was used to assess glycemic control because of the lack of facilities to assess glycated hemoglobin in the study area. Moreover, this study did not assess the impact of total cholesterol, HDL-C, LDL-C, and

creatinine levels on the existence of dry eye disease because of the lack of these data in the medical records of the study participants during the data collection period.

Conclusion

The study revealed a high prevalence of symptomatic dry eye disease. Higher educational status, government employed, use of visual display unit, longer duration of diabetes, poor glycemic control, allergic conjunctivitis, and tear film debris were significantly associated with symptomatic dry eye disease. Breaks in screen use, good glycemic control, and treatment of ocular morbidities such as allergic conjunctivitis and debris in the tear film were recommended for all diabetic patients. Moreover, further longitudinal studies using objective tests of dry eye are needed to identify the exact predictors of symptomatic dry eye among diabetic patients.

Data Sharing Statement

All the necessary data are included in the manuscript, and if needed, the supporting data are available by request to the corresponding author.

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