Relationship between low-frequency electromagnetic field and computer vision syndrome

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Abstract. – OBJECTIVE: This study aimed to determine the prevalence of computer vision syndrome (CVS) among secretaries working in different departments of a university hospital in Turkey and its relationship with low-frequency electromagnetic field (LF-EMF) exposure.

SUBJECTS AND METHODS: This cross-sectional study included 143 secretaries working in different departments of the hospital. Besides eye examinations, CVS Syndrome Questionnaire (CVS-Q) Scale and Ocular Surface Disease Index Scale (OSDI) were applied to the participants. LF-EMF of the work environment were measured with a 6010 Gauss/Teslameter device and the light intensity with an LX-1102 Device.

RESULTS: The mean age of participants was 39.6 years, with a male-to-female ratio of 25.2% to 74.8%. CVS-Q scale revealed 83.9% of computer vision syndrome among participants. A weak positive correlation was found between CVS-Q and LF-EMF, while a moderately strong, negative correlation was found between LF-EMF and Schirmer test of both eyes. The work environment LF-EMF values were significantly higher among the participants diagnosed with CVS (*p*<0.05). The risk of CVS was found to increase 3.27 times when the ambient LF-EMF was >1,725 µT and an increase of 0.004 units in the CVS-Q score was calculated for each one-unit increase in the LF-EMF of the environment.

CONCLUSIONS: A relationship between CVS, dry eye and EMF was observed among people exposed to LF-EMF. Regular measurement of EMF in work environments, and developing protective behaviours (work-break intervals, 20-20-20 rule, etc.) can be recommended.

Key Words:
Dry eyes, Electromagnetic field, Occupational health, Computer vision syndrome.

Introduction

With the widespread use of digital screens in business life, health problems related to the use of these devices have also been brought to the agenda. It is estimated that 90% of all work today is performed with the use of computers. Moreover, the widespread use of mobile phones, tablets, and television screens in addition to computers aggravates the health problems caused by digital devices[1]. As a result of global digitalisation, radiation and its effects on health have become the main topic leading researchers to work on this subject. Many devices used at home or work create non-ionizing radiation called "low-frequency electromagnetic field (LF-EMF)[2]. After exposure to an LF-EMF, visual sensitivities may occur such as headache, nausea, muscle spasm, and observing luminous shapes (retinal phosphene) in the absence of any light[3]. Computer Vision Syndrome (CVS) is defined as a common set of vision problems that occur after long-term exposure to digital screens accompanied by a series of disorders in the musculoskeletal system. Although individual differences may occur, the most common symptoms are dryness in the eyes, watering, blurred vision, focusing problems and head or neck aches[4]. In addition to long exposure to digital screens, CVS is caused by the presence of underlying eye diseases, work environment illuminance, the shape of the worktable and the sitting style, inappropriate screen height and screen-to-eye distance, use of wrong font and size on the screen, unproportionally between screen brightness to the ambient light, and omitting screen filters[5]. This study aimed to determine the prevalence of CVS among secretaries working in a hospital and its relationship with LF-EMF.

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Subjects and Methods

This research was a cross-sectional study targeting automation and department secretaries working at different clinics of Çukurova University's Balcalı Hospital (Adana, Turkey). The sample size analysis was performed using MINITAB 16 Statistical Software (Minitab Inc., State College, PA, USA) based on the CVS prevalence of 76%[6], a power of 80%, a confidence interval of 95%, and a design effect of 1.0. It revealed a study group of 143 participants who were randomly selected from the population list consisting of 290 secretaries.

Exclusion Criteria

The participants with a work history of less than one year or those recently recruited; those with a recent ophthalmological operation or trauma history, and those who denied an ophthalmological examination were excluded from the study.

Inclusion Criteria

The participants who had a work history of one year or longer, actively working with digital equipment like computer etc. were included in the study.

The chief staff was informed about the aim and the stages of the study regarding the application of the survey, electromagnetic field measurements and eye examinations. Before starting to collect the data, the participants' consent was obtained after face-to-face information was given about the study and the usage of the data collected only for scientific purposes and the protection of confidentiality of personal information. While the questionnaire was applied to the participants, simultaneous electromagnetic field, ambient and work area illuminance were measured by the researchers of the Department of Biophysics, Faculty of Medicine, Çukurova University, and eye examinations were carried out by ophthalmologists in the same Faculty.

Questionnaire Form

Age, sex, marital status, working time in the profession, daily time spent with digital devices, daily working hours, the number and the duration of breaks, presence of a screen filter, the distance to the computer screen, sitting position, the presence of any underlying eye-related disease, the use of an ophthalmological medicine, contact-lens or eye-glasses wearing, chronic comorbidities and use of drugs were determined using a questionnaire of 19 questions.

Computer Vision Syndrome Questionnaire (CVS-Q)

Seguí et al[7] developed the CVS-Q test as a pretest for diagnosing Computer Vision Syndrome (CVS). The scale consists of questions about the frequency and intensity of 16 eye-related symptoms. The frequencies are scored as never (0), sometimes (1) and often-always (3), while the intensity was scored as medium (1) and intense (2). The symptom scores are calculated with the formula (frequency Í intensity) and interpreted as "0-point" for a score of 0, "1-point" for a score of 1 or 2, and "2-point" for a score of 4. CVS is diagnosed if the total score is ≥6 in 16 questions.

Ocular Surface Disease Index (OSDI)

Schiffman et al[8] developed OSDI questionnaire to measure the severity of dry eye disease. Its validity and reliability in Turkey were determined by Ozcura et al[9] in 2007. The test consisting of three parts is used to rank ocular surface damage and dry eye. The sum of scores obtained in three sections is multiplied by 25 and divided by the number of questions answered to calculate the final score. The degree of ocular damage and dry eye is ranked as normal (0-12 points), mild (13-22 points), moderate (23-32 points), or severe (33-100 points).

Ophthalmological Examinations

Ophthalmological examinations of the participants were performed by ophthalmologists. Visual acuity, eye pressure, anterior segment and fundus were evaluated in the examination, and Schirmer test was applied to measure dry eye.

Schirmer Test

The Schirmer test paper was placed at the lateral one-third of the lower fornix of the eye and the wetness on the paper was measured in millimeters after five minutes. Measurements of 10 mm or less were considered dry eye.

Low-frequency EMF (LF-EMF) and Ambient Measurements

The environmental EMF was measured where the participants worked by using a 6010 Gauss/Teslameter (American Bell, Milwaukie, OR, USA) device in a quadratic area at a distance of 30 and 60 cm from the participant on all four sides of the work environment. The mean of measurements determined the EMF. Ambient illuminance was determined as the mean of four different measurements each made at a one-meter-step of distance. The work area illuminance was determined as the mean of two measurements made at the right and left of the middle point of the work monitor, and of the two measurements made at the right and left ends of the keyboard. The illuminance was measured with the LX-1102 device (Lutron, Coopersburg, PA, USA).

Statistical Analysis

The statistical analyses was performed using IBM SPSS 22 (IBM, Armonk, NY, USA). The normality was tested with Shapiro Wilk test. Parametric tests (*t*-test, Pearson's correlation test) were used for normally distributed data, and non-parametric tests (Mann-Whitney U test, Spearman correlation analysis) for non-normally distributed data. Chi-square, binary logistic regression, and multiple linear regression tests were used in the comparison of categorical data. A *p*-value <0.05 was considered statistically significant.

Results

The mean age of 143 people included in the study was 39.6±7.9 (min 22, max 63). CVS was observed in 83.9% of the participants. The sociodemographic characteristics of the individuals and the characteristics of the work environment were given in Table I.

When the work environment measurements and OSDI scale scores were compared according to the presence of CVS, statistically significant differences were found: OSDI score, mean work time, and ambient LF-EMF values were higher and Schirmer score was lower for both eyes in participants with CVS (Table II).

It was found that there was a weak positive correlation between CVS-Q and LF-EMF, and a moderately strong positive correlation with OSDI. Considering the correlations between LF-EMF measurements and dry eye test Schirmer; a moderately strong negative correlation was found between the Schirmer measurements of both eyes (Table III).

In the ROC analysis performed to find an optimum cut-off value for ambient LF-EMF according to the presence of CVS, it was found that the area under the curve was significant and values >1725 µT were diagnostic for CVS with a sensitivity of 100%. The logistic regression model with CVS (presence/absence) as the dependent variable created to predict CVS was also significant (omnibus test *p*<0.001). The independent variables in the model were EMF measurement (ref=0-1725 µT), presence of screen glare (ref=absent) and working times at work (non-categorical). They explained 21.3% of the change in the dependent variable with an accuracy rate of 83.9%. CVS risk increased 3.27 times if the ambient EMA was above 1725 µT, 1.097 times for every 0.0927 unit increase in the working time, and 4.15 times in cases of screen glare (Table IV).

The multivariate linear regression model constructed to predict CVS-Q score was found to be significant. The explanatory coefficient of the model was R^2=0.390. Our dependent variable was CVS-Q score, while independent variables were OSDI score, LF-EMA value, work-break duration, ambient light, work area light, working time with computer, daily working hours. The forward LR model revealed that OSDI score, and

Table I. Sociodemographic and work environment characteristics.

Characteristics	n (%)
Age 20-40/>40	79 (55.2) / 64 (44.8)
Sex Male/Female	36 (25.2) / 107 (74.8)
Marital Status Married/Single	106 (74.1) / 37 (25.9)
Eye Disease Yes/No	69 (48.3) / 74 (51.7)
Use of Ophthalmological Medicines Yes/No	9 (6.3) / 134 (93.7)
Wearing Glasses or Contact Lenses Yes/No	61 (42.7) / 82 (57.3)
Eye-to-Screen Distance Closer/Equal/Farther	77 (53.8) / 52 (36.4) / 14 (9.8)
Sitting Position Upright/Leaning/Reclining	52 (36.4) / 88 (61.5) / 3 (2.1)
Work-breaks Yes/No	104 (72.7) / 39 (27.3)
Glare/Reflection on Screen Yes/No	98 (68.5) / 45 (31.5)
Screen Filter Yes/No	10 (7.0) / 133 (93.0)
Aware of the 20-20-20 Rule Yes/No	3 (2.1) / 140 (97.9)
CVS undiagnosed/diagnosed	23 (16.1) / 120 (83.9)
Total	143 (100)

Table II. Comparison of work environment characteristics and ophthalmological findings according to CVS.

	CVS				
	Undiagnosed [n=23 (%16.1)]		Diagnosed [n=120 (%83.9)]		
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	*p*
Work history (Year)	10.84±6.66	11.0 (11.75)	14.93±7.79	14.0 (7.00)	**0.031**
Daily Working time (Hours)	8.04±0.20	8.0 (0.00)	8.05±0.38	8.0 (0.00)	0.995
Working with Digital Devices (Hours)	9.56±2.57	8.0 (2.00)	9.92±2.81	10.0 (4.00)	0.480
Time between Breaks (Hours)	2.44±0.78	2.0 (1.00)	2.33±0.85	2.0 (1.00)	0.746
Break Time Mean (Minutes)	11.76±5.57	10.0 (5.00)	10.11±5.00	10.0 (5.00)	0.131
SHIRMER (right eye)	16.91±5.89	14.3 (6.83)	13.52±6.18	13.2 (2.53)	**<0.001**
SHIRMER (left eye)	16.15±6.54	13.4 (4.39)	12.73±5.35	12.9 (1.56)	**<0.001**
LF-EMA (μT)	1457.39±187.13	1370.0 (325.0)	1545.41±224.91	1500.0 (385.00)	**0.047**
OSDI score	13.14±9.66	12.5 (13.47)	41.56±21.18	40.0 (26.23)	**<0.001**
Ambient light intensity	345.21±142.53	285.0 (210.50)	353.08±111.07	366.0 (184.00)	0.444
Working Area light intensity	153.52±100.33	118.0 (121.00)	153.96±67.48	135.0 (98.50)	0.334

Table III. Correlations between LF-EMF and Schirmer Test.

	CVS-Q	OSDI	LF-EMF	SHIRMER (right eye)
CVS-Q	—			
OSDI Score	0.584***	—		
LF-EMF	0.202*	0.015	—	
SHIRMER (right eye)	-0.077	-0.033	-0.536***	—
SHIRMER (left eye)	-0.073	-0.079	-0.488***	0.852***

**p*<0.05, ****p*<0.001.

EMA contributed significantly to the final model. A one-unit increase in the OSDI score caused an increase of 0.119 units in the CVS-Q score, and a one-unit increase in the EMA caused an increase of 0.004 units in the score (Table V).

Discussion

Computer vision syndrome (also known as digital eyestrain syndrome) is commonly observed all over the world. The frequent use of digital tools in daily life increases the importance of CVS. In our study, the prevalence of CVS was found to be 83.9%. When the predisposing factors were examined, CVS development was found to be significantly higher in those having eye-related morbidities and among eyeglasses or contact lens users. The risk of developing CVS increased with the increase in working time. The risk of CVS development was found to be higher in those who had reflection/glare on screen originating from the outside or indoor environment. When the relationship between CVS and EMF was examined, CVS risk was found to be significantly increased in those with an EMF exposure of over 1725 μT.

Table IV. Logistic Regression Analysis for predicting CVS-Q.

				95% CI	
	β	*p*	O.R.	Lower level	Upper level
Years worked	0.0927	0.025	1.09	1.01	1.19
EMF(μ) (≥1726 – <1726)	1.1875	0.020	3.27	1.21	8.88
Screen glare	1.4237	0.005	4.15	1.55	11.11

Table V. CVS-Q Skoru Tahmini Çok Değişkenli Lineer Regresyon Analizi.

	Unstandardised Coefficients			95% CI		Collinearity Statistics	
	R^2	B	*p*	Lower boundary	Upper boundary	Tolerance	VIF
1 (Constant)	0.352	6.252	**<0.001**	4.801	7.703		
OSDI score		0.120	**<0.001**	0.086	0.154	1.000	1.000
2 (Constant)	0.390	0.203	0.943	-5.456	5.862		
OSDI score		0.119	**<0.001**	0.085	0.152	0.999	1.001
LF-EMF (µT)		0.004	**0.031**	<0.001	0.008	0.999	1.001

The prevalence of CVS was reported to vary between 25 and 90%, while geographical differences existed[10]. In a study conducted on 2,210 office workers in Sri Lanka, the prevalence of CVS was reported as 67.4%[11], while 73.0% among 304 bank employees in Ethiopia (2015)[12], as 67.2% among 198 medical school students in Pakistan (2016)[13], 76.6% in 244 university students in Spain (2019)[6], 69.5% among 607 government employees working with computers in Ethiopia (2016)[14], and 51.9% in 200 university personnel in Gana (2020)[15].

CVS was reported as two to three times more common in women than men. Rahman and Sanip[16] (2011) reported a male-to-female ratio of CVS to be 31% to 69%. Zainuddin and Isa[17] (2014) reported it as 30% to 69.5%. In our study, 77.5% of those diagnosed with CVS were female and 22.5% were male. While the proportionality was preserved, the rate was higher compared to the literature. The fact might be attributed to the higher number of women participants in our study. The risk of developing CVS was reported to vary according to the individual characteristics like underlying eye disease, glasses/lens use, medications used and other systemic diseases, the years spent at the workplace, daily working hours with digital devices etc., in addition to their behavior while using digital devices in daily life[18]. Tesfa et al[19] reported that the risk of developing CVS was 2.84 times higher in those who had worked for more than 10 years compared to those who had worked less. Additionally, the risk was reported 2.92 times higher in people who spent more than 6 hours a day with digital devices than those who spent less, 2.44 times higher in those wearing eyeglasses, 2.77 times higher in those working under inappropriate ambient or screen brightness, and 4.39 times higher in those ignoring relevant protective measures (like 20/20/20 rule, etc.). Adane et al[20] (2021) reported a CVS risk 3.54 times higher in those having an underlying ophthalmological disorder, 2.38 times higher in cases of wrong sitting position, 2.71 times higher in those spending a longer time at the computer, and 2.07 times higher in eye-glasses wearers. When we examined the presence of predisposing factors for CVS, we found similarly that every 0.09-year increase in working time increased the risk of developing CVS by 1.09 times. We found the risk of developing CVS to be 4.15 times higher in secretaries whose screens had reflection or glare caused by the external or internal environment, significantly higher in people with ophthalmological disorders (53.3%) and eyeglasses and lens users (47.5%).

Regarding the health effects of LF-EMF on CVS, we found significant correlations between the CVS presence and the measurements in the working environment. CVS-Q questionnaire revealed a weak positive correlation with LF-EMF. Ambient LF-EMF values were found to be statistically significantly higher in participants with CVS, and the Schirmer test was significantly lower. A moderately strong and negative correlation was observed between LF-EMF values and Schirmer measurements in both eyes.

Portello et al[21] found a positive correlation between CVS and OSDI when they examined the relationship between CVS and dry eye. Logistic regression analysis in our study to evaluate the relation of CVS to LF-EMF and OSDI showed that the risk of developing CVS increased 3.27 times when the ambient EMF was over 1725 µT. In the multivariate linear regression analysis between the CVS-Q score and the work environment measurements, we found that each one-unit increase in the OSDI score caused an increase of 0.119 units in the CVS-Q score, and each one-unit increase in the EMF caused an increase of 0.004 units in the CVS-Q score. In a cross-sectional study[22] performed at Isfahan University in 2004, the electric and magnetic field strength in 125 laptop computers and its relationship with eye strain were examined at distances of 30 cm and 50 cm and in all four directions. It was found that the EMF values at a distance of 50 cm were above the recommended values in 20% of the examined computers and those at a distance of 50 cm were lower than the recommended values. On the other hand, no significant relationship was found between EMF and eye fatigue. On the contrary, Gowrisankaran and Sheedy[5] did not report EMF as one of the factors facilitating the development of CVS. Gajta et al[23] investigated the effects of EMF produced by mobile phones on the tear film in the eye and found that the pH of the tear increased after exposure to EMF and related this to the alteration of the physical appearance of the tear due to the EMF emitted by mobile phones with a resultant alteration in the quality of the tear film. They also observed a negative correlation between the tear pH and Schirmer test, with a resulting dry eye. In our study, a similar negative correlation was found between EMF and Schirmer test. Regarding devices emitting LF-EMF, the same mechanism can be attributed to the development of the dry eye even though not as strongly as in mobile phones.

Limitations

As our study included participants working in a single center, this can be interpreted as a limitation regarding the sampling diversity. A larger sampling group consisting of different occupational groups with diverse EMF exposure may be beneficial.

Conclusions

Our study revealed a weak correlation between LF-EMF and CVS and a moderate correlation with dry eye, and the risk was increased in environments with an LF-EMF above 1725 µT. We recommend to regularly measure LF-EMF in workplaces where digital devices are intensively used, and to give preventive training at workplaces.

Ethics Approval

The study was approved by Ethical Committee for Non-Interventional Studies of the Faculty of Medicine, Çukurova University, Adana, Turkey (June 11th, 2021, and Decree No: 112).

Informed Consent

All participants signed informed consent for inclusion.

Availability of Data and Material

The data of the study are available from the corresponding author.

Conflict of Interest

The Authors declare no conflict of interest in this study.

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Authors' Contributions

Osman Kösek: conception and design of the study, acquisition of data, analysis, interpretation of data; drafting the article. Burak METE: conception and design of the study, acquisition of data, analysis and interpretation of data; drafting the article, making critical revisions. Işıl ÖCAL: conception and design of the study, acquisition of data, analysis, making critical revisions. Kemal YAR: conception and design of the study, acquisition of data, analysis, making critical revisions. Hakan DEMİRHİNDİ: design of the study, acquisition of data, analysis, making critical revisions, revision for English. Murat TOKUŞ: conception and design of the study, acquisition of data, analysis, making critical revisions.

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References

1) Porcar E, Pons AM, Lorente A. Visual and ocular effects from the use of flat-panel displays IJO 2016; 9: 881-885.
2) Occupational hygiene laboratory TS EN ISO / IEC 17025 Electromagnetic spectrum. Available at: https//prosafety.com.tr/elektromanyetik-spektrum-radyoaktivite.
3) International commission on non-ionizing radiation protection website. Available at: https://www.icnirp.org/.
4) Griffiths KL, Mackey MG, Adamson BJ. The impact of a computerized work environment on professional occupational groups and behavioural and physiological risk factors for musculoskele-

tal symptoms: a literature review. J Occup Rehabil 2007; 17: 743-765.

5) Gowrisankaran S, Sheedy JE. Computer vision syndrome: A review. Work 2015; 52: 303-314.
6) Cantó-Sancho N, Sánchez-Brau M, Ivorra-Soler B, Seguí-Crespo M. Computer vision syndrome prevalence according to individual and video display terminal exposure characteristics in Spanish university students. Int J Clin Pract 2021; 75: e13681.
7) Seguí Mdel M, Cabrero-García J, Crespo A, Verdú J, Ronda E. A reliable and valid questionnaire was developed to measure computer vision syndrome at the workplace. JCE 2015; 68: 662-673.
8) Schiffman RM, Christianson MD, Jacobsen G, Hirsch JD, Reis BL. Reliability and validity of the Ocular Surface Disease Index. Arch Ophthalmol 2000; 118: 615-621.
9) Ozcura F, Aydin S, Helvaci MR. Ocular surface disease index for the diagnosis of dry eye syndrome. Ocul Immunol Inflamm 2007; 15: 389-393.
10) Daum KM, Clore KA, Simms SS, Vesely JW, Wilczek DD, Spittle BM, Good GW. Productivity associated with visual status of computer users. Optometry 2004; 75: 33-47.
11) Ranasinghe P, Wathurapatha WS, Perera YS, Lamabadusuriya DA, Kulatunga S, Jayawardana N, Katulanda P. Computer vision syndrome among computer office workers in a developing country: an evaluation of prevalence and risk factors. BMC Res Notes 2016; 9: 150.
12) Assefa NL, Weldemichael DZ, Alemu HW, Anbesse DH. Prevalence and associated factors of computer vision syndrome among bank workers in Gondar City, northwest Ethiopia. Clin Optom (Auckl) 2017; 9: 67-76.
13) Noreen K, Batool Z, Fatima T, Zzmir T. Prevalence of Computer Vision Syndrome and Its Associated Risk Factors among Undergraduate Medical Students of Urban Karachi. Pak J Ophthalmol 2016; 32: 140-146.
14) Adane F, Nega A, Wami SD. Computer Vision Syndrome and Associated Factors among Computer Users in Debre Tabor Town, Northwest Ethiopia. Journal of Environmental and Public Health 2018.
15) Boadi-Kusi SB, Abu SL, Acheampong GO, Adueming PO, Abu EK. Association between Poor Ergophthalmologic Practices and Computer Vision Syndrome among University Administrative Staff in Ghana. J Environ Public Health 2020; 2020: 7516357.
16) Rahman ZA, Sanip S. Computer User: Demographic and Computer Related Factors that Predispose User to Get Computer Vision Syndrome. IJBHT 2011; 1: 84-91.
17) Zainuddin H, Isa MM. Effect of Human and Technology Interaction: Computer Vision Syndrome among Administrative Staff in a Public University. IJBHT 2014; 4: 39-44.
18) Nahar NK, Sheedy JE, Hayes J, Tai YC. Objective measures of lower-level visual stress. Optom Vis Sci 2007; 84: 620-629.
19) Tesfa M, Sadik MI, Markos Y, Aleye LT. Prevalence and Predictors of Computer Vision Syndrome among Secretary Employees working in Jimma University, Southwest Ethiopia: A Cross Sectional Study at Jimma University. Research Square 2019.
20) Adane F, Alamneh YM, Desta M. Computer vision syndrome and predictors among computer users in Ethiopia: a systematic review and meta-analysis. Trop Med Health 2022; 50: 26.
21) Portello JK, Rosenfield M, Chu CA. Computer Vision Syndrome: Blink Rate and Dry Eye During Hard Copy or Computer Viewing. IOVS 2010; 51: 957.
22) Balkanabadi S, Yusufi HA, Dehghan H. Evaluation of Electromagnetic Field Density and Its Relationship with Computer Vision Syndrome. Journal of Health System Research 2014; 9: 1293-1300.
23) Gajta A, Jurca AM, Stănilă A, Stănilă D. The effects of microwave radiation generated by mobile phones on the tear film. Revista Română de Medicină de Laborator 2014; 29: 277-286.