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# The Influence of Work Ergonomics and The Use of Lubricating Drops on the Improvement of the Subjective and Objective Ocular Parameters in Patients with Computer Vision Syndrome

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**Keywords:** Computer Users; Dry Eye; Osmolarity; Discomfort; Lubricants

**Abstract**

**Objectives:** The aim of the study is to assess the subjective and objective factors in office workers who use computers as the primary tool of everyday work.

**Methods:** The retrospective study included 119 individuals – office workers who worked in front of a computer every day. The study was conducted in an Outpatient Department in Warsaw between October 2019 and February 2020. We compared the parameters assessing the condition of the ocular surface (the OSDI questionnaire, Schirmer's test, NIBUT, osmolarity) in persons who had used computers for many years. The parameters were assessed before and after using lubricating drops and the appropriate modification of occupational hygiene.

**Results:** We obtained the following results: the mean baseline osmolarity was 300.832±11.685, and in the final phase it was 292.303±9.493. The mean Schirmer's test result before instilling drops was 14.84±2.491, while after drop administration the mean was at the level of 16.076±2.02 millimeters. The mean NIBUT result prior to instilling drops was 13.126±3.131 seconds, while at the end of the study it was 15.403±2.33. The mean OSDI score before drop administration in office workers was 25.242±6.022, while after instilling drops and appropriate work modification it was 12.346±7.542.

**Conclusion:** A large amount of time spent in front of a screen may cause serious consequences for the eyes leading to severe dry eye syndrome and all the related consequences including the deterioration of vision. The correct diagnosis of eyeball surface disorders and the proper modification of working conditions may reduce or eliminate the problem entirely.

## Introduction

Currently, due to technological development people spend increasing amounts of time in front of a screen at work and at home [1]. It leads to the development of economy, industry and modern technologies. Conversely, more and more users of electronic devices complain of unfavourable symptoms associated with the eyes [2-4]. In 1994 the American Academy of Ophthalmology used the definition of computer vision syndrome (CVS) to describe ocular and extraocular manifestations associated with near-vision work, which are experienced during work on the computer or other electronic devices, such as tablets or smartphones [5]. It was noted that computer users complained of such signs and symptoms as eye redness, irritation, burning, ocular pain, sensation of having sand under eyelids. Some patients experienced double or blurred vision, or even a subjective feeling of visual deterioration [6]. In Poland, due to the increasing access to computers CVS is a growing social problem. According to data obtained in 2020 the average time spent by Polish computer users in front of a screen was 6 h 26 min (the data were retrieved from Digital 2020 report published

by WeAreSocial website in cooperation with Hootsuite). The risk of developing various ocular problems was found to increase with work duration of over 4 hours [5,6]. The problem will be intensifying in the following years. It is associated with prolonged lifespan, longer working time, and the necessity to work on the computer. Therefore, it is important to increase patient awareness of suitable working conditions to provide proper care of the eyesight.

## Objective

The aim of the study is to assess subjective and objective factors in office workers who use computers as the primary tool of everyday work. It is the first study conducted in the Polish population to assess the parameters testing the eyeball surface in computer vision syndrome and their analysis after the administration of lubricating drops and the implementation of suitable work hygiene in computer users.

## Subjects and Methods

The retrospective study included 119 individuals – office workers who used a computer every day. The study was conducted in an Outpatient Department in Warsaw between October 2019 and February 2020. Study participants were asked about the number of hours they spent in front of a computer daily, job seniority in the current workplace expressed in years. The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all the subjects. The subjective assessment of ocular manifestations in computer users. The participants completed the OSDI (Ocular Surface Disease Index) questionnaire concerning the symptoms, their influence on visual quality and environmental factors which may trigger or exacerbate the symptoms. The content of the questionnaire is presented in Tables 1-3 below. The OSDI index is calculated according to the formula:

**Table 1:** The first part of the OSDI questionnaire.

| Have you experienced any of the following symptoms during the last week? | All the time | Most of the time | Half of the time | Occasionally | Never |
|---|---|---|---|---|---|
| 1. Hypersensitivity to light? | 4 | 3 | 2 | 1 | 0 |
| 2. Gritty eyes? | 4 | 3 | 2 | 1 | 0 |
| 3. Painful eyes (discomfort)? | 4 | 3 | 2 | 1 | 0 |
| 4. Blurred vision? | 4 | 3 | 2 | 1 | 0 |
| 5. Deteriorated vision? | 4 | 3 | 2 | 1 | 0 |

**Table 2:** The second part of the OSDI questionnaire.

| Have problems with your eyes limited you in performing any of the following activities during the last week? | All the time | Most of the time | Half of the time | Occasionally | Never | N/A |
|---|---|---|---|---|---|---|
| 6. Reading? | 4 | 3 | 2 | 1 | 0 | |
| 7. Driving at night? | 4 | 3 | 2 | 1 | 0 | |
| 8. Working on a computer or using a cash machine? | 4 | 3 | 2 | 1 | 0 | |
| 9. Watching TV? | 4 | 3 | 2 | 1 | 0 | |

**Table 3:** The third part of the OSDI questionnaire.

| Have you experienced any eye discomfort in the following circumstances during the last week? | All the time | Most of the time | Half of the time | Occasionally | Never | N/A |
|---|---|---|---|---|---|---|
| 10. Windy conditions? | 4 | 3 | 2 | 1 | 0 | |
| 11. Places or areas with low humidity (very dry)? | 4 | 3 | 2 | 1 | 0 | |
| 12. Air-conditioned areas? | 4 | 3 | 2 | 1 | 0 | |

$$OSDI\ score = \frac{\left(Sum\ of\ scores\right)\times 25}{\left(total\ number\ of\ questions\ answered\right)}$$

The Ocular Surface Disease Index is assessed on the scale from 0 to 100 with higher scores referring to more severe manifestations and ocular surface disorders [7].The total score interpretations are: from 0 to 12 (normal score), 13-22 (mild dry eye syndrome), 23-32 (moderate dry eye syndrome), and 33-100 (severe dry eye syndrome). The objective assessment of ocular manifestations in computer users. Schirmer's test used for the quantitative assessment of the watery layer of the tear film, osmolarity and the non-invasive tear break-up time (NIBUT) are important parameters in the diagnostics of ocular disorders and the diagnosis of dry eye syndrome [8]. The parameters were measured in the same room at the temperature of 22 degrees Celsius and the air humidity of 45%. Schirmer's test was performed after instilling 1 drop of an analgesic medication (Proxymetacaine hydrochloride 0.5%) in the conjunctival sac. One minute had to pass to obtain the therapeutic effect of the drops. A strip of test paper was placed in the lateral canthus. The eyes had to be closed for another 5 minutes. The result was visible on the millimeter scale of the strip showing its wetting.

All study participants had the osmolarity of the tear film measured with the TearLab device. Non-invasive tear film break-up time (NIBUT) was tested with comprehensive eye surface and tear analyser (OSA). All study participants were advised to use lubricating drops including trehalose 3% and sodium hyaluronate 0.15%. The dosage was 1 drop, four times a day for 2 months. The participants were instructed to introduce appropriate conditions of work on a computer, i.e. the proper distance between the eyes and the screen (65-80 cm), proper lighting in the workplace, frequent blinking, breaks every 30 minutes of work in front of a screen and fixing one's eyes on a distant point for a minute. The OSDI questionnaire, Schirmer's test, osmolarity, and NIBUT were performed again after 2 months.

### Statistical Analysis

A t-Student test for dependent samples was used to compare the analyzed values: the OSDI index, Schirmer's test, osmolarity, NIBUT before and after using lubricating drops, and suitable work hygiene. Statistical calculations and graphs were performed with Excel 365 and Statistica 12 licensed to the Medical University of Warsaw.

## Results

The study included 119 participants (79 men and 40 women) who had been using computers for a long time. Their average age was 38.34±6.99 (range: 25-55) years. The mean duration of daily work on the computer was 4.8±2.09 (range: 2-10) hours. The mean job seniority in the workplace requiring work on the computer was 13.66±7.01 (range: 2-27) years. The mean baseline osmolarity was 300.832 mOsm/l ±11.685, while after drop administration it was 292.303±9.493 mOsm/l. It was demonstrated that osmolarity was significantly higher prior to instilling drops ($p<0.001$). The mean Schirmer's test result before instilling drops was 14.84±2.491 millimeters, while after drop administration the mean was at the level of 16.076±2.022 millimeters. Schirmer's test results were significantly higher after drop administration ($p<0.00001$). The mean NIBUT score prior to instilling drops was 13.126±3.131 seconds, while after the administration it was 15.403±2.33 seconds. NIBUT results were significantly higher after drop administration ($p<0.00001$). As regards the OSDI variable the mean baseline result was at the level of 25.242±6.022, while 2 months later it was 12.346±7.542. OSDI reached significantly higher scores prior to instilling drops ($p<0.00001$) (Table 4) (Figures 1&2).

**Table 4:** Significance tests of differences.

| Variable | Measurement | Descriptive statistics | | | Tests for dependent samples | | | |
|---|---|---|---|---|---|---|---|---|
| | | M | SD | r | M | SD | t (df=118) | p |
| Osmolarity | before drop administration | 300.832 | 11.685 | 0.906 | 8.529 | 5.057 | 18.399 | <0.001 |
| | after drop administration | 292.303 | 9.493 | p<0.001 | | | | |
| Schirmer's test | before drop administration | 14.841 | 2.491 | 0.898 | -1.235 | 1.118 | -12.056 | <0.00001 |
| | after drop administration | 16.076 | 2.022 | p<0.001 | | | | |
| NIBUT | before drop administration | 13.126 | 3.131 | 0.842 | -2.277 | 1.717 | -14.469 | <0.00001 |
| | after drop administration | 15.403 | 2.330 | p<0.001 | | | | |
| OSDI | before drop administration | 25.242 | 6.022 | -0.600 | 12.896 | 12.151 | 11.578 | <0.00001 |
| | after drop administration | 12.346 | 7.542 | p<0.0001 | | | | |

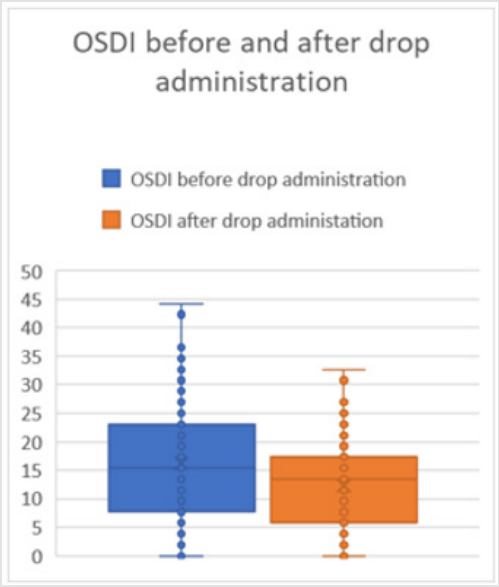


**Figure 1:** OSDI before and after drop administration.

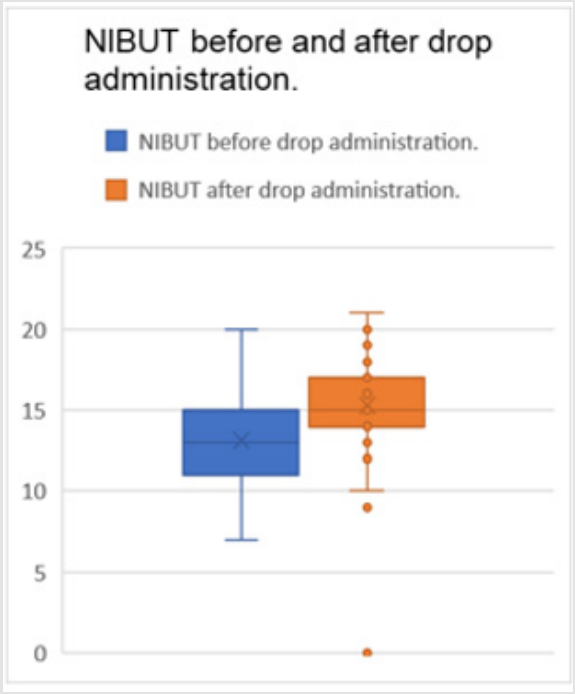


**Figure 2:** NIBUT before and after drop administration.

## Discussion

It is commonly known that the large amount of time spent in front of a computer has a negative effect on the condition of the eyeball surface, which may lead to dry eye syndrome [8]. The complaints of eye discomfort, sensation of a foreign body, pain, blurred or deteriorated vision are more commonly voiced by computer users than by those who spend little time in front of a screen. The symptoms exacerbate during reading, watching TV, driving a car, or spending time in dry air-conditioned rooms [9,10]. Such undesirable manifestations lead to the malaise, poor mental status and even frustration. It may result in the reduced productivity of workers [10,11]. In a study conducted on a group of Polish dentistry students by Bartoszek et al. over 70% of participants suffered from computer vision syndrome. In contrast to our study they were younger individuals (mean age 21,65 years, SD 1,98) and women dominated (77%) vs our study (33,6%) [12].

The present study showed the influence of working on a computer on the condition of the ocular surface measured through the following parameters: the OSDI index, Schirmer's test, osmolarity, non-invasive tear film break-up time in office workers and the improvement of the parameters after the administration of lubricating drops and adjusting working conditions. According to the present analysis the mean Schirmer's test result was 14.84±2.49 seconds which means the initial deficit of the watery component of tears. Nakamura et al. also demonstrated a reduction in tear secretion and indicated poorer Schirmer's test results in individuals using computers for many years [13]. Akkaya et al. noted no significant difference between Schirmer's test results obtained in the morning and evening in a group of workers using computers. Similar observations were reported by Uchino, et al. [14,15]. The osmolarity of the tear film is one of the best markers of dry eye syndrome [16]. Increased osmolarity has a negative influence on the corneal epithelium, causing its more marked shedding, increased loss of intercellular connections, and the aggravation of symptoms associated with dry eye syndrome in people [17,18].

Normal osmolarity values of the tear film range from 296 to 302 mOsm/l in healthy individuals [19]. The present analysis showed the mean baseline value of osmolarity to be within normal limits for the healthy population (300.832±11.685 mOsm/l). The mean non-invasive tear break-up time (NIBUT) prior to drop administration in office workers was 13.13±3.13 seconds, which is normal in the healthy population. The result of over 10 seconds is considered normal for the healthy population [16]. A similar result was obtained by Unlü et al. They reported the mean non-invasive tear break-up time at 11.37±3.69 seconds in computer users [10]. Uchino et al. obtained much lower values in a group of office workers. The results were 4±2.5 seconds which meant advanced dry eye syndrome [15]. The present analysis showed that the mean OSDI index in computer users before instilling drops was 25.24, which meant moderate dry eye syndrome. OSDI values reported in the literature are higher. Unlü et al. reported the OSDI index of 37.12±19.05 in their analysis [20]. The fact that our patients used lubricating drops including trehalose 3% and sodium hyaluronate 0.15% and were instructed to adjust working conditions when using a computer translated into the improvement of all parameters used to assess the condition of the ocular surface.

The mean OSDI (Ocular Surface Disease Index) concerning subjective ocular manifestations, environmental factors and visual function improved, with the value decreasing from 25.242 to 12.346, i.e. by approx. 50% compared to baseline. Fariselli et al. also demonstrated OSDI values to be reduced by 20% [21]. Fondi et al. reported OSDI reduction, but the change was not statistically significant [22]. In the present analysis the mean non-invasive tear break-up time (NIBUT) improved by 17% - from 13.126 seconds to 15.403 seconds. Fondi et al. and Fariselli et al. also demonstrated an improvement concerning tear film break-up time [21,22]. Schirmer's test result improved, as it increased from 14.84±2.49 seconds to 16.07±2.02 seconds. Such an increase was not reported by [21,22]. Normal osmolarity values of the tear film range from 296 to 302 mOsm/l in healthy individuals [19].The mean osmolarity was 300.83±11.68 mOsm/l. Yazici et al. conducted a study in which they obtained 306.6±14.9 mOsm/L at the beginning of a working day and 311.0±12.5 mOsm/L at the end of a working day in computer users [23]. The present study showed the mean NIBUT before drop administration in office workers to be 13.13±3.13 seconds, which is normal.

A similar result was obtained by Unlü et al. who reported the mean non-invasive tear break-up time at 11.37±3.69 seconds [20]. It may be compared with the results obtained by Uchino et al. The mean non-invasive tear break-up time (NIBUT) was 4±2.5 seconds which meant advanced dry eye syndrome [16]. The fact that our patients used lubricating drops including trehalose 3% and sodium hyaluronate 0.15% and observed appropriate working conditions when using a computer caused the improvement of all parameters used to assess the condition of the ocular surface. The mean OSDI decreased from 25.24 to 12.34, i.e. by approx. 50% compared to baseline. Fariselli et al. also demonstrated OSDI values to be reduced by about 20% in computer users [21]. Fondi et al. demonstrated a reduction in the OSDI index from 37.3±21.4 to 36.1±21.5 after using a lubricating gel including trehalose, sodium hyaluronate and carbomer and to 33.4±20.2 after the application of lubricating drops including sodium hyaluronate. The measurements were performed after 1 week of using lubricating agents. However, the changes were not statistically significant [22].

A more marked improvement in the OSDI index observed in the present analysis may be due to the implementation of suitable work hygiene combined with the use of lubricating drops. In the present analysis the mean non-invasive tear break-up time (NIBUT) improved by about 17% - from 13.13 to 15.40 seconds. Fondi et al. also reported an improvement in the tear film break-up time (BUT) from 3.5±1.7 seconds to 4.2±1.7 seconds after using a lubricating gel and 4.3±1.9 seconds after using lubricating drops for 1 week [22]. Similarly, Fariselli et al. observed a 20% increase in the tear film break-up time (BUT) compared to baseline values [21]. Schirmer's test result improved, as it increased from 14.84±2.49 seconds at baseline to 16.076±2.02 seconds at the end of the study. Such an increase was not reported by Fariselli et al. and Fondi et al. (a change from 11.6±9.6 to 11.0±9.2 seconds) [21,22]. The present study showed the mean osmolarity result to be within normal limits (300.83±11.69 mOsm/l). The implemented drop regimen and suitable working conditions contributed to its improvement, i.e. a reduction to 292.30±9.49.

The reduction in osmolarity level causes better stability of the tear film, lower evaporation of the tear film, and the resultant alleviation of symptoms associated with dry eye syndrome and computer vision syndrome [24]. Corrales et al. demonstrated a beneficial influence of using lubricating drops by the reduction in osmolarity, homeostasis improvement on the ocular surface and the alleviation of undesirable symptoms associated with dry eye syndrome [25]. The present paper demonstrated a positive influence of the use of lubricating drops and the modification of working conditions, i.e. adequate distance between the eyes and the screen (65-80 cm), taking breaks every 30 minutes during work and fixing one's eyes on a distant object, frequent blinking, suitable lighting, appropriate temperature and humidity in the workplace. All the parameters were measured under the same conditions (temperature, humidity, the same time during the day – the afternoon). All the participants were using the same lubricating drops for the same period and received identical recommendations regarding the adjustment of working conditions. Further research requires an analysis including a double-blind trial with a lubricating drop group and a placebo group (e.g. with 0.9% normal saline solution) and the comparison of the influence of lubricating drops and modified working conditions on the ocular surface. Moreover, it is worth studying various types of lubricating preparations in patients with computer vision syndrome.

## Conclusion

A large amount of time spent in front of a screen may cause serious consequences for the eyes leading to severe dry eye syndrome and all the related consequences including the deterioration of vision and the subsequent irritability, frustration, and even depression among computer users. It may be prevented by the appropriate diagnosis of ocular surface disorders, using proper eye lubricating substances and the modification of working conditions when using a computer.

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## Disclosure

Approval of the research protocol: N/A. Informed consent: All participants signed an informed consent for the original trial. Registry and the Registration No. of the study/trial: N/A. Animal Studies: N/A. Conflict of Interest: The authors declare no conflicts of interest.

## Author's Contributions

KEN had the idea for the study and developed the study design with KN. KEN performed the analyses and wrote the first draft of the article together. JPSz contributed with her expertise in all steps. All authors critically reviewed and approved the final manuscript.

## References

1. ÇalÕúkan HK (2015) Technological Change and Economic Growth. Procedia - Social and Behavioral Sciences 95: 649-654.
2. Blehm C, Seema Vishnu, Ashbala Khattak, Shrabanee Mitra, Richard W Yee, et al. (2005) Computer vision syndrome: a review. Surv Ophthalmol 50(3): 253-262.
3. Loh K, Redd S (2008) Understanding and preventing computer vision syndrome. Malays Fam Physician 3(3): 128-130.
4. Fujita H (2019) Blind working time in visual display terminal users. J Occup Health 61(2): 175-181.
5. American Optometric Association. Computer vision syndrome (CVS).
6. Mylona I, Emmanouil S Deres, Georgianna Despoina S Dere, Ioannis Tsinopoulos, Mikes Glynatsis, et al. (2020) The Impact of Internet and Videogaming addiction on adolescent vision: A Review of the Literature. Front Public Health 8: 63.

7. Ozcura F, Aydin S, Helvaci MR (2007) Ocular surface disease index for the diagnosis of dry eye syndrome. Ocul Immunol Inflamm 15(5): 389-393.
8. (2007) Methodologies to Diagnose and Monitor Dry Eye Disease: Report of Diagnostic Methodology Subcommittee of International Dry Eye Workshop. Ocul Surf 5: 108-123.
9. Rossi GCM (2019) Prevalence of dry eye in video display terminal users: a cross-sectional Caucasian study in Italy. Int Ophthalmol 39(6): 1315-1322.
10. Rosenfield M (2011) Computer vision syndrome: a review of ocular causes and potential treatments. Ophthalmic Physiol Opt 31(5): 502-515.
11. Daum (2004) Productivity associated with visual status of computer users. Optometry 75: 33-47.
12. Bartoszek A, Szalast K, Kardas G (2019) Computer Vision Syndrome among undergraduate dentistry students. Journal of Education,Health and Sport 9(6): 407-414.
13. Nakamura S (2010) Lacrimal hypofunction as a new mechanism of dry eye in visual display terminal users. PLoS One 5(6).
14. Sezen Akkaya. Prevalence of Dry Eye Disease and its Risk Factors in Visual Display Terminal Users: The Osaka Study.
15. Uchino M (2013) Prevalence of dry eye disease and its risk factors in visual display terminal users: the Osaka study. Am J Ophthalmol 156(4): 759-766.
16. (2007) The epidemiology of dry eye disease: report of the Epidemiology Subcommittee of the International Dry Eye WorkShop. Ocul Surf 5(93): 1-7.
17. Lemp MA (2011) Tear osmolarity in the diagnosis and management of dry eye disease. Am J Ophthalmol 151: 792-798.
18. Gilbard JP, JB Carter, DN Sang, MF Refojo, LA Hanninen, et al. (1984) Morphologic effect hyperosmolarity on rabbit corneal epithelium. Ophthalmology 91(10): 1205-1212.
19. Tomlinson A (2006) Tear film osmolarity: determination of a referent for dry eye diagnosis. Invest Ophthalmol Vis Sci 47(10): 4309-4315.
20. Unlü C (2012) Comparison of ocular-surface disease index questionnaire, tearfilm break-up time, and Schirmer tests for the evaluation of the tearfilm in computer users with and without dry-eye symptomatology. Clin Ophthalmol 6: 1303-1306.
21. Fariselli Ch (2018) Trehalose/hyaluronate eyedrop effects on ocular surface inflammatory markers and mucin expression in dry eye patients. Clin Ophthalmol 12: 1293-1300.
22. Fondi K (2018) Effect of Hyaluronic Acid/Trehalose in Two Different Formulations on Signs and Symptoms in Patients with Moderate to Severe Dry Eye Disease. J Ophthalmol 6.
23. Yazici A (2015) Change in tear film characteristics in visual display terminal users. Eur J Ophthalmol 25(2): 85-89.
24. Lemp MA (2011) Tear osmolarity in the diagnosis and management of dry eye disease. Am J Ophthalmol 151(5): 792-798.
25. Corrales RM (2008) Effects of osmoprotectants on hyperosmolar stress in cultured human corneal epithelial cells. Cornea 27(5): 574-579.


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