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ORIGINAL PAPER

Prevalence of dry eye in video display terminal users: a cross-sectional Caucasian study in Italy

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Abstract

Purpose To estimate the prevalence of dry eye among video-terminal (VDT) users and to assess risk factors for dry eye in this population.

Study design A single-centre, cross-sectional study was carried out on subjects employed as VDT workers and on a control group.

Methods Demographic data, years spent working at a VDT, number of effective hours at VDT/day, number and hours of breaks/day were considered. All subjects underwent a complete ophthalmic examination and completed the Italian version of the computer vision symptom scale 17-item (CVSS17) questionnaire. Both groups were classified as definite, suspect and non-dry eye syndrome (DES).

Results One-hundred and ninety four subjects completed the study; 70 (36.1%) of which represented the control group, and 124 (63.9%) represented the VDT group. Among VDT workers, 29 (23.4%) presented definite DES and 55 (44.4%) suspect DES, while among controls, only 2 (2.9%) presented definite DES and 37 (52.8%) suspect DES. In the univariate analysis, the DES group was older ($p < 0.001$), spent more time a day at VDT ($p < 0.001$), used VDT from more time ($p < 0.001$), instilled artificial tears ($p = 0.031$), and presented worst quality of life ($p < 0.001$). At the multivariate analysis, only age and time at VDT retained association with DES (OR 1.05; 95% CI 1.01–1.09; $p = 0.01$ and OR 1.57; 95% CI 1.07–2.02; $p = 0.017$, respectively).

Conclusions The global increase of VDT workers is accompanied by a higher frequency of ocular complaints. Older subjects and people spending more than 4 h a day at VDT are at major risk to develop DES and should take precautions to prevent the onset of the disease.

Keywords Dry eye · Ocular surface · Prevalence · Occupational health · Quality of life · Video display terminal (VDT)

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Introduction

"Video-terminal workers" are defined as employees whose primary job, for at least 20 h per week, involves work at a video display terminal (VDT).

The prolonged use of VDTs generates, besides muscolo-skeletal disorders, also ocular-visual disorders: the risk due to VDT use is one of the factors

considered in the health and safety at work legislation in Italy and places its assessment among the legal obligations of the employer.

VDT users often complain of eye strain, eye fatigue, burning, irritation, redness, blurred vision, and dry eyes [1]. In 2002, "computer vision syndrome" (CVS) [2] was introduced to define ocular complaints resulting from VDT use: it is associated with the prolonged and sustained visual attention to a monitor, and with decreased blink rate. In a 2005 review, authors evidenced that dry eye is the main cause of asthenopia, glare, and accommodative difficulty, that is CVS symptoms [3].

In 2017, the Report of the International Dry Eye Workshop (DEWS) referred that dry eye syndrome (DES) is one of the most prevalent eye disorders and reasons for seeking eye care [4]. Comparison of age-specific data on the prevalence of dry eye from large epidemiological studies reveals a range of about 5–50% at various ages [5].

In particular, a review of the epidemiology of dry eye, based on data from the largest studies of dry eye, suggested that its prevalence is age dependent, affecting approximately 11% of patients between the ages of 40 and 59 and 18% of those older than age 80 [6].

The DEWS report defined the DES as "a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film, and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles" [4]. Dry eye may be due to a reduction in tear secretion or to an increase in tear evaporation, but a fundamental role is also played by the environment, understood both as physiological variation between individuals (blink rate, androgens' levels, height of the palpebral aperture) and occupational and/or external environments' conditions (conditioned air, wind, humidity) [4].

The prolonged use of a VDT causes not only the evaporation of the tears, but also slows the blink rate [7] and gives a malfunction of meibomian glands [8] inducing a vicious circle of conditions that worsen dry eye. The interest about the relation between VDT use and ocular surface status is becoming more and more actual, given the occupational changes with the increased use of computers.

The main purpose of the present study was to estimate the prevalence of dry eye among VDT users and to assess risk factors (besides VDT usage) for dry eye (absent, suspect, present) in this population.

Materials and methods

This was a single centre, cross-sectional study carried out at the University Eye Clinc of Pavia in accordance with the Declaration of Helsinki after approval by the Local Ethics Committee of the IRCCS Policlinico San Matteo Foundation of Pavia (Prot. 2015000565).

All consecutive subjects working at the Foundation (VDT workers or not) referring to the Eye Clinic in order to complete an ocular status evaluation according to D.LGS 81/08 (i.e., the compulsory heath assessment of workers in Italy), without (random or other) selection, were invited to complete the study and to sign the informed consent form: the signed informed consent was obtained from all individual participants included in the study. All the subjects received information about the study directly with the convocation letter that they receive annually from the "health assistants".

Subjects who had undergone any ocular surgery in the preceding 6 months, or presented with systemic or ocular conditions (such as rheumatoid arthritis; Sjogren Syndrome; rosacea; infectious disease; previous glaucoma diagnosis) that could interfere with ocular surface status were excluded.

The following variables were collected for each subject: date of birth, gender, schooling level, number of years spent working at a VDT, number of effective hours a day at a VDT, and number and duration of breaks a day taken from VDT use.

Controls (non-VDT workers) were defined as those subjects spending less then 4 h a day at a VDT.

All subjects underwent a complete ophthalmic examination comprehensive of near and far best corrected visual acuity (VA) and used correction, tear film break-up time (T-BUT), and corneal staining. All subjects also completed the Italian version of the computer vision symptom scale 17-item (CVSS17) questionnaire.

The Computer Vision Symptom Scale questionnaire (CVSS17) assesses visual and ocular symptoms in VDT workers: it includes 17 items, and has been designed and validated in Spanish [9]. The questionnaire contains a single main dimension (quality of life) in 17 items and assesses the following symptoms:

blurred vision, burning, stinging, tearing, ocular heaviness, ocular fatigue/strain, blinking rate, photophobia, diplopia while working on a VDT, considering symptom's severity and frequency, and subjects' opinion. The original authors did not validate a grading system, but use the total score (ranging 17–52), with higher numbers indicating increased severity of symptoms. The internal consistency of the questionnaire (cronbach's $\alpha = 0.92$) makes it useful for comparison between groups and for clinical application. It has been found to be valid for both genders and both for presbyopes and for non-presbyopes. All the subjects were asked to self-complete the questionnaire prior to the visit with the Ophthalmologist, to avoid interference with visit results.

Tear film stability was assessed using the T-BUT method. A fluorescein wetted strip (Fluorescein Sodium Ophthalmic Strips USP, Optitech®) was placed on the inferior conjunctiva at the outer canthus to avoid ocular surface damage and the patient was asked to blink several times. One–two minutes later, the time required for the first area of tear film break-up to appear after a complete blink was determined using the cobalt blue filter on the slit lamp biomicroscope. T-BUT was calculated for a mean value after three successive measurements. T-BUT values $\geq$ 10 s were coded as normal and T-BUT values $\leq$ 10 s as abnormal [10].

The presence of corneal surface damage was determined by staining the cornea with fluorescein: corneal staining was assessed immediately after the T-BUT evaluation, since optimal viewing is between 1 and 3 min after instillation of fluorescein [11]. Staining was graded in accordance with Whitcher et al. (2010). Punctate epithelial erosions (PEE) that stain with fluorescein were counted and scored as follows: 0—no PEE, 1—if 1–5 PEE were seen, 2—if 6–30 PEE were seen, and 3—if $>$ 30 PEE were seen [12]. For the purpose of this study, we focussed on the presence and absence of corneal staining. A positive result was defined $>$ 5 staining PEE on the cornea. The same observer (i.e., RGC) performed both the break-up time and the fluorescein staining to minimize the variability of these evaluations.

According to a previous study of our group [13] we defined: presence of dry eye disease as the concomitant presence of T-BUT $<$ 10 s AND corneal staining of any grade; suspect DES the presence of T-BUT $<$ 10 s OR corneal staining of any grade; while absence of DES the concomitant presence of T-BUT $\geq$ 10 s AND the absence of corneal staining (i.e., grade 0).

Sample size calculation

Sample size calculation was based on a feasibility sample of 180 patients which would allow us to estimate an expected prevalence of 20%, with 95% CI between 14.5 and 26.5.

Statistical analysis

Descriptive statistics were produced for demographic, clinical and laboratory characteristics of cases. Mean and standard deviation (SD) are presented for normally distributed variables, and median and interquartile range (IQR) for non-normally distributed variables, number and percentages for categorical variables. For group comparison, Student t test (Mann–Whitney test for skewed distributions) was used for quantitative variables (ANOVA or Kruskall–Wallis for $>$ 2 groups, respectively), and Pearson's chi2 test (Fisher exact test where appropriate) for categorical variables. Shapiro–Wilk's and Kolmogorov–Smirnov test, as well as visual methods, were applied to test for normality.

Ordered logistic regression was used in univariate and multivariate models to assess risk factors for dry eye (definite, suspect, absent).

In all cases, 2-tailed tests were used. P value significance cutoff was 0.05.

Results

A total of 194 Caucasian subjects completed the study, of which 70 (36.1%) spending $<$ 4 h a day at VDT represented the control group (Table 1). Briefly, the mean age was 41.8 $\pm$ 13.3 years, 127 (65.4%) were women; 128 (65.9%) were employed at IRCCS Policlinico San Matteo Foundation; schooling level was high: bachelor's degree for 111 (57.2%) subjects, and high school graduation for 81 (41.7%). Only 39 (20.1%) were affected by a systemic disease, in particular 22 (11.3%) subjects suffered from systemic hypertension, eight (4.1%) thyroid disorders, three (1.5%) allergic rhinitis/asthma, three (1.5%) hypercholesterolemia, two (1%) diabetes, two (1%) gastroenteric disorders.

Table 1 Demographic data, clinical variables and quality of life in the overall group, in the definite dry eye syndrome (DES) group, in the suspect DES group and in the non-DES group; and the univariate analysis

Variables	Overall patients $n = 194$	DES present $n = 32$	DES suspect $n = 92$	DES absent $n = 70$	p value group comparison	Odds ratio	95% CI	p value of OR
Anamnestic data								
Age, years	41.8 ± 13.3	47.8 ± 12	44.4 ± 12.3	35.8 ± 11.6	< **0.001**	1.05	1.03–1.07	< **0.001**
Gender, F, *n* (%)	127 (65.5)	24 (75)	58 (63)	45 (64.3)	0.403	1.337	0.78–2.29	0.289
Subjects using artificial tears, *n* (%)	20 (10.3)	5 (15.6)	12 (13.1)	3 (4.3)	**0.031**	2.72	1.27–5.82	**0.01**
Concomitant systemic diseases, *n* (%)	39 (20.1)	8 (25)	21 (22.8)	10 (14.3)	0.149	1.6	0.86–2.94	0.136
Time since VDT user, years	9.5 ± 9	14.8 ± 7.9	9.9 ± 9.5	6.6 ± 7.6	< **0.001**	1.06	1.03–1.09	**0.001**
Time spent at VDT/day, h	5.3 ± 2.9	7.3 ± 1.9	5 ± 2.9	4.6 ± 2.7	< **0.001**	1.17	1.07–1.29	**0.001**
Breaks/day, *n*	1.9 ± 1.8	2.5 ± 1.6	1.6 ± 1.7	1.8 ± 2.1	0.057	1.05	0.89–1.24	0.526
Breaks/day, min	42 ± 34	61 ± 28	37 ± 33	39 ± 35	**0.009**	1	1–1	0.098
Time spent at VDT <4 h, *n* (%)	70 (36.1)	2 (6.3)	37 (40.2)	31 (44.3)	< **0.001**		Reference category	
4–6 h, n (%)	20 (10.3)	3 (9.4)	7 (7.6)	10 (14.3)	< **0.001**	1.07	0.38–2.99	0.899
6–8 h, *n* (%)	44 (22.7)	9 (28.1)	23 (25)	12 (17.1)	< **0.001**	2.17	1.13–4.15	**0.02**
> 8 h, *n* (%)	60 (30.9)	18 (56.3)	25 (27.2)	17 (24.3)	< **0.001**	2.7	1.35–5.14	**0.005**
Clinical data								
Visual acuity, decimals	0.98 ± 0.12	0.93 ± 0.21	0.97 ± 0.11	0.99 ± 0.1	**0.041**	0.75	0.62–0.89	**0.002**
Far vision correction, *n* (%)	103 (53.1)	16 (50)	51 (55.4)	37 (53.3)	0.887	0.92	0.54–1.5	0.746
Presbyopia, *n* (%)	70 (36.1)	14 (43.8)	43 (46.7)	13 (18.6)	**0.001**	2.63	1.51–4.55	**0.001**
Corneal staining, *n* (%)	32 (16.5)	30 (93.8)	2 (2.2)	0 (0)	< **0.001**	NC	NC	
T-BUT, s	9.3 ± 2.8	6.8 ± 2	7.7 ± 1.5	11.7 ± 1.8	< **0.001**	0.36	0.26–0.49	**0.001**
Intraocular pressure (IOP), mmHg	14.3 ± 1.1	14.7 ± 1.5	14.2 ± 1.1	14.3 ± .9	0.149	1.19	0.97–1.47	0.091
Quality of life data								
CVSS17, total score	28.2 ± 7.6	34.9 ± 7.6	28.3 ± 7.8	24.9 ± 4.9	< **0.001**	1.12	1.2–1.16	< **0.001**

For statistical methods, please see text

Bold values indicate statistically significant p values

NC not calculable due to mathematical reasons, *OR* odds ratio, *VDT* videoterminal, *CVSS17* computer vision symptom scale questionnaire 17-item

Eighty-nine (45.8%) people wore eyeglasses, 105 (54.1%) did not: 64 (32.9%) were myopic. Most of the subjects (126, 64.9%) were not presbyopic, 70 (36.1%) were presbyopic. Only a few subjects presented some retinal condition: 16 (8.3%) myopic chorioretinitis, one (0.5%) epiretinal membrane and one (0.5%) macular drusen. With respect to dry eye disease, only 20 (10.3%) subjects regularly used lacrimal substitutes.

In the total group, best corrected visual acuity was high (0.9 ± 1.1 decimals); mean IOP was 14.3 ± 1.1 mmHg; T-BUT was < 10 s in 85

(43.8%) subjects recording a mean value of 9.3 ± 2.8 s; corneal staining was present in both eyes in 66 (34.0%) subjects.

In the control group, only two (2.8%) subjects presented a definite DES; in this group subjects were younger ($p = 0.001$), T-BUT was longer (10.5 ± 2.5 s, $p < 0.001$), and pathological (< 10 s) only in 13 (18.6%, $p < 0.001$), corneal staining was present in 2 (2.9%, $p = 0.001$) people.

Among VDT users, a total of 30 (24.2%) subjects presented a definite DES, 55 (44.3%) had a suspect DES, and 39 (31.4%) did not present any sign of DES (Table 1). The DES group was significantly older ($p < 0.001$), spent significantly more time per day at a VDT ($p < 0.001$), has been using a VDT for a greater number of years ($p < 0.001$), was significantly more presbyopic ($p = 0.001$), and used artificial tears ($p = 0.031$). VDT users presented more symptoms and, therefore, worst quality of life (score = 31.1 ± 7.3) than controls (score = 22.9 ± 4.8) ($p < 0.001$).The CVSS17 demonstrated that subjects with DES had a lower quality of life in comparison to those without DES ($p < 0.001$).

The multivariate analysis pointed out that after adjusting for age, gender, time since working at VDT, number of effective hours at VDT a day, visual acuity, presbyopia, only age and time at VDT retained independent association with DES ($p = 0.01$ and 0.017 respectively) (Table 2).

Overall, T-BUT was abnormal in 84 (43.3%) eyes, independently of gender ($p = 0.29$) but related to increasing age ($p < 0.001$) and time spent at VDT ($p < 0.001$).

Punctate keratitis was independent of gender ($p = 0.81$) and of total time spent at VDT ($p = 0.81$) but it was related to age ($p = 0.019$).

There was a significant association between quality of life scores and both T-BUT ($p < 0.0001$) and corneal staining ($p = 0.019$).

Discussion

Dry eye disease is one of the most frequent diagnoses in ophthalmology [14] and it is the result of tear film dysfunction subsequent to a lot of unrelated causes or conditions: computer work is one of these.

Dry eye in VDT workers represents a growing public health concern [15, 16], with consequences that remain widely underestimated. In fact, the presence of ocular surface disease and dry eye causes not only a significant impact on visual function but also negative effects both on quality of life [17] and on work productivity [18, 19].

To the best of the authors' knowledge, this is the first study that analyzes the prevalence of dry eye disease in a large sample of VDT workers in a Caucasian setting. In addition, this study compares DES prevalence both in a VDT workers group and in a control group of non-VDT workers with the same methods at the same time.

Literature about the prevalence of DES in VDT users refers to Asiatic population, from two large studies: the Osaka study [20] that recorded a prevalence of definite DES of 11.9% and of suspect DES of 53.9%; and the Moriguchi study [21] reporting definite DES in 3.8% and suspect DES in 55.3%.

Our data are in agreement with these, even if caution is advised in direct comparisons of studies using different settings. In fact, in the two Asian studies most subjects were men (66.7 and 89.7%, respectively), while in ours women represented 65.5% of the sample. Moreover, in our case there is a difference of race/ethnicity: it must be remembered that data from the World Health Surveys (WHS) suggest that the prevalence of severe symptoms and/or clinical diagnosis of dry eye may be greater in Hispanic and Asian, as compared to Caucasian, women [5]. Finally, some differences might be explained by the different diagnostic criteria to define

Table 2 Multivariate analysis for dry eye diagnosis (present, suspect, absent) among a sample of 124 VDT users and 70 controls

	Odds ratio	95% confidence interval	*p* value
Age	1.05	1.01–1.09	**0.01**
Gender	1.46	0.78–2.73	0.23
Years since VDT user	1.01	0.97–1.05	0.66
Hours spent at VDT/day	1.57	1.07–2.02	**0.02**
Visual acuity	0.86	0.68–1.09	0.21
Presbyopia	1.14	0.48–2.69	0.76

Bold values indicate statistically significant *p* values

a definite DES. In our study, dry eye was defined by the concomitant reduction of T-BUT < 10 s and the presence of corneal staining. However, in the Asian studies by the presence of T-BUT less than five seconds and symptoms and corneal staining were used to diagnose DES.

With regard to the prevalence of DES in VDT users, a recently published meta-analysis by Courtin et al. [22] reports a significant heterogeneous prevalence of the condition with values ranging from 9.5 to 87.5% depending on the diagnostic criteria of ocular surface disease and dry eye. The authors stratified diagnostic criteria in the following groups: questionnaires on dry eye symptoms, tear film abnormalities and corneo-conjunctival epithelial damage, and studies combining two or three of these diagnostic criteria. Stratification of diagnostic criteria on symptoms generated an overall prevalence of 39.1% (95% CI 37.6–40.5), stratification of diagnostic criteria on tear film abnormalities resulted in an overall prevalence of 25.4% (95% CI 22.4–26.8). It has been observed that the higher estimates are derived from studies in which a less restrictive definition was used and the lower estimates are derived from those studies in which a more restrictive definition was used [5].

For the purpose of the study, it was decided that both tear film abnormality and epithelial damage would be required for diagnosis of definite DES. This is due to the fact that T-BUT alone has poor specificity and corneal fluorescein staining alone has poor sensitivity [23].

Uchino et al. found that the majority of VDT users with DES had normal tear secretion and no ocular surface staining [21]. This suggests that symptoms and T-BUT may be more relevant parameters for detecting DES in VDT users. In fact, data from the literature [19] reported that the severity of subjective symptoms, despite no or minor epithelial damage, was greater in short T-BUT DES, being most likely attributable to tear film instability; additionally, an office-working population using VDT generally has a short T-BUT [21]. In our sample, T-BUT was abnormal in 43.3% and corneal staining was present in 16.5%, both independently of gender but significantly related to age. In particular, T-BUT was also significantly related to the total time spent at VDT during a day (in the control group T-BUT was abnormal only in 18.6%). The fact that gender was not independently associated with DES, after adjusting for age and other factors is a somewhat surprising result and is in disagreement with literature [24]. This could suggest that the environment has a more negative effect than was thought in determining the onset of DES in VDT users, even more than gender.

Tear film instability in VDT users seems to be due to altered mucins: decreased expression of mucins (MUC16 and MUC5AC) may be the main factor affecting the dysfunction of ocular surface wettability and tear film stability [25]. Moreover, some authors reported that tear hyperosmolarity induces changes in some electrolytes resulting in tear film instability [26].

In the univariate analysis, there appeared to be a linear trend in the relative risk with increasing time at VDT. The multivariate analysis pointed out that the age and the time spent at VDT a day are the main independent risk factors for DES in VDT workers, with an increase in risk of 1.05 folds per year and 1.57 folds per 2-h, respectively.

These data confirm those of Uchino [20] and suggest that workers who spend more time at a VDT develop DES with a higher risk than the normal population, needing not only ergonomics and environmental improvements but also specific ophthalmic evaluations and treatments.

The current study found no association between systemic diseases/therapies and DES presence, unlike other authors that found an association to the use of diuretics [6].

In the current study, lacrimal substitutes were regularly used by 10.3% of VDT users at work, mainly subjects presenting with definite DES. The use of lacrimal substitutes can improve ocular discomfort and improve both quality of life and productivity [18, 19].

One strength of our study is that we included, besides VDT users, a control group applying the same diagnostic criteria, which have not been attempted before, and we provide the first assessment in a Caucasian population. Moreover, this is the first study to investigate the role that the number of years spent working on a VDT and the number and length of daily breaks from VDT have on DES. No association was found between DES and number of years spent working at a VDT or number and length of daily breaks. Finally, we considered and evaluated symptoms using a specific validated questionnaire, even if we decided not to introduce symptoms among diagnostic criteria of DES. Symptoms have been

considered to be an important component of DES but some studies have reported a high prevalence of subjects with objective evidence of dry eye who are asymptomatic: interestingly, our study has pointed out that both signs, reduced T-BUT and presence of corneal staining, are statistically related to CVSS total score.

We must acknowledge that we did not consider some factors, such as work environment parameters (temperature, humidity, lighting), nor ergonomics, that may represent a risk factor for body fatigue and musculoskeletal pain but also for visual fatigue.

In conclusion, modern life requires the daily use of a computer or an affine system (smartphones, tablets) by everyone, so many are individuals at risk of developing dry eye. The analysis of our data has shown that the increase in age and the number of hours spent on computers are the main risk factors for developing dry eye: this suggests the need to think and propose preventive measures to avoid the onset or the worsening of dry eye.

Researchers should promote international guidelines for dry eye diagnostic criteria, since to date diagnostic criteria are heterogeneous while a shared definition of DES in workers could lead to greater ease in implementing preventative actions.

Compliance with ethical standards

Conflict of interest All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (Local Ethics Committee of the IRCCS Policlinico San Matteo Foundation of Pavia) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Nakaishi H, Yamada Y (1999) Abnormal tear dynamics and symptoms of eyestrain in operators of visual display terminals. Occup Environ Med 56:6–9
2. Sheedy J (2002) What's in a name: "computer vision syndrome"? Optometry 73:399–402
3. Blehm CS, Vishnu S, Khattak A et al (2005) Computer vision syndrome: a review. Surv Ophthalmol 50:253–262
4. Craig JP, Nelson JD, Azar DT et al (2017) TFOS DEWS II report executive summary. Ocular Surf 15:802–812. https://doi.org/10.1016/j.jtos.2017.08.003
5. Stapleton F, Alves M, Bunya VY et al (2017) TFOS DEWS II report epidemiology report. Ocular Surf 15:334–365
6. Moss SE, Klein R, Klein BE (2000) Prevalence of and risk factors for dry eye syndrome. Arch Ophthalmol 118:1264–1268
7. Tsubota K, Nakamori K (1993) Dry eyes and video display terminals. N Engl J Med 328:584
8. Wu H, Wang Y, Dong N et al (2014) Meibomiam gland dysfunction determines the severity of the dry eye conditions in visual display terminal workers. PLoS ONE 9:e105575
9. Gonzalez-Perez M, Susi R, Antona B, Barrio A, Gonzalez E (2014) The computer-vision symptom scale (CVSS17): development and initial validation. Investig Ophthalmol Vis Sci 55:4504–4511
10. Lemp MA, Bron AJ, Baudouin C, Benitez Del Castillo JM, Geffen D, Tauber J et al (2011) Tear osmolarity in the diagnosis and management of dry eye disease. Am J Ophthalmol 151:792–798
11. Peterson RC, Wolffsohn JS, Fowler CW (2006) Optimization of anterior eye fluorescein viewing. Am J Ophthalmol 142:572e5
12. Whitcher JP, Shiboski CH, Shiboski SC, Heidenreich AM, Kitagawa K, Zhang S et al (2010) A simplified quantitative method for assessing keratoconjunctivitis sicca from the Sjogren's syndrome international registry. Am J Ophthalmol 149:405–415
13. Rossi G, Pasinetti GM, Scudeller L, Raimondi M et al (2013) Risk factors to develop ocular surface disease in treated glaucoma or ocular hypertension patients. Eur J Ophthalmol 23:296–302
14. Brewitt H, Sistani F (2001) Dry eye disease: the scale of the problem. Surv Ophthalmol 45:S199–S202
15. Randolph SA (2017) Computer vision syndrome. Workplace Health Saf 65:328
16. Munshi S, Varghese A, Dhar-Munshi S (2017) Computer vision syndrome-a common cause of unexplained visual symptoms in the modern era. Int J Clin Pract 71:e12962
17. Labetoulle M, Rolando M, Baudouin C, van Setten G (2016) Patients' perception of DED and its relation with time to diagnosis and quality of life: an international and multilingual survey. Br J Ophthalmol. https://doi.org/10.1136/bjophthalmol-2016-309193
18. Nichols KK, Bacharach J, Holland E et al (2016) Impact of dry eye disease on work productivity, and patients' satisfaction with over-the-counter dry eye treatments. Investig Ophthalmol Vis Sci 57:2975–2982

19. Uchino M, Uchino Y, Dogru M et al (2014) Dry eye disease and work productivity loss in visual display users: the Osaka study. Am J Ophthalmol 157:294–300
20. Courtin R, Pereira B, Naughton G et al (2016) Prevalence of dry eye disease in visual display terminal workers: a systematic review and meta-analysis. BMJ Open 14(6):e009675
21. Kawashima M, Yamatsuji M, Yokoi N et al (2015) Screening of dry eye disease in visual display terminal workers during occupational health examinations: the Moriguchi study. J Occup Health 57:253–258
22. Uchino M, Yokoi N, Uchino Y et al (2013) Prevalence of dry eye disease and risk factors in visual display terminal users: the Osaka study. Am J Ophthalmol 156:759–766
23. Sullivan BD, Crews LA, Sonmez B et al (2012) Clinical utility of objective tests for dry eye disease: variability over time and implications for clinical trials and disease management. Cornea 31:1000–1008
24. Sriprasert I, Warren DW, Mircheff AK, Stanczyk FZ (2016) Dry eye in postmenopausal women: a hormonal disorder. Menopause 23:343–351
25. Shimazaki-Den S, Dogru M, Higa K, Shimazaki J (2013) Symptoms, visual function, and mucin expression of eyes with tear film instability. Cornea 32:1211–1218
26. Woodward AM, Senchyna M, Argueso P (2012) Differential contribution of hypertonic electrolytes to corneal epithelial dysfunction. Exp Eye Res 100:98–100