· Original article ·

Prevalence of symptomatic dry eye disease among Chinese college students with associated risk factors

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大学生干眼症的流行病学调查及相关危险因素分析

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摘要

目的:了解中国大学生干眼症患病状况,探讨干眼症发病的相关危险因素。

方法:横断面研究方法。以兰州大学医学院所有在读学生作为研究对象,采用问卷调查方式对干眼症患病状况及相关危险因素进行调查。干眼症诊断采用六项问卷形式,以受检者经常或总是出现一个或一个以上症状作为干眼症的诊断标准。干眼症阳性体征包括泪膜破裂时间(TBUT)≤10s以及单眼或双眼角膜染色(FSS)计分≥1。采用多因素logistic回归模型进行相关危险因素分析。

结果:共1139名学生纳入本研究,应答率为84.37%,其中男生475名,女生664名,年龄16~26岁。干眼症的患病率为18.70%(95% *CI*=16.59~20.81),阳性体征中TBUT≤10s的比例大约占47.67%(95% *CI*=44.95~50.57),FSS≥1占了13.97%(95% *CI*=11.95~15.99)。多因素Logistic回归分析结果显示每日阅读时间≥4h(*OR*=1.58, 95% *CI*=1.15~2.18)、每日电脑使用时间≥4h(*OR*=1.52, 95% *CI*=1.02~2.25)以及长时间配戴眼镜(*OR*=1.54, 95% *CI*=1.08~2.13)是干眼症发生的危险因素,不同性别、是否进行准分子手术、是否戴隐形眼镜之间干眼症患病率无显著性差异。

结论:中国大学生干眼症患病率较高,主要的危险因素包括每日阅读时间和电脑使用时间超过4h,以及长时间配戴眼镜。

关键词:大学生;干眼;患病率;危险因素;症状

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Abstract

• AIM: To obtain the prevalence and risk factors of symptomatic dry eye disease (SDED) among college students in China.

• METHODS: Population-based cross-sectional study. Students in Medical School of Lanzhou University were approached. A questionnaire was used to evaluate the prevalence of SDED and its risk factors. The diagnosis of SDED was based on reported symptoms and was established if the participants reported "often" or "all the time" once or more for 6-item questionnaire. Positive tests included a tear-film breakup time (TBUT) ≤10s and a fluorescein staining score (FSS) ≥1. Demographic information and possible factors that may contribute to SDED were analyzed in a step-wise multivariate logistic regression modelto assess risk factors of SDED.

• RESULTS: There were 1139 participants (84.37% response rate) have completed the questionnaire, 475 males and 664 females aged 16-26y. The prevalence of SDED was 18.70% [95% confidence interval (CI)=16.59-20.81]. A TBUT of ≤10s and a FSS≥1 were noted in 47.67% (95% CI=44.95-50.57) and 13.97% (95% CI=11.95-15.99) for all participants, respectively. The multivariate regression analysis revealed the following risk factors: daily reading time of ≥4h (OR=1.58, 95% CI=1.15-2.18), daily computer use of ≥4h (OR=1.52, 95% CI=1.02-2.25), and constant eyeglasses wearing (OR=1.54, 95% CI=1.08-2.13). The female gender, refractive surgery and contact lens (CLs) wearing were not risk factors for SDED in this analysis.

• CONCLUSION: The prevalence for SDED is high in Chinese college students. The risk factors include daily reading time of ≥4h, daily computer use of ≥4h and constant eyeglasses wearing.

• KEYWORDS: college student; dry eye disease;

prevalence; risk factor; symptom
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INTRODUCTION

Dry eye disease (DED) is a common disorder characterized by eye discomfort, visual disturbance and tear-film instability; it could lead potential damage to the ocular surface[1]. DED symptoms (*e.g.* dryness, ocular fatigue or visual difficulty) become common complaints as well as ocular surface diseases in daily ophthalmic practice worldwide and are reported more frequently than musculoskeletal pain and mental stress[2]. It negatively influences daily activities and life quality[3-4] and place a heavy burden on society through costs of care and treatment[5].

A variety of factors, including environmental, occupational and personal factors, contribute to DED[1]. Indoor pollutants, low humidity, high altitude, and visual display terminal (VDT) related work, senior age, female gender, smoking, contact lens (CLs) use, ocular surgeries and systemic medication are associated with DED[6-10]. In addition, Zhang *et al*[11] found that inadequate refractive correction is a strong risk factor for symptomatic dry eye disease (SDED). It is instructive to study the risk factors because reduced exposures to risk factors will alleviate the symptoms[6,12]. Except for the difference in investigated population, factors including differences in questionnaire setting and diagnose criteria lead to significantly varying prevalence of DED from 3.9% to 52.4% across different populations[13-18].

Several population-based studies of DED have been carried out in China. Among elderly Chinese population in Taiwan[19], the prevalence of SDED was 33.7%; the prevalence in people living at high altitude were 50.1% and 52.4%, respectively, according to the Henan Eye Study (HES)[10] and the Zeku Survey (ZES)[20] (Qinghai Province, China). Li *et al*[21] reported a 9.54% prevalence of SDED in outpatients in southeast China. It is worthy of noting that the prevalence of SDED in senior high school students was 23.7% in China[11], being higher than those reported in senior population by some[15,22-24] but not all studies[14,18]. DED symptoms will interfere daily activities and restrain ability to perform various tasks requiring sustained visual concentration, forming a particularly severe problem for students. To date, prevalence of dry eye in different Chinese cohorts have been reported by previous studies; however, the college-aged group remains largely unknown. This study aims at examining the prevalence along with potential risk factors of SDED among college students.

SUBJECTS AND METHODS

Study Population This cross-sectional study was conducted between Sep. and Nov. 2011 in the Schools of Clinical Medicine, Pharmacy, Stomatology and Public Health at Lanzhou University in Gansu Province, China. We obtained permissions by all deans and informed all students of these schools to take part in our survey. Students attending classes on the date of survey (n = 1350) were asked to fill out a questionnaire and received a series of eye examinations. We excluded those who had systemic diseases (*e.g.* rheumatoid arthritis, Sjögren syndrome or thyroid disease) and who did not complete the questionnaire. The final response rate was 84.37% (1139 out of 1350). The study was carried out in agreement with the guidelines of the Declaration of Helsinki (2010) and was approved by the Institutional Review Board of Lanzhou University Second Hospital, Gansu Province, China. All participants provided written informed consent.

Questionnaires The questionnaire included basic demographic information (*e.g.* name, age, gender, and grade), a 6-item domain for SDED diagnosis, and potential SDED-related factors. A diagnosis of SDED was established if the subjects reported "often" or "all the time" for at least one of the following symptoms[1,15-16,23-24]: 1) did you feel dry in the eyes? 2) did you feel a gritty or sandy sensation in the eyes? 3) did you feel the eyes ever having a burning sensation? 4) did your eyes ever get stuck shut? 5) did you notice much crusting on your lashes? 6) did your eyes ever turn red? Multiple choices, which comprising none, sometimes (at least once in 2wk), often (at least once in 1wk), and all the time, followed each question. Potential risk factors included CLs use, refractive surgery, eye exercise, daily computer use time (<4h *vs* ≥4h), daily reading time (<4h *vs* ≥4h), and frequency of eyeglasses wearing ("no", "intermittent", or "constant"). Four trained team members collected all the questionnaires.

Examination All participants underwent ocular examinations by five ophthalmologists from Lanzhou University Second Hospital. The examinations consisted of auto-refraction, visual acuity test, slit lamp examination of anterior segment and lens, corneal and conjunctival fluorescein staining (FSS), and tear-film breakup time test (TBUT). The participants were requested to remove CL at least 2h prior to the examinations and not to use artificial tears within 2h prior to the tests[21].

The TBUT and FSS test were conducted following the instillation of one drop of sodium fluorescein solution (1%) in the lower conjunctival sac. Observations were aided with a slit-lamp with a cobalt-blue filter. Subjects were asked to blink several times and then hold eyes open. The time between the last blink and the appearance of first desiccation spot was recorded as the TBUT. TBUT ≤10s in one or both eyes was considered to be abnormal. The FSS test was performed after TBUT test with results graded as 0 (no staining), 1 (mild staining limited to less than one-third of the cornea), 2 (moderate staining of less than half of the cornea), or 3 (severe staining of half or more of the cornea). FSS≥1 in one or both eyes was considered to be abnormal[25-26].

Table 1 Baseline characteristics of 1139 participants

Patient characteristics	Total subjects, n^a(%)	M, n^a(%)	F, n^a(%)
Age (a)[b]	20.97±1.38	21.08±1.36	20.89±1.38
Gender			
M	475(41.70)	–	–
F	664(58.30)	–	–
Contact lens use			
No	1029(90.34)	450(94.74)	579(87.20)
Yes	110(9.66)	25(5.26)	85(12.80)
Refractive surgery			
No	1116(98.60)	465(98.73)	651(98.49)
Yes	16(1.40)	6(1.27)	10(1.51)

[a]The sum does not necessarily equal the sample size for all variables because of data missing;
[b]Values represent mean ± standard deviation for age.

Table 2 Prevalence of symptoms and tests for SDED in 1139 participants with age and gender

Parameters	Total	SDED		TBUT≤10s		FSS≥1	
		n	Percentage(95% CI)	*n*	Percentage(95% CI)	*n*	Percentage(95% CI)
Age (a)[b]	–		20.97±1.36		20.97±1.43		20.96±1.35
Prevalence	1139	213	18.70(16.59-20.81)	543	47.67(44.95-50.57)	159	13.97(11.95-15.99)
Gender							
M	475	86	18.11(14.74-21.68)	202	42.53(38.11-47.15)	51	10.76(8.02-13.71)
F	664	127	19.13(16.12-21.99)	341	51.36(47.74-55.12)	108	16.27(13.40-19.13)
P			0.66		0.003		0.008

SDED: Symptomatic dry eye disease; TBUT: Tear film breakup time; FSS: Fluorescein staining.

Statistical Analysis The statistical analysis was performed with Statistical Analysis System Software (Version 8.2, SAS Institute Inc. Cary, NC, USA). Categorical variables were analyzed using Chi-square test or trend test. Student's *t*-test was employed to analyze ages in different groups. Predisposing factors for SDED were examined by a step-wise multivariate logistic regression model. Factors with $P \leqslant 0.2$ in univariate analysis were involved in ensuing multivariate analysis. Results were reported as adjusted odds ratios (AORs) and 95% CIs. CL and refractive surgery history were both included in the multivariable analysis despite that $P>0.2$ because they are clearly important risk factors for DED[7,24,27]. Statistical significance was set at $P<0.05$.

RESULTS

The overall participation response rate was 84.37% (1139 out of 1350) including 475 males (41.70%) and 664 females (58.30%). The ages of participated subjects ranged from 16-26y (20.97 in average with a standard deviation of 1.38). Particularly, 16 (1.40%) and 110 (9.66%) participants had refractive surgery and CL wearing (Table 1), respectively.

Among the participants, SDED prevalence was found in 18.70% (95% CI=16.59-20.81) of the subjects (Table 2), specifically, 18.11% (95% CI=14.74-21.68) of males and 19.13% (95% CI=16.12-21.99) of females (P=0.66). TBUT abnormality was noted in 47.67% (95% CI=44.95-50.57) and FSS abnormality 13.97% (95% CI=11.95-15.99). SDED did not correlate with TBUT and FSS (Table 3).

Table 3 The correlations between signs and symptoms of DED

Signs	Total	SDED (*n*,%)		Correlation	
		Negative	Positive	*F*	*P*
TBUT≤10s	543	430(46.4)	113(53.1)	3.04	0.09
FSS≥1	159	122(13.2)	37(17.4)	2.52	0.13

SDED: Symptomatic dry eye disease; TBUT: Tear film breakup time; FSS: Fluorescein staining.

Table 4 delivers the frequency distributions of different DED. Dryness by different degree (sometimes, often or all the time) was the most commonly complained symptom with a prevalence of 64.27%. Totally, 445 participants (39.07%) reported to have experienced red eyes, which is the second most common symptom. By contrast, 12.03% participants suffer from crusting on eyelashes, indicating a lowest prevalence. Regarding the severe symptoms that bring continuous distortion (reported by "all the time"), dryness (0.44%) and red eyes (0.44%) are the most prevalent ones.

The risk factors associated with SDED are shown in Table 5. According to the univariate analysis, SDED was associated with the duration of reading time and frequency of wearing spectacles (P=0.006, 0.01, respectively). Meanwhile adjusted multivariate analysis revealed significant association of SDED with daily reading time≥4h (AOR=1.58, 95% CI=1.15-2.18) and constant eyeglasses wearing (AOR=1.52, 95% CI=1.08-2.13). On the other hand, the crude odds ratio for the association between daily computer using time≥4

Table 4 Symptoms distributionin number and percentage of 1139 participants *n*, %

Symptoms	None	Sometimes	Often	All the time
Dryness	407(35.73)	614(53.91)	113(9.92)	5(0.44)
Gritty or sandy sensation	749(65.76)	357(31.34)	30(2.63)	3(0.26)
Burning sensation	841(73.84)	268(23.53)	29(2.55)	1(0.09)
Red eyes	694(60.93)	394(34.59)	46(4.04)	5(0.44)
Crusting on lashes	1002(87.97)	124(10.89)	11(0.97)	2(0.18)
Get stuck shut	809(71.03)	283(24.85)	44(3.86)	3(0.26)

None:Less once in 3mo; Sometimes: At least once in 2wk; Often: At least once in 1wk.

Table 5 Risk factors for SDED

Risk factors	Non-DED		SDED		*P*	OR(95% CI)	AOR(95% CI)[a]
	n	%	*n*	%			
Age (a)	20.97±1.36		20.98±1.38		0.94[b]	-	-
Gender							
M	389	81.89	86	18.11	-	1	1
F	537	80.87	127	19.13	0.66	1.07(0.79,1.45)	1.02(0.73,1.38)
Time of wearing eyeglasses							
No	173	84.80	31	15.20	-	1	1
Intermittent[d]	390	83.33	78	16.67	-	0.90(0.57,1.41)	1.53(0.96,2.43)
Constant[e]	369	77.73	104	22.27	0.01[c]	0.63(0.40,0.97)	1.52(1.08,2.13)
Contact lens use							
No	839	81.44	191	18.56	-	1	1
Yes	88	80.00	22	20.00	0.71	1.10(0.67,1.80)	0.90(0.53,1.51)
Refractive surgery							
No	907	81.27	209	18.73	-	1	1
Yes	12	75.00	4	25.00	0.52	1.46(0.46,4.53)	1.87(0.57,6.09)
Eye exercises							
No	843	81.61	190	18.39	-	1	-
Yes	78	78.79	21	21.21	0.49	1.19(0.72,1.98)	-
Time of reading (h/d)[f]							
<4	448	84.69	81	15.31	-	1	1
≥4	469	78.30	130	11.52	0.006	1.53(1.13,2.08)	1.58(1.15,2.18)
Time of computer using (h/d)							
<4	778	82.07	170	17.93	-	1	1
≥4	137	76.54	42	23.46	0.08	1.40(0.96,2.06)	1.52(1.02,2.25)

SDED: Symptomatic dry eye disease; OR: Odds ratio; AOR: Adjusted odds ratio; CI: Confidence interval; [a]Odds ratio was adjusted for sex, contact lens use, refractive surgery and all of the associated factors identified in the univariate analyses($P<0.2$); [b]The *P* value of *t*-test is given; [c]The *P* value of trend test is given; [d]Intermittent wearing eyeglasses: wearing glasses just for having classes, reading, watching TV or using computers; [e]Constant eyeglasses wearing: wearing glasses all the time except sleeping; [f]Time of reading: limited to traditional reading, excluding VDT reading.

hand SDED was insignificant ($P=0.08$, OR=1.40, 95% CI=0.96-2.06). However, we found a borderline association between SDED and the daily computer using time≥4h (AOR=1.52, 95% CI=1.02-2.25) after multivariate adjustment analysis. In addition, gender and eye exercises were not the risk factors of SDED. Significant correlation between SDED with CL wearing (AOR=0.90, 95% CI=0.53-1.51) or refractive surgery (AOR=1.87, 95% CI=0.57-6.09) was unproven because of the limited sample size.

DISCUSSION

DED is a worldwide multifactorial disorder influencing daily activities and life quality. Limited study regarding the prevalence of DED in college-aged population has been carried out. In this population-based cross-sectional association study, a 18.70% prevalence of SDED among college students has been observed along with risk factors of daily reading time≥4h, daily computer using time≥4h and constant eyeglasses wearing. Note that significant associations of SDED with gender, refractive surgery history or CL use haven't been validated with this study, differing from some other previous reports[3,7,27].

Prevalence of SDED varied significantly in different population-based studies because of the utilizations of different questionnaires, objective tests and definitions on dry eye.

HES and ZES showed high prevalence (50.1% and 52.4%, respectively) of dry eye syndrome in people with age ≥40y at high altitude in China[10,20]. All the subjects in HES and ZES studies lived at altitude ≥3000m with dry and cold climate, as well as with strong solar infrared light and ultraviolet radiation, which are also factors contributing to high SDED prevalence[28-29]. Prevalence of SDED adjusted for age was 27.5% in Indonesia[30]. The Salisbury Eye Evaluation Study found that 14.6% of the participants with an average age of 73.5y suffered from SDED[26]. Previous studies reported prevalence of 7.8% in females and 4.7% in males with ages ≥50y in the United States[15,22], of 11.0% in a Spanish population with ages ≥40y[31], and of 9.5% in a Singapore populationwith ages ≤25y[13]. Additionally, a survey covering 963 people with age ≥73y from French exhibited a 29.6% prevalence of DED[18].

Because of the narrow age interval (16-26y) in our study, the association of SDED with age, which is considered as a risk factor according to previous investigations [15,32-34], has not been validated herein.

Gender difference does not constitute a risk factor for SDED in this study, showing agreement with some previous reports[10-11,17]. Note that exceptions where gender difference is considered as a risk factor for SDED have been reported as well[4,7,18,21]. Many previous studies suggested the high prevalence in female results from the sex hormones[13,32,35]. The hormonal variations are related to the tendency to have dry eye symptoms in female. In addition, menopause in aged women may contribute to the emergence or aggravation of DED as a consequence of overall hormonal imbalances[36]. In this study, the female group did have higher prevalence of SDED, but statistically significant difference in gender-specific prevalence was not observed. One possible reason may be that the female participants were young and were unlikely to suffer from imbalance in sex hormones.

In our study, abnormal TBUT and FSS results were noted in 47.67% and 13.97% of the participants, respectively. Many of the participants (51.36% in female and 42.53% in male) did not have a stable tear-film and sustain TBUT abnormality. The abnormality rates were higher than several previously reported results[10,20]. The TBUT and FSS abnormalities rate were 37.7% and 6.0% in HES, and 35.3% and 5.8% in ZES. Moreover, a study on VDT workers showed amuch higher rate of TBUT≤5s at 74.6%[6]. TBUT, which describes the stability of tear film on the ocular surface, is capable of measuring evaporation problems in DED accurately[37]. Previous studies showed that VDT use increased the proportion of incomplete blinks and accelerated the evaporation of tear film[6,38]. In our study, although 15.88% participants declare to possess daily computer uses over 4h, yet the rest participants as well experience certain daily computer uses, constituting a potential reason for high prevalence rate of TBUT.

Recent studies suggested that SDED is not correlated to clinical tests[14,39-41]; our findings agreed well with these previous studies, even though HES study found the correlations between SDED and tests[10]. The poor correlation between tests and symptoms might be due to wide variation in the sensation of symptoms and variable disease process[40]. Further research is needed to develop methods of testing or refining existing tests to provide accurate, objective measures for DED.

This study showed an association of SDED with daily reading duration ≥4h, computer use duration ≥4h and constant eyeglasses wearing after adjusting other factors.

Prolonged visually stressful activities (*e. g.* viewing computer, watching television, driving, and reading) will cause and aggravate SDED[42-44]. Specifically, the daily VDT use ≥4h is a risk factor for SDED[45-46], and the daily duration of VDT use is linearly related to SDED[2], the rate of SDED increases with increasing exposure to VDTs[6,47,48]. With the widespread use of mobile devices, computers and smart phones, VDT exposure is increasing in the general population (particularly in college students) instead of VDT workers merely. Logaraj *et al*[46] reported 31.2% rate of SDED in students with more frequent computer use (engineering major) *vs* 17.4% in students with less computer use (medical students). Prolonged blinking intervals while gazing in VDT users lead to excessive evaporation of tear fluid and further higher prevalence of SDED. Several studies reported that blink rate significantly reduces during reading[49-50], which in part explain the correlation between computer use and SDED, as well as between reading and SDED in this study.

We also explored the relation between SDED and frequency of eyeglasses wearing. Our results revealed that participants reporting "constant eyeglasses wearing" had significant higher prevalence (22.27%) for SDED than those who reporting "no" and "occasionally" (15.20% and 16.67%, respectively). Nichols *et al*[51] found that a spectacle wearing is a risk factor for SDED (OR=2.06, 95% CI=1.12-3.80). Logaraj *et al*[46] also reported higher rate of ocular symptoms in people wearing eyeglasses. Several factors may possibly explain such findings. First, it is possible that spectacles wearers tend to be more aware of their ocular health and status and thus may offer over-estimated results than an individual not requiring refractive correction. Second, inadequate refractive correction may play an important role in enlarging the prevalence of SDED[11,52-54]. Further study is still necessary to determine the relation between inadequate refractive correction and SDED.

The CLs use[7,24,55] and refractive surgery[56-58] are validated as two risk factors for SDED. Refractive surgery tends to break tear film[59], and decrease corneal sensitivity and aqueous tear production[57]. However, due to the low rates of CLs use (only 9.60% *vs* 37.8% among Japanese students[45]) and refractive surgery (1.4%), our statistical analyses did not provide sufficient proof for determining these two factors.

In this study, all participants were students from medical-related majors and may thereafter run healthier lifestyle than students from other majors, which may introduce a population-

selection bias. The threshold for categorizing daily reading duration or computer-use time was set as a certain value (4h herein). However, it may suffer from potential deviation because a direct cut actually hides the fact that bilateral values are similar, *e. g.* 3. 9h does not exhibit significant difference from 4. 1h. Moreover, the use of artificial tears was not included in our survey because of the complicated accompanied problem: artificial tears with various functions are provided by the drugstore, does the user choose a suitable one? Artificial tear should be used according to certain professional advice (*e. g.* specification or prescription); does the use adopt regular proper dosage?

In summary, this study discovers a high prevalence of SDED among college students. Meanwhile, the risk factors involve VDT use, prolonged reading duration and constant spectacles wearing. Based on these results, we recommend college students decrease VDT use and have proper breaks during reading and studying. The recommendations also apply to those who share similar environment and life style with college students.

REFERENCES

1 The epidemiology of dry eye disease: report of the Epidemiology Subcommittee of the International Dry Eye WorkShop (2007). *Ocul Surf* 2007; 5(2):93-107

2 Nakazawa T, Okubo Y, Suwazono Y, Kobayashi E, Komine S, Kato N, Nogawa K. Association between duration of daily VDT use and subjective symptoms. *Am J Ind Me* 2002; 42(5):421-426

3 Um SB, Kim NH, Lee HK, Song JS, Kim HC. Spatial epidemiology of dry eye disease: findings from South Korea. *Int J Health Geogr* 2014; 13:31

4 Ahn JM, Lee SH, Rim TH, Park RJ, Yang HS, Kim TI, Yoon KC, Seo KY, the Epidemiologic Survey Committee of the Korean Ophthalmological S. Prevalence of and Risk Factors Associated With Dry Eye: The Korea National Health and Nutrition Examination Survey 2010-2011. *Am J Ophthalmol* 2014;158(6):1205-1214. e7

5 The definition and classification of dry eye disease: report of the Definition and Classification Subcommittee of the International Dry Eye WorkShop (2007). *Ocul Surf* 2007;5(2):75-92

6 Uchino M, Yokoi N, Uchino Y, Dogru M, Kawashima M, Komuro A, Sonomura Y, Kato H, Kinoshita S, Schaumberg DA, Tsubota K. Prevalence of dry eye disease and its risk factors in visual display terminal users: the Osaka study. *Am J Ophthalmol* 2013;156(4):759-766

7 Paulsen AJ, Cruickshanks KJ, Fischer ME, Huang GH, Klein BE, Klein R, Dalton DS. Dry eye in the beaver dam offspring study: prevalence, risk factors, and health-related quality of life. *Am J Ophthalmol* 2014;157(4):799-806

8 Gupta RC, Ranjan R, Kushwaha RN, Khan P, Mohan S. A questionnaire-based survey of dry eye disease among leather tannery workers in Kanpur, India: a case-control study. *Cutan Ocul Toxicol* 2014;33(4):265-269

9 Schaumberg DA, Uchino M, Christen WG, Semba RD, Buring JE, Li JZ. Patient reported differences in dry eye disease between men and women: impact, management, and patient satisfaction. *PloS One* 2013;8(9):e76121

10 Guo B, Lu P, Chen X, Zhang W, Chen R. Prevalence of dry eye disease in Mongolians at high altitude in China: the Henan eye study. *Ophthalmic Epidemiol* 2010;17(4):234-241

11 Zhang Y, Chen H, Wu X. Prevalence and risk factors associated with dry eye syndrome among senior high school students in a county of Shandong Province, China. *Ophthalmic Epidemiol* 2012;19(4):226-230

12 Management and therapy of dry eye disease: report of the Management and Therapy Subcommittee of the International Dry Eye WorkShop (2007). *Ocul Surf* 2007;5(2):163-178

13 Tan LL, Morgan P, Cai ZQ, Straughan RA. Prevalence of and risk factors for symptomatic dry eye disease in Singapore. *Clin Exp Optom* 2015;98(1):45-53

14 Han SB, Hyon JY, Woo SJ, Lee JJ, Kim TH, Kim KW. Prevalence of dry eye disease in an elderly Korean population. *Arch Ophthalmol* 2011;129(5):633-638

15 Schaumberg DA, Dana R, Buring JE, Sullivan DA. Prevalence of dry eye disease among US men: estimates from the Physicians´ Health Studies. *Arch Ophthalmol* 2009;127(6):763-768

16 Vehof J, Kozareva D, Hysi PG, Hammond CJ. Prevalence and risk factors of dry eye disease in a British female cohort. *Br J Ophthalmol* 2014;98(12):1712-1717

17 Onwubiko SN, Eze BI, Udeh NN, Arinze OC, Onwasigwe EN, Umeh RE. Dry eye disease: prevalence, distribution and determinants in a hospital-based population. *Cont Lens Anterior Eye* 2014;37(3):157-161

18 Malet F, Le Goff M, Colin J, Schweitzer C, Delyfer MN, Korobelnik JF, Rougier MB, Radeau T, Dartigues JF, Delcourt C. Dry eye disease in French elderly subjects: the Alienor Study. *Acta ophthalmol* 2014;92(6):e429-436

19 Lin PY, Tsai SY, Cheng CY, Liu JH, Chou P, Hsu WM. Prevalence of dry eye among an elderly Chinese population in Taiwan: the Shihpai Eye Study. *Ophthalmology* 2003;110(6):1096-1101

20 Lu P, Chen X, Liu X, Yu L, Kang Y, Xie Q, Ke L, Wei X. Dry eye syndrome in elderly Tibetans at high altitude: a population-based study in China. *Cornea* 2008;27(5):545-551

21 Li J, Zheng K, Deng Z, Zheng J, Ma H, Sun L, Chen W. Prevalence and Risk Factors of Dry Eye Disease Among a Hospital-Based Population in Southeast China. *Eye Contact Lens* 2015;41(1):44-50

22 Schaumberg DA, Sullivan DA, Buring JE, Dana MR. Prevalence of dry eye syndrome among US women. *Am J Ophthalmol* 2003;136(2):318-326

23 Tong L, Saw SM, Lamoureux EL, Wang JJ, Rosman M, Tan DT, Wong TY. A questionnaire-based assessment of symptoms associated with tear film dysfunction and lid margin disease in an Asian population. *Ophthalmic Epidemiol* 2009;16(1):31-37

24 Uchino M, Nishiwaki Y, Michikawa T, Shirakawa K, Kuwahara E, Yamada M, Dogru M, Schaumberg DA, Kawakita T, Takebayashi T, Tsubota K. Prevalence and risk factors of dry eye disease in Japan: Koumi study. *Ophthalmology* 2011;118(12):2361-2367

25 McCarty CA, Bansal AK, Livingston PM, Stanislavsky YL, Taylor HR. The epidemiology of dry eye in Melbourne, Australia. *Ophthalmology* 1998;105(6):1114-1119

26 Schein OD, Munoz B, Tielsch JM, Bandeen-Roche K, West S. Prevalence of dry eye among the elderly. *Am J Ophthalmol* 1997;124(6):723-728

27 Garcia-Zalisnak D, Nash D, Yeu E. Ocular surface diseases and corneal refractive surgery. *Curr Opin Ophthalmol* 2014;25(4):264-269

28 Mader TH, Tabin G: Going to high altitude with preexisting ocular conditions. *High Alt Med Biol* 2003;4(4):419-430

29 Gupta N, Prasad I, Himashree G, D'Souza P. Prevalence of dry eye at high altitude: a case controlled comparative study. *High Alt Med Biol* 2008;9(4):327-334

30 Lee AJ, Lee J, Saw SM, Gazzard G, Koh D, Widjaja D, Tan DT. Prevalence and risk factors associated with dry eye symptoms: a population based study in Indonesia. *Br J Ophthalmol* 2002;86(12):

1347-1351
31 Viso E, Rodriguez-Ares MT, Gude F. Prevalence of and associated factors for dry eye in a Spanish adult population (the Salnes Eye Study). *Ophthalmic Epidemiol* 2009;16(1):15-21
32 Chia EM, Mitchell P, Rochtchina E, Lee AJ, Maroun R, Wang JJ. Prevalence and associations of dry eye syndrome in an older population: the Blue Mountains Eye Study. *Clin Experiment Ophthalmol* 2003;31(3):229-232
33 Galor A, Feuer W, Lee DJ, Florez H, Carter D, Pouyeh B, Prunty WJ, Perez VL. Prevalence and risk factors of dry eye syndrome in a United States veterans affairs population. *Am J Ophthalmol* 2011;152(3):377-384 e2
34 Moss SE, Klein R, Klein BE. Prevalence of and risk factors for dry eye syndrome. *Arch Ophthalmol* 2000;118(9):1264-1268
35 Mathers WD, Stovall D, Lane JA, Zimmerman MB, Johnson S. Menopause and tear function: the influence of prolactin and sex hormones on human tear production. *Cornea* 1998;17(4):353-358
36 Versura P, Giannaccare G, Campos EC. Sex-Steroid Imbalance in Females and Dry Eye. *Curr Eye Res* 2015;40(2):162-175
37 King-Smith PE, Nichols JJ, Nichols KK, Fink BA, Braun RJ. Contributions of evaporation and other mechanisms to tear film thinning and break-up. *Optom Vis Sci* 2008;85(8):623-630
38 Cardona G, Garcia C, Seres C, Vilaseca M, Gispets . Blink rate, blink amplitude, and tear film integrity during dynamic visual display terminal tasks. *Curr Eye Res* 2011;36(3):190-197
39 Nichols KK, Nichols JJ, Mitchell GL. The lack of association between signs and symptoms in patients with dry eye disease. *Cornea* 2004;23(8):762-770
40 Begley CG, Chalmers RL, Abetz L, Venkataraman K, Mertzanis P, Caffery BA, Snyder C, Edrington T, Nelson D, Simpson T. The relationship between habitual patient-reported symptoms and clinical signs among patients with dry eye of varying severity. *Invest Ophthalmol Vis Sci* 2003;44(11):4753-4761
41 Chalmers RL, Begley CG, Edrington T, Caffery B, Nelson D, Snyder C, Simpson T. The agreement between self-assessment and clinician assessment of dry eye severity. *Cornea* 2005;24(7):804-810
42 Schlote T, Kadner G, Freudenthaler N. Marked reduction and distinct patterns of eye blinking in patients with moderately dry eyes during video display terminal use. *Graefes Arch Clin Exp Ophthalmol* 2004;242(4):306-312
43 Walker PM, Lane KJ, Ousler GW3rd, Abelson MB. Diurnal variation of visual function and the signs and symptoms of dry eye. *Cornea* 2010;29(6):607-612
44 Iyer JV, Lee SY, Tong L. The dry eye disease activity log study. *Scientific World Journal* 2012;2012:589875
45 Uchino M, Dogru M, Uchino Y, Fukagawa K, Shimmura S, Takebayashi T, Schaumberg DA, Tsubota K. Japan Ministry of Health study on prevalence of dry eye disease among Japanese high school students. *Am J Ophthalmol* 2008;146(6):925-929. e2
46 Logaraj M, Madhupriya V, Hegde S. Computer vision syndrome and associated factors among medical and engineering students in chennai. *Ann Med Health Sci Res* 2014;4(2):179-185
47 Zhu Y, Yu WL, Xu M, Han L, Cao WD, Zhang HB, Zhang HD. Analysis of risk factors for dry eye syndrome in visual display terminal workers. *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi* 2013;31(8):597-599
48 Kawashima M, Yamatsuji M, Yokoi N, Fukui M, Ichihashi Y, Kato H, Nishida M, Uchino M, Kinoshita S, Tsubota K. Screening of dry eye disease in visual display terminal workers during occupational health examinations: the Moriguchi Study. *J Occup Health* 2015;57(3):253-258
49 Yang SN, Tai YC, Sheedy JE, Kinoshita B, Lampa M, Kern JR. Comparative effect of lens care solutions on blink rate, ocular discomfort and visual performance. *Ophthalmic Physiol Opt* 2012;32(5):412-420
50 Bentivoglio AR, Bressman SB, Cassetta E, Carretta D, Tonali P, Albanese A. Analysis of blink rate patterns in normal subjects. *Mov Disord* 1997;12(6):1028-1034
51 Nichols JJ, Ziegler C, Mitchell GL, Nichols KK. Self-reported dry eye disease across refractive modalities. *Invest Ophthalmol Vis Sci* 2005;46(6):1911-1914
52 He M, Huang W, Zheng Y, Huang L, Ellwein LB. Refractive error and visual impairment in school children in rural southern China. *Ophthalmology* 2007;114(2):374-382
53 Congdon N, Wang Y, Song Y, Choi K, Zhang M, Zhou Z, Xie Z, Li L, Liu X, Sharma A, Wu B, Lam DS. Visual disability, visual function, and myopia among rural chinese secondary school children: the Xichang Pediatric Refractive Error Study (X-PRES)-report 1. *Invest Ophthalmol Vis Sci* 2008;49(7):2888-2894
54 Zhang M, Lv H, Gao Y, Griffiths S, Sharma A, Lam D, Li L, Tse YK, Liu X, Xu D, Lu B, Congdon N. Visual morbidity due to inaccurate spectacles among school children in rural China: the See Well to Learn Well Project, report 1. *Invest Ophthalmol Vis Sci* 2009, 50(5):2011-2017
55 Guillon M, Maissa C. Dry eye symptomatology of soft contact lens wearers and nonwearers. *Optom Vis Sci* 2005;82(9):829-834
56 Nettune GR, Pflugfelder SC. Post-LASIK tear dysfunction and dysesthesia. *Ocul Surf* 2010;8(3):135-145
57 Turu L, Alexandrescu C, Stana D, Tudosescu R. Dry eye disease after LASIK. *J Med Life* 2012;5(1):82-84
58 Chao C, Golebiowski B, Stapleton F. The role of corneal innervation in LASIK-induced neuropathic dry eye. *Ocul Surf* 2014;12(1):32-45
59 Campos M, Trokel SL, McDonnell PJ. Surface morphology following photorefractive keratectomy. *Ophthalmic Surg* 1993;24(12):822-825