Symptomatic Dry Eye Prevalence and Related Factors in an Open University, Bangkok, Thailand

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Abstract

Although dry eye is not a life-threatening disease, its chronic conditions cause ocular damage, and impair daily activities and work performance. Dry eye is a geriatric disease; however, its prevalence has recently increased among the productive-age group. In Thailand, open universities offering distance learning necessitate excessive eye use among members that possibly induces dry eye. This study aimed to explore the prevalence of symptomatic dry eye and its associated factors in an open university's productive-age group in Bangkok by using an internet-based cross-sectional study. 630 university members were conveniently selected from 13 academic faculties. Four sections of the structured questionnaire i.e. 1.) personal factors, 2.) Thai-Perceived Stress Scale-10 and the Thai version of the Pittsburgh sleep quality index, 3.) digital gadget use, and 4.) McMonies questionnaire were transformed to online versions and sent to selected subjects from May to June 2020. Of 542 respondents, the overall prevalence of symptomatic dry eye was 17.5%. The prevalence among those aged <30 years was 10%, and 40% among those aged >49 years. Multiple binary logistic regression revealed a significant association between age >49 years (OR = 9.01), wearing contact lenses (OR = 2.00), and poor sleep quality (OR = 1.70) and higher prevalence of dry eye (p<0.05). The high prevalence of symptomatic dry eye in this study emphasizes a need for public health attention on dry eye prevention among the productive-age group in academic institutions. Productive-age individuals who are aged >49 years, wear contact lenses and have poor sleep quality should be advised to be aware of dry eye condition.

Keywords: Productive-age group, Symptomatic dry eye, Prevalence, Related factors, Open university Thailand

Introduction

Dry eye is a neglected health condition. The World Health Organization raised the world's awareness of this condition in the first report on vision in 2019[1]. Dry eye, a multifactorial eye condition characterized by loss of tear film homeostasis, can cause ocular surface inflammation and damage[2]. Dry eye symptoms such as itching, burning, eye irritation, blurred vision, and photophobia negatively affect daily life[3] and impair work productivity[4,5]. The financial burden of dry eye on health care services in the UK and Singapore amounts to approximately US$1.10 million and US$1.5 million per year, respectively[6,7].

The prevalence of dry eye has increased across the globe[8-14]. In large population-based studies in the U.S. and the Netherlands, the prevalence was 6.8%[8] and 9.1%[9], respectively. In Asia, the prevalence of symptomatic dry eye was 39.8% in China[10], 17.1% in South Korea[11] and 12.3% in Singapore[12]. Two studies in Thailand reported the prevalence of dry eye to be 34.0% in 2006[13] and 14.2% in 2012[14]. In a population-based cross-sectional study conducted in the U.S., dry eye prevalence increased with age, from 0.2% among those aged 2-17 years, to 11.6% among those aged >50 years[15]. However, other studies conducted among university students aged 18 to 34 years in Mexico and Ghana showed a high prevalence of dry eye[16,17], and the prevalence was as high as 44.3% among the elderly in Ghana[17].

Besides age, prevalence of dry eye was reported to be higher among females than males[11,18-23]. In addition, a study in the Netherlands found a greater prevalence of dry eye among individuals with poor sleep quality[21], while other studies in the middle-east found a higher risk of dry eye among individuals undergoing ocular surgery such as laser-assisted in-situ keratomileusis (LASIK) and cataract surgery than in individuals with healthy eyes[24,25]. Several reports have indicated inconsistent associations between dry eye and smoking, alcohol consumption and wearing contact lenses[9,12,22,23,26]. Additionally, a study among paramedical workers at a university hospital underlined a higher risk of dry eye among stressed workers[27].

Digital technologies, e.g., smartphones and computers etc., are currently used extensively in human activities and a previous study reported an association between longer digital screen use and dry eye[28-30]. In Thailand, the average duration of daily internet use has doubled from 2012 to 2018, and the average duration of daily internet use in 2018 was 10 hours (ranging from 9.49-10.35 hours)[31]. The productive-age group reported a longer duration of daily internet use than the elderly; common online activities are to socialize, sell products, search information for studying and working, etc.[31]. This situation may elevate the risk of dry eye among the productive-age group.

An open university offers distance education to both part-time and full-time students. Although educational activities are arranged both online and onsite, most student activities are internet-based. Due to the type of educational management, both staff and students are required to use digital technology,[32-34] and are likely to have excessive digital screen time. Such conditions may raise the risk of dry eye among university staff and students, but no report currently exists.

In Thailand, dry eye has been studied among the elderly since 2006[13,14], but the study of dry eye among the productive-age group has not yet been conducted. Therefore, this study aimed to explore the prevalence of dry eye and identify its related factors in a productive-age group at a public open university in the Bangkok Metropolitan Area, Thailand.

Materials and Methods

Ethical considerations

The study protocol was approved by the Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University on 15 May 2020 (MUPH 2020-051). The study began after ethical approval was obtained.

Study design and sample

This cross-sectional study was composed of an online survey of open university staff and students in Bangkok, from May to June 2020.

The required sample size was calculated for a single proportion estimation: $n = \frac{z^2_{\alpha/2}p(1-p)}{d^2}$, where p is the proportion of dry eye in a population at 0.34[13], and $Z_{\alpha/2}$ is the critical value of normal distribution at $\alpha = 0.05$. Lastly, d is the margin of error at 5%. The sample size (n) estimated to achieve the research objective was 345. A previous online survey had only a 20% response rate[35], therefore we added 276 (80% of 345) to compensate for nonresponse. We then recruited 630 respondents.

This study included current university students and staff aged between 18 and 65 years. All of the respondents voluntarily consented to participate in the study. Students and staff who were blind, used an artificial eye, or suffered from an eye infection were excluded from this study.

An online-based survey was conducted. After receiving permission from the authorities of 13 faculties, we contacted each faculty coordinator to explain the objective of this study and the number of staff and students from each faculty that was required to reach a total sample size of 630. The coordinators of each faculty then sent the internet-based structured questionnaire to students and staff, who then returned their consent to participate in this study via email and LINE application.

Study tools

The internet-based structured questionnaire was comprised of four sections:

Section 1: Personal factors totaled seven questions including status at the university, age, sex, history of ocular surgery, smoking, alcohol consumption, and contact lens wear.

Section 2: Psychological factors comprised of two sets of questions, i.e., sleep quality and stress level. The Thai version of the Pittsburgh sleep quality index (T-PSQI)[36] was used to assess individual sleep quality and covered seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. The possible scores ranged from 0 to 21 points and were classified as poor sleep quality for scores >5. The Thai-Perceived Stress Scale-10 (T-PSS-10)[37] was used to assess the level of stress and comprised of 10 questions. The 5-point Likert scale had six negative items ranging from 0 (never) to 4 (the most frequent) and four positive items ranging from 4 (never) to 0 (the most frequent). The possible scores ranged from 0 to 40 and were classified as mild (0 to 13), moderate (14 to 26) and severe stress (27 to 40). The Cronbach's alpha coefficient of T-PSQI was 0.71, and 0.76 for T-PSS-10.

Section 3: Digital gadget use consisted of two questions including types of digital gadget use, (smartphone, tablet, computer, and television) and duration of digital gadget use (number of hours daily).

Section 4: The McMonnies questionnaire is a self-reported screening tool for dry eye symptoms containing 12 questions. The total score ranges from 0 to 40, and scores ≥14.5 are considered as indicative of dry eye symptoms and at this cut-off point presented a sensitivity of 98% and specificity of 97%[38]. Permission to translate and reproduce this screening tool was obtained.

Statistical analysis

All statistical analyses were executed using SPSS, Version 18.0 (Mahidol University), and the prevalence of dry eye was calculated. Descriptive statistics such as percentage, mean, and SD were used to describe data. Binary logistic regression was used to calculate odds ratio (OR) and 95% confidence interval (95% CI). All significant factors in univariate analysis and digital gadget use were further analyzed using multivariable binary logistic regression. Statistical significance was considered at $p < 0.05$.

Results

General characteristics and prevalence of symptomatic dry eye among respondents

Of 630, 542 subjects agreed and completed questionnaires (response rate = 86%). Of 542 respondents, 70.7% were female, and about 50% were aged between 30 and 49 years. Only 20 (3.7%) respondents had received ocular surgery. Overall, 62 (11.4%) and 320 (59.0%) respondents smoked and consumed alcohol, respectively. A total of 194 respondents (35.8%) wore contact lenses. Regarding psychological factors, most respondents experienced moderate stress (71.4%) while 253 respondents (46.8%) experienced poor sleep quality (Table 1).

The overall prevalence of dry eye was 17.5% and the highest prevalence presented among respondents aged >49 years (40.9%). The prevalence of dry eye among females was slightly higher than in males (18% vs. 16.4%). Dry eye was more prevalent among those who had a history of ocular surgery, in contrast to those without a history of this surgery (40.0% vs. 16.7%). The prevalence of dry eye among smokers was 17.7%, while it was 16.3% among alcohol drinkers. Among contact lens wearers and among individuals with severe stress, the prevalence of dry eye was 22.2% and 33.3%, respectively. Dry eye prevalence in those who reported to have poor sleep quality was 21.7% (Table 1).

Table 1 Distribution and crude association of personal and psychological factors with dry eye among study respondents

Variable	Total (%)	n (%) Dry Eye	OR (95% CI)	*p*
Personal factors				
Age (years)				
≤29 (ref.)	212 (39.1)	23 (10.8)		
30-49	264 (48.7)	45 (17.0)	1.69 (0.99 - 2.89)	0.057
>49	66 (12.2)	27 (40.9)	5.69 (2.96 - 10.95)	<0.001
Mean (SD) = 34.6 (11.6)				
Sex				
Male (ref.)	159 (29.3)	26 (16.4)		
Female	383 (70.7)	69 (18.0)	1.12 (0.69 - 1.84)	0.643
History of ocular surgery				
No (ref.)	522 (96.3)	87 (16.7)		
Yes	20 (3.7)	8 (40.0)	3.33 (1.32 - 8.40)	0.011
Smoking				
No (ref.)	480 (88.6)	84 (17.5)		
Yes	62 (11.4)	11 (17.7)	1.00 (0.50 - 2.03)	0.962
Alcohol consumption				
No (ref.)	222 (41.0)	43 (19.4)		
Yes	320 (59.0)	52 (16.3)	0.81 (0.52 - 1.26)	0.348
Contact lens wear				
No (ref.)	348 (64.2)	52 (14.9)		
Yes	194 (35.8)	43 (22.2)	1.62 (1.04 - 2.54)	0.035
Psychological factors				
Stress				
Mild (ref.)	137 (25.3)	20 (14.6)		
Moderate	387 (71.4)	69 (17.8)	1.27 (0.74 - 2.18)	0.388
Severe	18 (3.3)	6 (33.3)	2.93 (0.99 - 8.69)	0.053
Sleep quality				
Good (ref.)	288 (53.2	40 (13.9)		
Poor	253 (46.8)	55 (21.7)	1.72 (1.10 - 2.70)	0.017

OR, odds ratio; 95% CI, 95% confident internal; (ref.) reference group; SD, standard deviation

Regarding digital gadget use behavior, we found that 77.7% of respondents used more than one digital gadget, and 19.0% of them reported dry eye symptoms. Almost half of respondents used digital gadgets for longer than 9 hours per day, but the prevalence of dry eye (16.7%) was lower than in other groups (19.0%) (Table 2).

Factors related to symptomatic dry eye

Respondents aged >49 years, versus those in other age groups, were more likely to have dry eye. In particular, participants who were over the age of 49 years were 5.69 times more likely than individuals aged ≤29 years to suffer from dry eye (OR 5.69, 95% CI: 2.96-10.95). Respondents who reported past ocular surgery had a 3.33 times increased risk of dry eye, in contrast with those who had not undergone this surgery (OR 3.33, 95% CI: 1.32-8.40). Respondents who wore contact lenses were 1.62 times more likely to suffer from dry eye than non-wearers (OR 1.62, 95% CI: 1.04-2.54). However, our results suggested that sex, alcohol consumption and smoking were not associated with symptomatic dry eye (Table 1).

With regards to psychological factors, poor sleep quality (vs. good sleep quality) was associated with a 1.72 increased chance of dry eye (OR 1.72; 95% CI, 1.10-2.70). On the contrary, stress level was not associated with dry eye (Table 1).

Table 2 Distribution and crude association of digital gadget use with dry eye among study respondents

Variable	Total (%)	n (%) of dry eye	OR (95% CI)	*p*
Digital gadget use				
Number of digital gadgets				
Only one [(ref.)]	121 (22.3)	15 (12.4)		
More than one	421 (77.7)	80 (19.0)	1.660 (0.92 - 3.00)	0.095
Total hours of digital gadget use daily				
≤ 9 [(ref.)]	236 (52.3)	47 (19.9)		
> 9	215 (47.7)	36 (16.7)	0.809 (0.50 - 1.31)	0.386
Mean (SD) = 9.6 (4.9) hours				

OR, odds ratio; 95% CI, 95% confident internal; [(ref.)] reference group; SD, standard deviation

In relation to digital gadgets, using more than one increased the risk of symptomatic dry eye compared with single digital gadget use (OR 1.66; 95% CI, 0.92-3.00). However, the amount of time per day spent using digital gadgets was unrelated to symptomatic dry eye (Table 2).

The outcome of multiple binary logistic regression is shown in Table 3. The respondents aged >49 years had a 9.01 times higher prevalence of dry eye than those aged ≤29 years. Contact lens users and respondents who experienced poor sleep quality had 2.15- and 1.79-times higher prevalence of dry eye, respectively. However, the number and duration of digital gadget use were not associated with dry eye (Table 3).

Table 3 Multiple binary logistic regression model of factors related to dry eye

Variable	Adjusted OR (95% CI)	*p*
Age (years)		
≤29 [(ref.)]		
30 - 49	1.83 (1.01 - 3.35)	0.049
>49	9.01 (4.06 - 20.33)	<0.001
History of ocular surgery		
No [(ref.)]		
Yes	2.44 (0.79 - 7.55)	0.121
Contact lens wear		
No [(ref.)]		
Yes	2.15 (1.24 - 3.72)	0.006
Sleep quality		
Good [(ref.)]		
Poor	1.79 (1.07 - 3.00)	0.026
Number of digital gadgets		
Only one [(ref.)]		
More than one	1.78 (0.89 - 3.53)	0.101
Total hours of digital gadget use daily		
≤ 9 [(ref.)]		
> 9	0.97 (0.56 - 1.67)	0.899

OR, odds ratio; 95% CI, 95% confident internal; [(ref.)] reference group

Discussion

This study was a university-based cross-sectional online survey of dry eye among a productive-age group. The results indicated that the prevalence of symptomatic dry eye was 17.5% among the members of this open university. In a previous study conducted in Thailand, Lekhanont *et al.* reported the prevalence of dry eye was 34%, which is greater than that found in our study, possibly because they recruited respondents aged ≥40 years from annual hospital eye examinations[13]. On the other hand, Kasetsuwan et al. focused on a community-based study (age >50 years); the prevalence of dry eye symptoms (14.2%) was lower than that shown in our study[14].

Our study presented a high prevalence (40.9%) of symptomatic dry eye in respondents aged ≥49 years compared with other studies carried out in Thailand (14.2%)[14], Singapore (12.3%)[12], and South Korea (16.2%)[11]. A study among Singaporeans aged >45 years, which also used the McMonnies questionnaire, revealed a lower prevalence of symptomatic dry eye (12.3%)[12] than that presented in our study. Our study revealed the prevalence of dry eye among younger adults (18 to 28 years) to be (10.8%), while related studies of symptomatic dry eye in young adult populations varied from 10.0 to 44.3%[16, 17, 30, 39]. Compared with those studies, our prevalence was closest to that of Li et al.'s study in China[30]. However, Asiedu *et al.* showed a high prevalence (44.3%) of dry eye among undergraduate students in Ghana (age 18 to 34 years)[17]. Our study emphasized the need for focusing on dry eye at an earlier age, which is in line with the current trend of increasing prevalence of dry eye among children, adolescents and young adults[16,17,30,39].

In terms of associated factors, age, contact lens use, and poor sleep quality were significantly associated with symptomatic dry eye. In this report, the results show a higher risk of symptomatic dry eye among older age groups, which is consistent with other studies conducted in different countries[13-15,18,20-22,40]. Quite possibly, increasing age alters lacrimal gland functions and correlates with androgen deficiency, which disturbs the Meibomian gland. These changes decrease tear production and stability and increase osmolality[41]. Systemic diseases, mostly occurring among the elderly, e.g., rheumatoid arthritis and diabetes mellitus, may relate to intervening tear function.

Currently, several publications show an association between wearing contact lenses and dry eye[9,12,26,42]. Our reported result was consistent with this but in contrast with that of Kasetsuwan et al.[14]. This difference may be because the study population was comprised of a small proportion (0.8%) of elderly contact lens wearers [14]. Contact lens wear can change the corneal surface in pre- and post-lens tear film, resulting in biophysical and biochemical composition changes. Wettability and mucin layer are disrupted, thereby producing dry eye symptoms[43].

Several studies have reported that digital gadget use increases the risk of dry eye[26,28-30,40]. Among these studies, the duration (hours daily) of digital gadget use, as a risk factor, varied depending on the study from >1 hour to >8 hours daily, suggesting that digital gadget use may be influenced by other factors. However, our finding revealed no association, similar to Asiedu et al.'s and Garza-Leon et al.'s results that focused on university members[16,17].

The insignificance of digital gadget use and dry eye in this study may firstly be explained by the similarity of gadget use in this population. Also, the pattern of digital gadget use, such as the length of break times, may vary among individuals. Recently, Rossi et al. showed that the duration of daily breaks taken from digital gadget use was significantly different between dry eye and no dry eye groups[40]. Secondly, the use of digital gadgets results in a reduction of eye blinking that can impair tear stability. Such a condition is determined by clinical examination not self-assessment screening tools. Thirdly, the significant association between dry eye and gadget use presented among people with severe dry eye[26], but our study could not classify severity of dry eye due to the limitation of the McMonnies questionnaire. Lastly, those in the mild stage of dry eye could recover after closing their eyelids for a while and those in the young age group may not have been aware of their symptoms. To better investigate the association between gadget use and dry eye, the measurement of the duration of gadget use should take in to account break times and include clinical examination of dry eye.

Our study found poor sleep quality increased the risk of dry eye, in agreement with previous studies[10,21,44]. Currently, one possible explanation is that poor sleep quality causes sleep deprivation, which leads to several mechanisms that contribute to the development of dry eye. First, sleep deprivation raises cortisol, epinephrine and norepinephrine levels, leading to a decreased parasympathetic tone and resulting in reduced tear production from the lacrimal gland, which is surrounded by parasympathetic nerve fibers and controlled via parasympathetic stimulation[45]. Second, sleep deprivation causes elevated diuresis and natriuresis by activating the hypothalamic-pituitary-adrenal axis. It induces a state of dehydration and affects tear secretion[45]. However, exposure to self-luminous displays, such as computers and smartphones, suppresses the sleep-promoting hormone melatonin at nighttime[46] and consequently affects sleep quality[47]. Therefore, poor sleep quality may result from digital gadget use. Further investigation of pathways from digital gadget use and poor sleep quality to dry eye may be needed.

This study encountered several limitations. Firstly, convenience sampling could have led to healthy worker effects and could have resulted in an underestimation of both the prevalence and magnitude of the association. Secondly, this study involved open university members and it may not be possible to generalize the findings to other educational systems. Thirdly, symptomatic dry eye in this study was classified using a self-evaluated questionnaire which did not directly detect ocular surface pathology. However, McMonnies presented optimal diagnostic performance among a productive-age group. Likely false positives and false negatives may have been very few. Lastly, our work was a cross-sectional design that limits assessing dry eye and causative factors.

Conclusion

In summary, this constitutes the first study of prevalence and risk factors in an education setting in Thailand. The predictive factors comprised of age, contact lens wear, and poor sleep quality. Eye health promotion to prevent dry eye among age groups higher than 49 years should be implemented. A significantly high prevalence of dry eye among contact lens wearers and individuals with poor sleep quality can be used to raise awareness of dry eye in the productive-age population. In addition, digital gadget factors should be further investigated for association with dry eye by conducting a follow-up study.

Author contributions

PT initiated the idea, conducted the study, analyzed data and drafted the manuscript. VK advised on the protocol and the manuscript. NS advised on the protocol and the manuscript. MT guided the research idea and data analysis, and finalized the manuscript. All authors read and approved the final submitted version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest

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