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Prevalence and Associated Risk Factors of Symptomatic Dry Eye in Ghana: A cross-sectional population-based study

Emmnuel Kobia Acquah
Technological University Dublin, d19123789@mytudublin.ie

Stephen Ankamah-Lomotey
Crystal Eye Clinic, Accra, Ghana

Ebenezer Owusu
Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

See next page for additional authors

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Authors

Emmnuel Kobia Acquah, Stephen Ankamah-Lomotey, Ebenezer Owusu, Sedinam Forfoe, Joseph Bannor, Joana Abokoma Koomson, Martin Opoku, Daniel Mensah Dzikpo, Derrick Nii Okaikwei Mensah, Jedidiah N. Amonoo, and Prince Kwaku Akowuah

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Prevalence and associated risk factors of symptomatic dry eye in Ghana: A cross-sectional population-based study

Emmanuel Kobia-Acquah [a,b,*], Stephen Ankamah-Lomotey [c,d], Ebenezer Owusu [a], Sedinam Forfoe [e], Joseph Bannor [a], Joana Abokoma Koomson [f], Martin Opoku [g], Daniel Mensah Dzikpo [h], Derrick Nii Okaikwei Mensah [i], Jedidiah N. Amonoo [j], Prince Kwaku Akowuah [a,k]

[a] Department of Optometry and Visual Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[b] Centre for Eye Research Ireland, School of Physics, Clinical and Optometric Sciences, College of Sciences and Health, Technological University Dublin, Dublin, Ireland
[c] Crystal Eye Clinic, Accra, Ghana
[d] School of Optometry, Cardiff University, Cardiff, United Kingdom
[e] Eye Department, Tamale Teaching Hospital, Tamale, Ghana
[f] Bishop Ackon Memorial Christian Eye Center, Cape Coast, Ghana
[g] Three D Eye Care, Sunyani, Ghana
[h] Eye Department, Ho Teaching Hospital, Ho, Ghana
[i] Amasha Eye Care, Koforidua, Ghana
[j] Eye Department, Western Regional Hospital, Takoradi, Ghana
[k] College of Optometry, University of Houston, Houston, Texas, USA

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ABSTRACT

Purpose: This study sought to estimate the prevalence and associated risk factors of symptomatic dry eye in the general non-clinical Ghanaian population.
Methods: This was a cross-sectional population-based study conducted from November 2019 to February 2020. A stratified, multistage, random sampling technique was used to select participants aged 18 years and above from the capital cities of eight administrative regions in Ghana. Symptomatic dry eye was assessed using the Ocular Surface Disease Index questionnaire (OSDI). A study specific structured questionnaire was administered to collect information on participants' demographics and self-reported risk factors of dry eye disease such as smoking, diabetes, hypertension, arthritis, ocular allergies, pregnancy, contact lens wear, use of topical glaucoma medication and multivitamin supplement. Multiple linear regression analysis was used to explore associations between symptomatic dry eye and participant characteristics. A p-value of 0.05 was considered statistically significant.
Results: A total of 1316 individuals participated in the study [mean (SD) age 37.0 (15.72) years; range 18–90 years; 50.2 % males]. The prevalence of symptomatic dry eye was 69.3 % [95 % CI: 66.7 % - 71.7 %; mean (SD) OSDI score of 26.97 (21.52)]: 19.8 %, 16.6 % and 32.9 % mild, moderate and severe symptoms respectively. The most common ocular symptom was sensitivity to light (experienced at least some of the time), reported by 67.1 % of participants; most affected vision-related activity was reading (49.3 %); most common environmental trigger of dry eye symptoms was windy conditions (61.3 %). There was a significant positive association between symptomatic dry eye and age ($p < .0001$), female sex ($p = .026$), arthritis ($p = .031$), ocular surface allergy ($p = .036$) and regional zone ($p = .043$).
Conclusion: There is a high prevalence of dry eye symptoms in Ghana. This represents a high dry eye disease burden and a significant public health problem that needs immediate attention.

* Corresponding author at: Kwame Nkrumah University of Science and Technology, Department of Optometry and Visual Science, Private Mail Bag, University Post Office, Kumasi, Ghana.

E-mail addresses: ekobiaacquah.cos@knust.edu.gh (E. Kobia-Acquah), stephenlomotey7@yahoo.com (S. Ankamah-Lomotey), snreben8@gmail.com (E. Owusu), sedito10@yahoo.com (S. Forfoe), bannor126@gmail.com (J. Bannor), jkoomson1234@gmail.com (J.A. Koomson), mofkok50@yahoo.com (M. Opoku), dannymensah267@gmail.com (D.M. Dzikpo), mensah.der@gmail.com (D.N.O. Mensah), jedamon77@gmail.com (J.N. Amonoo), pkakowua@central.uh.edu (P.K. Akowuah).

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1. Introduction

Dry eye disease (DED) is a multifactorial disease of the ocular surface associated with loss of homeostasis and inflammation of ocular surface tissues [1]. Evaporative DED and aqueous deficiency DED are the two main types of DED, with evaporative DED being the commonest type [2]. Dry eye disease causes a broad range of symptoms including grittiness, stinging, burning and foreign body sensation, photosensitivity, sporadic visual disturbance, dryness and tired eyes. Clinically, DED is mostly diagnosed using DED symptoms and signs. Dry eye symptoms are assessed using validated questionnaires such as the Ocular Surface Disease Index (OSDI), Standard Patient Evaluation of Eye Dryness (SPEED), McMonnies or Dry Eye Questionnaire (DEQ-5) [3]. Notwithstanding the good correlation between these questionnaires, the OSDI appears to be the most commonly used diagnostic tool for dry eye symptoms, perhaps due to its ease of use, high validity and reliability in assessing dry eye symptoms [4,5]. Clinical signs of DED are assessed by one or a combination of the following tests: tear break up time (TBUT), Schirmer's test, ocular surface staining, tear osmolarity and meibography. Dry eye symptoms may or may not correlate with the severity of the clinical signs and can be aggravated by environmental factors such as humidity and windy conditions [6–8].

Several risk factors, both modifiable and non-modifiable, have been implicated in DED. Examples of non-modifiable risk factors of DED are age and sex. In addition to increasing age being a primary risk factor for DED, older persons tend to be more prone to diseases such as diabetes and arthritis, which have also been independently associated with DED [9–11]. Female gender has been identified as a risk factor of DED, mainly due to the hormonal changes that occur during pregnancy and menopause [12,13]. Modifiable risk factors include environmental and lifestyle factors such as smoking, use of contact lens, windy and humid environments [14,15]. It is important to assess risk factors of DED within the general population as it informs the choice of management plan within these populations, in some cases by simply limiting exposure to these risk factors. Another important use of prevalence data is to identify patients who are at higher risk and should be considered for added clinical testing to verify a diagnosis.

Dry eye disease affects millions of people globally, with prevalence estimates as high as 73.5 % reported in some populations [9,11,15–18]. The prevalence of DED varies significantly among different populations, primarily due to the study setting (population-based or hospital-based), demographic characteristics of the population, and diagnostic criteria used. Studies using symptoms with signs as a diagnostic criterion have reported prevalence of 8.7–30.1 %, however, studies using signs or symptoms alone to assess DED prevalence seem to report higher prevalence estimates [19]. The public health significance of DED cannot be overstated, as it can significantly affect an individual's visual function and performance of routine activities such as driving, writing and reading [20]. The impact of DED on an individual's quality of life and overall productivity has been well documented; loss of working time due to dry eye symptoms resulted in an estimated USD 55.4 billion annual loss of productivity in the United States alone [21–24]. Dry eye disease can also cause a considerable economic burden on the health care system, given that most persons affected with the condition may have to undertake multiple visits to the eye clinic within a year [24].

Dry eye disease is well-studied in most Asian and Western countries. There is however paucity of information on DED in developing countries like Ghana and Africa at large, due to the lack of major population-based studies on DED. This is reflected in the Tear Film and Ocular Surface Dry Eye Workshop II (TFOS DEWS II) Epidemiology Report, where the estimated prevalence of DED was sampled from population-based studies in Asia, USA, and European countries with no representation from Africa [19]. In Ghana, the only study on symptomatic dry eye in a non-clinical population was done among university undergraduate students [25], who are not a good representation of the general population. To date, there is no epidemiological study on DED among the general non-clinical Ghanaian population. This study will therefore represent the first population-based data on DED in Ghana. While diagnoses of DED may require either one or more dry eye clinical tests, it is important to acknowledge that pre-clinical dry eye (which involves presentation of symptoms without clinical signs) may indicate an incipient DED episode [1,26]. Information on dry eye symptoms among the general population may therefore reveal the burden of DED, hence, inform policy decisions on DED practice in Ghana. This study sought to estimate the prevalence and associated risk factors of symptomatic dry eye in the general non-clinical Ghanaian population.

2. Methods

This was a cross-sectional population-based study conducted in Ghana between November 2019 and February 2020.

2.1. Study area

Ghana is in the western part of Africa with a population size of approximately 25 million as of 2010 [27]. Ghana was previously made up of 10 administrative regions (Ashanti Region, Brong Ahafo Region, Central Region, Eastern Region, Greater Accra Region, Northern Region, Upper East Region, Upper West Region, Volta Region and Western Region) [27]. Although now consisting of 16 administrative regions, there are no available population data for the 6 newly created administrative regions. Ghana is in the tropical climate zone, with subtle variations in climatic conditions across the different regional zones: the eastern coastal zone is warm and comparatively dry, the southwest corner of Ghana is hot and humid, and the north of Ghana is hot and dry. Ghana has two main seasons: the dry season, typically between late December and early March and the wet season, typically between late March and late November [28,29].

2.2. Sampling

Sample size was calculated using the OpenEpi open-source calculator version 3.0. OpenEpi calculates sample using the formula: $n = DEFF [N*X / (X + N - 1)]X = Z^2_{\alpha/2}*p*(1-p) / d^2$

Where n is the calculated sample size, DEFF is the design effect, N is the population size (assumes a population size of 1,000,000 for population sizes greater than 1,000,000), $Z_{\alpha/2}$ is the critical value of the normal distribution at $\alpha/2$ (e.g., for a confidence level of 95 %, α is 0.05 and the critical value is 1.96), d is the margin of error, p is the sample proportion. Assuming a design effect of 1.5 and a sample proportion of 44.3 % as reported by Asiedu et al. [25], the calculated sample size was 569. To increase the statistical power of the study, the calculated sample size was doubled. A final sample size of 1365 was derived after allowing for a 20 % non-response and spoilt data.

The study area (Ghana) was grouped into clusters based on the previous 10 administrative regions of Ghana. The decision to group the study area based on the previous 10 administrative regions was due to the availability of population data for the 10 previous administrative regions. Eight administrative regions (Ashanti Region, Brong Ahafo Region, Central Region, Eastern Region, Greater Accra Region, Northern Region, Volta Region and Western Region) were randomly selected out of the 10 regions by balloting.

The number of participants included from each region was determined by the proportion their respective regions contributed to the total population size of Ghana. Study participants were contacted in person. As many individuals were contacted as possible until the sample size was achieved. The capital cities of the selected administrative regions were chosen for data collection due to the availability of research personnel and ease of access to those locations. Two municipal districts in each capital city were randomly selected by balloting. In each municipal district, using the town hall as a starting point, every third house was selected for sampling. In each house, each member of the household was assigned a number after obtaining their consent to participate in the study; a maximum of 2 individuals were selected from each household for participation through balloting.

2.3. Inclusion criteria

Individuals aged 18 years and above were included in the study. Excluded from the study were individuals with an obvious ocular infection or inflammation, and individuals who have undergone any type of ocular surgery.

2.4. Approval and informed consent

Approval for the study was obtained from the Board of the Department of Optometry and Visual Science at the Kwame Nkrumah University of Science and Technology. Written informed consents were obtained from all participants prior to their participation in the study and all study protocols complied with the tenets of the Declaration of Helsinki.

2.5. Questionnaires

Symptomatic dry eye was assessed with the OSDI. The OSDI is a validated dry eye questionnaire developed by the Outcomes Research Group at Allergan (Irvine, CA); designed to rapidly assess dry eye related symptoms within the immediate past week [5], It is a 12-item questionnaire created to provide a quick assessment of the symptoms of ocular discomfort consistent with dry eye and their consequence on vision-related functioning. It assesses dry eye symptoms on three subscales: ocular symptoms, visual related function and environmental triggers [5,30]. Each answer is scored on a 5-point scale, resulting in a composite OSDI score ranging from 0 to 100 [5]. Responses to all questions on the OSDI were scored on a scale of 0–4 (0 = none of the times, 1 = sometimes, 2 = half of the time, 3 = most of the time and 4 = all the time). The overall OSDI score was calculated using the formula: OSDI = (sum of OSDI scores X 25) / (total number of questions). Overall OSDI score was grouped as normal (< 13), mild (13–22), moderate (23–32) and severe (> 32) [31]. An individual with OSDI score ≥ 13 was classified as having symptomatic dry eye.

A study specific structured questionnaire was also administered to collect information on participants' demographics and self-reported smoking, diabetes, hypertension, arthritis, ocular allergies, pregnancy, contact lens wear, use of topical glaucoma medication and oral multivitamin supplement use.

Both questionnaires were self-administered by participants. Members of the research team were trained to interpret and translate the questionnaires from English to a comprehensible local language for study participants, when needed. 8.7 % of participants required translation; local languages translated into were Twi, Ewe, Ga and Hausa.

2.6. Statistical analysis

Statistical analysis of data was done with the Statistical Package for the Social Sciences (SPSS) software version 25.0. Graphs were done with GraphPad Prism Version 8.4.3 (GraphPad Software, LLC). Mean, standard deviation and percentages were used to describe data, where appropriate. Univariate and multiple linear regression analyses were performed to explore associations between symptomatic dry eye and sex, age, education, occupation, regional zone, smoking, diabetes, hypertension, arthritis, ocular allergies, pregnancy, contact lens wear, use of topical glaucoma medication and oral multivitamin supplement use. For analysis, the regions were grouped into four zones: Northern zone (Northern Region), Middle zone (Brong Ahafo Region and Ashanti Region), Southeast zone (Greater Accra Region, Eastern Region, and Volta Region), Southwest zone (Western Region and Central Region). Binary logistic regression analysis was performed to determine the relationship between symptomatic dry eye and duration of systemic or ocular conditions that showed a significant association with symptomatic dry eye on multiple linear regression analysis. At 95 % confidence interval, $p \leq 0.05$ was considered statistically significant.

3. Results

A total of 1597 individuals were contacted; 232 (14.5 %) declined to participate in the study, yielding an 85.5 % response rate. Out of the 1365 study participants, 1316 (96.4 %) valid data was obtained. The characteristics of the participants are summarized in Table 1.0. The age range of participants was 18–90 years; mean (SD) age for the overall sample was 37.0 (15.73) years. The mean (SD) age for males and females were 35.87 (14.83) years and 38.13 (16.51) years respectively. Majority (66.4 %) of the participants were ≤ 40 years old.

The mean (SD) OSDI score was 26.97 (21.52). The prevalence of symptomatic dry eye in the study was 69.3 % (95 % CI: 66.7 % - 71.7 %): mild symptoms (19.8 %; 95 % CI: 17.7 % - 22.1 %), moderate symptoms (16.6 %; 95 % CI: 14.6 % - 18.7 %) and severe symptoms (32.9 %; 95 % CI: 30.4 % - 35.5 %) (Fig. 1).

The most common ocular symptom was sensitivity to light

Table 1
Characteristics of study participants.

Characteristics		Participants [n (%)]
Sex	Males	661 (50.2)
	Females	655 (49.8)
Age	≤30	615 (46.7)
	31 – 40	259 (19.7)
	41 – 50	177 (13.5)
	51 – 60	121 (9.2)
	>60	144 (10.9)
Education	Primary	176 (13.4)
	Secondary	285 (21.6)
	Vocational	118 (9.0)
	Tertiary	647 (49.2)
	None	90 (6.8)
Occupation	Teaching	93 (7.1)
	Health	120 (9.1)
	Public service	79 (6.0)
	Banking	136 (10.3)
	Farming	269 (20.4)
	Trading	101 (7.7)
	Retired/ unemployed	292 (22.2)
	Student	110 (8.4)
	Others	116 (8.8)
Regional zone	Northern zone	150 (11.4)
	Middle zone	460 (35.0)
	Southeast zone	406 (30.8)
	Southwest zone	300 (22.8)
Smoking	Yes	23 (1.7)
	No	1293 (98.3)
Contact lens wear	Yes	35 (2.7)
	No	1281 (97.3)
Diabetes	Yes	70 (5.3)
	No	1165 (88.5)
	Don't know	81 (6.2)
Hypertension	Yes	128 (9.7)
	No	1090 (82.8)
	Don't know	98 (7.5)
Arthritis	Yes	68 (5.2)
	No	1186 (90.1)
	Don't know	62 (4.7)
Itchy eye/ocular allergy	Yes	406 (30.9)
	No	910 (69.1)
Pregnancy (females only)	Yes	17 (2.6)
	No	638 (97.4)
Ophthalmic glaucoma medication use	Yes	65 (4.9)
	No	1251 (95.1)
Multivitamin supplement use	Yes	176 (13.4)
	No	1140 (86.6)

(experienced at least some of the time), reported by 67.1 % of participants and the least common symptom was poor vision, reported by 34.2 % of participants. Dry eye disease symptoms affected the vision-related quality of life of participants. The most affected vision-related activity was reading, affecting 49.3 % of participants and the least affected vision-related activity was driving at night, affecting 23.0 % of participants. The most common environmental trigger of dry eye symptoms was windy conditions (61.3 %), and the least common environmental trigger was air conditioning (36.4 %). Table 2 provides a summary of the ocular symptoms, vision-related quality of life and environmental trigger.

Across regional zones, the prevalence of symptomatic dry eye was highest in the Southeast zone (86.5 %) and lowest in the Middle zone (59.1 %) (Fig. 2). The prevalence of symptomatic dry eye was highest among participants > 60 years old and lowest among participants ≤ 30 years old. Table 3 provides a summary of the prevalence of symptomatic dry eye and mean OSDI scores across the study variables as well as the results for the multiple linear regression analysis to assess the association between study variables and symptomatic dry eye in Ghana. Binary logistic regression revealed that there was no significant association between symptomatic dry eye and duration of arthritis ($p = .281$) and ocular surface allergy ($p = .378$).

Univariate linear regression analysis showed that the following factors have significant association with symptomatic dry eye in Ghana: age ($p < .0001$), sex ($p < .0001$), contact lens wear ($p = .022$), diabetes ($p < .0001$), hypertension ($p < .0001$), arthritis ($p < .0001$), ocular surface allergy ($p < .0001$), ophthalmic glaucoma medication use ($p = .001$), multi-vitamin supplement use ($p < .0001$) and regional zone in which study was conducted ($p < .0001$). The following factors were still associated with symptomatic dry eye after multiple linear regression analysis: age ($p < .0001$), sex ($p = .026$), arthritis ($p = .031$), ocular surface allergy ($p = .036$) and regional zone ($p = .043$).

4. Discussion

To the authors' best knowledge, the findings from this study represent the first population-based data on dry eye disease among the general non-clinical Ghanaian population. The mean (SD) OSDI score was 26.97 (21.52). The prevalence of symptomatic dry eye in the study was 69.3 % (95 % CI: 66.7 % - 71.7 %): mild symptoms (19.8 %; 95 % CI: 17.7 % - 22.1 %), moderate symptoms (16.6 %; 95 % CI: 14.6 % - 18.7 %) and severe symptoms (32.9 %; 95 % CI: 30.4 % - 35.5 %). Symptomatic dry eye was significantly associated with sex, age, arthritis, ocular allergy, and regional zone.

The prevalence of symptomatic dry eye in Ghana (69.3 %) is noticeably higher than that reported in studies conducted in developing [32–34] and developed countries [9,15,35,36]. High prevalence of symptomatic dry eye has been reported in Jordan (59 %) [37], however, the prevalence reported in this study was still higher, perhaps due to the

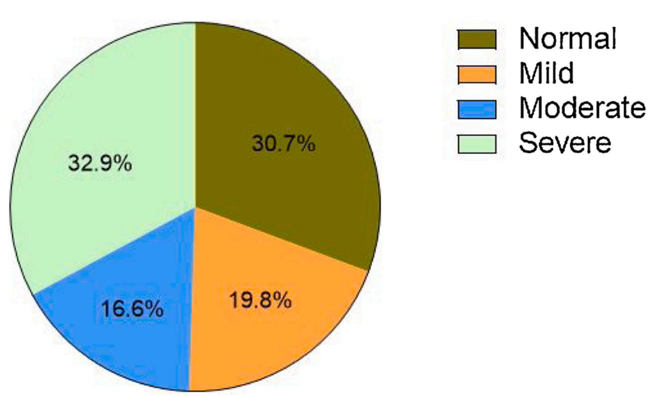

Fig. 1. Severity of dry eye symptoms.

Table 2
Summary of the ocular symptoms, vision-related function and environmental triggers of dry eye symptoms experienced at least some of the time.

Factors	Participants [n (%)]
Ocular symptoms	
Sensitivity to light	883 (67.1)
Gritty sensation	777 (59.0)
Painful or sore eyes	667 (50.7)
Blurred vision	658 (50.0)
Poor vision	448 (34.0)
Vision-related function	
Reading	648 (49.2)
Driving at night	302 (22.9)
Working with a computer or bank machine	600 (45.6)
Watching television	619 (47.0)
Environmental triggers	
Windy conditions	806 (61.2)
Low humidity (dryness)	691 (52.5)
Air conditioning	479 (36.4)

difference in the OSDI cut-off thresholds used in the two studies. While there was a difference in the OSDI cut-off used in the Jordan study (OSDI ≥ 20) and the current study (OSDI ≥ 13), the mean OSDI scores (27 and 26.9 respectively) were similar for both studies, suggesting similar intensity of symptomatic dry eye in the two countries [37]. A recent meta-analysis of dry eye disease prevalence in Africa estimated the prevalence of dry eye by symptoms in Africa and Ghana to be 36.2 % and 38.3 % respectively [38]. The higher prevalence of symptomatic dry eye in the current study compared to the meta-analysis could be due to the variation in the population characteristics, study setting as well as the diagnostic criteria of the studies included in the meta-analysis. For instance, none of the studies included in the meta-analysis in assessing dry eye symptoms in Ghana was a population-based study. The prevalence of symptomatic dry eye in an earlier study among undergraduate students was 44.3 % [25], lower than observed in the current study. This may be due to a combination of their younger age as well as the period which the current study was conducted. The current study was conducted during the dry season (November to February) when environmental conditions in Ghana are typically windy and dry. This might have influenced the reported symptoms since dry eye disease is known to be affected by environmental conditions such as humidity [39]. Expectedly, the most reported environmental trigger for symptoms was windy environment. In addition to the high prevalence of symptomatic dry eye, a significant number of those with symptomatic dry eye reported severe dry eye symptoms (32.9 %) (Fig. 1). This is reflected in practice, as artificial tear drops have been one of the most frequently dispensed topical medication by optometrists and other eye care practitioners during community outreach programmes in Ghana over the years [40].

As reported in literature, an age-related increase in symptomatic dry eye prevalence was observed in the current study. The prevalence of symptomatic dry eye increased from 61.8 % in ages ≤ 30 years to 87.5 % in ages > 60 years. Multiple linear regression revealed a significant association between age and symptomatic dry eye ($p < .0001$). Consistent with literature, older persons reported severe forms of symptomatic dry eye [mean (SD) OSDI score of 46.92 (24.86)]. Increasing age is an established risk factor for dry eye disease; several studies have reported higher prevalence of dry eye disease in older populations [9,11,16,32,37]. Aging leads to changes in various components of the lacrimal functional unit responsible for the maintenance of the integrity of the ocular surface. One well-reported change in the lacrimal functional unit with age is decreased production of tears [41–43]. Reduction in tear production results in increased ocular surface inflammation and damage of peripheral corneal nerves [44]. In such situation, polymodal and mechanoceptor nerve endings are sensitized and the activity of thermoreceptors increases. This produces the pain and sensation of dryness experienced in dry eye disease [45]. Also, older persons are mostly

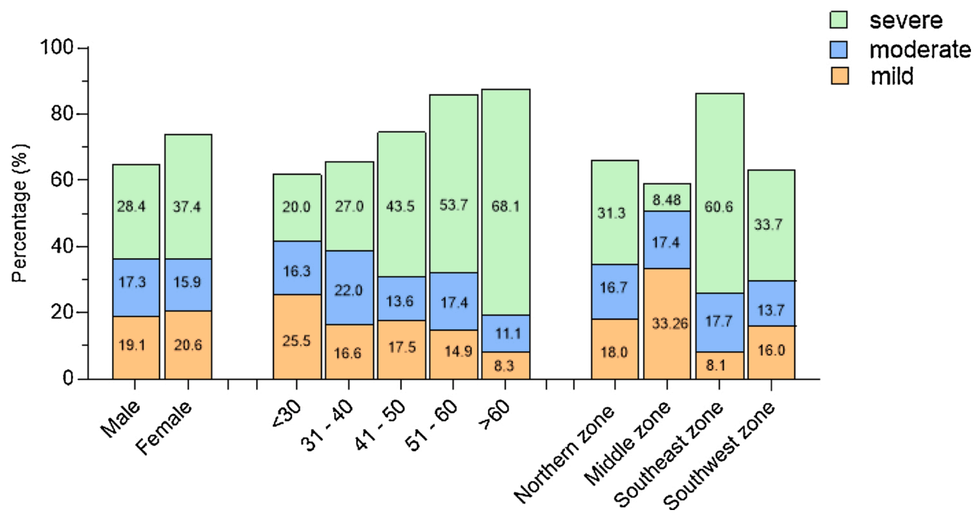

Fig. 2. Prevalence of symptomatic dry eye according to symptoms severity by sex, age, and regional zone.

affected by conditions such as diabetes and arthritis which are considered risk factors for dry eye disease [14].

In agreement with other studies, there was a significant association between sex and symptomatic dry eye in the study (p = .026); the proportion of females (73.9 %) with symptomatic dry eye was significantly higher than the proportion of males (64.75 %) with symptomatic dry eye. This finding is consistent with studies by Tan et. al [15] and Farrand et. al [9] who reported higher dry eye disease prevalence in females in Singapore and USA respectively. Other studies have however reported no significant association between gender and dry eye disease [32,35]. Females experience of dry eye disease more than males, has been attributed to the disproportionate distribution of hormones such as estrogen and androgens (during pregnancy and menopause) which are responsible for lacrimal gland secretion [46,47].

Environmental conditions significantly influence the occurrence of dry eye disease within a given population. Despite our study taking place in eight administrative regions in Ghana, the regions were grouped into four regional zones (Northern, Middle, Southeast, and Southwest) to reflect the climatic conditions of these regions. Participants residing in the Southeast zone (86.5 %) reported the highest prevalence and severity [mean (SD) OSDI score of 40.29 (22.17)] of symptomatic dry eye and residents in the Middle zone (59.1 %) reported the least prevalence and severity [mean (SD) OSDI score of 16.19 (12.16)] (Table 3). There was a significant association between the regional zones and symptomatic dry eye in Ghana (p = .043). It is difficult to explain why persons residing in the Southeast zone seemed to experience more dry eye symptoms because the Northern zone is known to be the region with severe harmattan conditions during the dry season in Ghana. A possible reason could be that the capital and largest city in Ghana, Accra, is located in the Southeast zone, with residents known to be more educated and also have better health seeking behaviour than residents in other regions of the country. Majority of eye care facilities in the country are located in the Southeast zone (Accra) [48], as such, residents may have been exposed to more DED education and awareness programmes. This may have enhanced their understanding of dry eye symptoms and may have accounted for the increased levels of dry eye symptoms reported in the region. Also, with the national capital, Accra being the most urbanized and industrialized city in Ghana [49], it is possible that industrialization and modernization related causes of dry eye might be more prevalent in the Southeast zone than in other regions of Ghana. Industrialization, urbanization and modernization almost always lead to increased air pollution, increased domestic and industrial heat release and increased surface temperature, all of which could directly or indirectly affect DED [50,51]. Future studies are needed to investigate how the increasing trend of urbanization and industrialization are affecting dry eye disease in Ghana.

Several potential modifiable risk factors for dry eye disease were evaluated in this study; contact lens wear, diabetes, hypertension, arthritis, smoking, educational level, occupation, ocular surface allergy, ophthalmic glaucoma medication use, and multi-vitamin supplement use. Even though symptomatic dry eye was high among persons with diabetes (88.6 %), hypertension (83.6 %), smokers (73.9 %), contact lens wearers (71.4 %), and persons using ophthalmic glaucoma medication (80 %) (Table 3), multiple linear regression showed that arthritis (p = .031) and ocular surface allergy (p = .036) were the only modifiable risk factors significantly associated with symptomatic dry eye. Ocular surface allergy [13,17] and arthritis [13,52] have both been cited to correlate significantly with dry eye disease. Ocular allergy affects the tissues of the ocular surface through inflammatory regulated mediators just like dry eye disease. Given the high prevalence of allergic conjunctivitis in Ghana [53] and the fact that ocular surface allergy and dry eye disease share similar chemical and biochemical features [54], it is expected that persons with allergic conjunctivitis will also report high dry eye symptoms. Ocular manifestation of arthritis is very common and can be the first clinical presentation of arthritis [55]. Dry eye disease is a common ocular manifestation of arthritis [56–58]. As high as 90 % prevalence of dry eye disease has been reported in arthritis, with up to 50 % of individuals with arthritis experiencing moderate or severe dry eye disease symptoms [57,59]. Although, both aqueous deficiency and evaporative dry eye disease can co-exist in arthritis, aqueous deficiency dry eye disease is the most common form of dry eye disease seen in arthritis [60]. Arthritis affects the ocular surface as a result of the autoimmune inflammatory responses associated with the disease [56,61].

A major limitation of this study was that participants were asked to provide self-reported information on the assessed risk factors without any documentary evidence or confirmatory tests. This may have resulted in underestimation of the prevalence in persons with conditions such as diabetes known to significantly influence dry eye disease. Another limitation was the inclusion of participants from capital cities of the sampled regions. The symptomatic dry eye prevalence reported in this study may therefore be a reflection of persons living in the urban cities

Table 3
Mean OSDI scores and prevalence of symptomatic dry eye according to participants' characteristics.

Characteristics		Mean (SD) OSDI	Number (%) of respondents with OSDI score ≥ 13	p-value
Sex	Males	24.46 (20.33)	428 (64.8)	.026
	Females	29.51 (22.39)	484 (73.9)	
Age	≤30	20.68 (17.69)	380 (61.8)	<.0001
	31 – 40	23.51 (18.82)	170 (65.6)	
	41 – 50	31.94 (22.32)	132 (74.6)	
	51 – 60	35.37 (20.73)	104 (86.0)	
	>60	46.92 (24.86)	126 (87.5)	
Education	Primary	32.08 (25.18)	118 (67.0)	.287
	Secondary	23.78 (20.06)	181 (63.5)	
	Vocational	26.66 (21.84)	81 (68.6)	
	Tertiary	24.83 (19.29)	450 (69.6)	
	None	43.29 (24.87)	79 (87.8)	
Occupation	Teaching	25.99 (19.17)	63 (67.7)	.822
	Health	24.42 (19.99)	91 (75.8)	
	Public service	26.24 (19.74)	55 (69.6)	
	Banking	44.76 (14.55)	121 (89.0)	
	Farming	21.85 (19.74)	183 (68.0)	
	Trading	40.78 (23.91)	88 (87.1)	
	Retired/ unemployed	23.22 (20.73)	161 (55.1)	
	Student	35.46 (20.63)	97 (88.2)	
	Others	34.33 (33.96)	86 (74.1)	
Regional zone	Northern zone	26.16 (19.64)	99 (66.0)	.043
	Middle zone	16.19 (12.16)	272 (59.1)	
	Southeast zone	40.29 (22.17)	351 (86.5)	
	Southwest zone	25.88 (23.02)	190 (63.3)	
Smoking	Yes	34.49 (24.58)	17 (73.9)	.120
	No	26.84 (21.45)	895 (69.2)	
Contact lens wear	Yes	33.24 (20.94)	25 (71.4)	.828
	No	26.77 (21.50)	885 (69.1)	
Diabetes	Yes	40.69 (22.50)	62 (88.6)	.761
	No	25.84 (21.04)	793 (68.1)	
	Don't know	31.43 (23.02)	57 (70.4)	
Hypertension	Yes	42.69 (24.92)	107 (83.6)	.190
	No	24.97 (20.22)	738 (67.7)	
	Don't know	27.89 (21.92)	67 (68.4)	
Arthritis	Yes	48.54 (24.76)	61 (89.7)	.031
	No	25.78 (20.72)	810 (68.3)	
	Don't know	25.45 (20.70)	39 (62.9)	
Itchy eye/ocular allergy	Yes	32.4 (23.43)	300 (73.9)	.036
	No	24.63 (20.19)	610 (67.0)	
Pregnancy (females only)	Yes	18.29 (9.53)	10 (58.8)	.716
	No	23.81 (15.76)	474 (74.3)	
Ophthalmic glaucoma medication use	Yes	37.09 (23.46)	52 (80.0)	.679
	No	26.45 (21.29)	860 (68.7)	
Multivitamin supplement use	Yes	31.87 (21.83)	136 (77.3)	.601
	No	26.21 (21.38)	776 (68.1)	

and not translatable to those in rural areas. Future studies may be required to estimate the symptomatic dry eye prevalence in rural Ghana and also project the rural-urban differences in dry eye disease.

The high prevalence of symptomatic dry eye in Ghana represents an emerging dry eye disease burden among the general Ghanaian population that requires urgent attention. Eye care practitioners in Ghana commonly prescribe preservative-containing lubricants whiles effective dry eye treatments (such as thermal pulsation and autologous serum tears) for severe forms of dry eye disease are not available on the Ghanaian market [40]. The emerging dry eye disease burden in Ghana therefore requires eye care professionals, industry players, and other relevant stakeholders to improve dry eye disease management by providing effective dry eye disease therapies in Ghana. Further, the reported loss of productivity and economic burden posed by dry eye disease in other countries necessitates an urgent need in addressing the dry eye disease burden in Ghana [62,63].

In conclusion, there is a high prevalence of symptomatic dry eye in Ghana, which is significantly associated with factors such as age, female sex, arthritis, ocular surface allergy and regional zone. This represents a high dry eye disease burden and a significant public health problem that needs immediate attention.

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Declaration of competing interest

All authors have no conflict of interest to declare.

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