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Article

As a Common Disturbing Ocular Issue: Dry Eye Syndrome Due to Reckless Use of Digital Screens

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Abstract: The excessive and prolonged use of the electronic devices with digital screens may cause some serious health problems. The ocular surface problems particularly Dry Eye Syndrome may be the most common and preventable one of them. In this study, unfavourable and potentially harmful effects of digital screens on lacrimal system and tear functions were evaluated in 221 participants. Their ocular surface conditions were evaluated by Ocular Surface Disease Index (OSDI) scores and their lacrimal functioning was measured by Schirmer's test. A reciprocal and statistically significant relationship was found between dry eye symptoms and OSDI scores. This relationship was more prominent especially in long duration use of smartphones with brighter background lights.

Keywords: dry eye syndrome; digital screens; Schirmer's test; OSDI scores

Introduction

The electromagnetic field is a physical force phenomenon that can affect entities in its vicinity. So many devices such as radars, mobile phones, refrigerators, hair dryers, electrical shavers, MRI equipments, radiographic imaging machines, diathermy units, base stations, radios, and computers can emit electromagnetic waves creating an electromagnetic field. The digital screens may also cause an augmentation in electromagnetic waves of the combined electronic devices. The long standing low doses of electromagnetic irradiation or its sudden impulse in high doses can cause some serious health problems due to damaged neuro-sensorial transmission, inadequate immune response or blocked lymphatic drainage system and eventually can lead headache, eyeache,, burning sensations, dizziness, weight loss, and cardiovascular problems [1,2].

According to National Institute of Environmental Protection and Health Science Association, electromagnetic emission particularly from mobile phones can also cause Alzheimer Parkinson, and Multiple Sclerosis disease [3].

The electromagnetic radiation especially within the blue spectrum may cause a diminished lacrimal secretion due to its negative effects on neural network activity in the corneal nerve plexus. On the other hand, although the printed materials on papers or other items have more distinctive visibility, the newspapers, magazines, or books are increasingly being replaced by their digital versions and almost all communications can be actualised through the e-mails, text messages or other digital apps. To see better to have more background brightness in digital platforms is a common mistake.

The prolonged use of digital devices in higher brightnesses may have some ocular problems such as squeezing the eye lid, decreasing blinking, excessive evaporation of tears leading Dry Eye Syndrome [4]. That kind of Dry Eye condition is also named as Computer Eye Syndrome (CES), Digital Eye Strain (DES), or Digital Eye Fatigue Disorder (DEFD). Actually, these conditions can be seen in any time and any age by excessive use of the smartphones, game consoles, personal computers, LED screen TVs, or e-books. Today, there are 4.3 billion internet (57%), 3.5 billion social media (45%), and 5.1 billion (67%) mobile phone users in the world and every day one million new users are being added to the list [5,6].

Material and Method

The study was performed by conducting anamnesis, Ocular Surface Disease Index (OSDI) questionnaire, Schirmer ‘s test, and digital screen usage survey on all participants The OSDI scoring is proven and reliable assessment method for ranking the dry eye conditions between 0-100 points. The OSDI scores within 0-12 are normal. The 13-33 points refer mild to moderate ocular surface problems and more than 34 points indicate severe dry eye issues. As OSDI is evaluated according to subjective answers to specific questions, Schirmer 's test is evaluated by objective measurements. Schirmer test is done with a special paper strip that is placed in the middle of temporal bulbar conjunctival sac and the wetness of the strip is measured by a ruler. If the wetness on the paper strip is low than 5mm, it can be evaluated as dry eye, but if it is over 10 mm, it can be said as normal [7].

Statistics

The statistical analyses of the study were performed by using the SPSS package program 27 (IBM SPSS Statistics 27). The descriptive findings and collected results of the study were organised in frequency tables and interpreted by proper statistical methods. Non-parametric methods were used for the measurement values that did not comply with normal distribution. In line with non-parametric methods, the “Mann-Whitney U” test (Z-table value) was used to compare the measurement values of two independent groups, and the “Kruskal-Wallis H” test (χ^2 -table value) was used to compare the measurement values of three or more independent groups. The “Bonferroni Correction” was used to determine which group the difference resulted from the variables that were significant in three or more independent groups. The “Spearman Correlation Coefficient” was used to examine the relationships of two quantitative variables that did not have a normal distribution.

Terms such as “[1-2, 3]” were used in pairwise comparisons for the variables that showed significant differences for three or more groups (“[1-2, 3]” means that there was a significant difference between 1 and 2 and between 1 and 3).

Table 1. The distribution of the descriptive characteristics of the study.

Variable (N=221)	n	%
Age class []		
<25	47	21.3
25-34	66	29.9
35-44	43	19.4
≥45	65	29.4
Gender		
Female	122	55.2
Male	99	44.8
Chronic disease status		
Yes	67	30.3
No	154	69.7
Smoking status		
Yes	116	52.5
No	105	47.5
Wearing contact lenses		
Yes	46	20.8
No	175	79.2
Chronic eye disease status		
Yes	70	31.7
No	151	68.3
History of ocular trauma		
Yes	45	20.4

No	176	79.6
Ocular surgery		
Yes	89	40.3
No	132	59.7
Long-term use of topical medication for the eye		
Yes	60	27.1
No	161	72.9
Existing refractive error*		
Myopia	42	22.2
Hypermetropic	20	9.0
Myopia + Astigmatism	39	17.6
Hyperopia + Astigmatism	37	16.7
Astigmatism	26	11.8
No visual impairment	54	24.4
Wearing glasses		
Yes	136	61.5
No	82	37.1
Other	3	1.4

It was found that the mean age of the participants was 37.65±15.62 (years), 66 (29.9%) were in the 25-34 age group, 122 (55.2%) were women, 154 (69.7%) did not have a chronic disease, 116 (52.5%) were smokers, 175 (79.2%) did not use contact lenses, 151 (68.3%) had no chronic eye disease, 176 (79.6%) had no history of ocular trauma, 132 (59.7%) had no ocular surgery, 161 (72.9%) had eye surgery. There was no long-term use of topical medication, 54 participants (24.4%) had no vision defects and 136 (61.5%) used glasses permanently.

Table 2. The distribution of the time spent with electronic screens.

Variable (N=221)	Less than 1 year		1-5 years		More than 5 years		Not using	
	N	%	n	%	n	%	n	%
Smartphone	5	2.3	12	5.4	204	92.3	-	-
LED TV	7	3.2	8	3.6	189	85.5	17	7.7
Computer	5	2,3	4	1.7	150	67.9	62	28.1
E-book	9	4.1	8	3.6	28	12.7	175	79.6
Tablet	3	1.4	22	10.0	53	24.0	143	64.7
Game console	3	1.4	10	4.5	33	14.9	175	79.2
Other digital displays	3	1.4	6	2.6	57	25.8	155	70.2

It was found that 204 participants (92.3%) used smartphones, 189 participants (85.5%) used LED TVs and 150 participants (67.9%) used computers for more than 5 years.

Table 3. The distribution of the time spent with electronic screens in a day.

Variable (N=221)	Less than 1 hour		1-5 hours		More than 5 hours		Not using	
	N	%	n	%	n	%	n	%
Smartphone	5	2,3	52	23.5	164	74.2	-	-
LED TV	45	20.4	72	32.6	89	40.2	15	6.8

Computer	8	3.6	25	11.3	128	57.9	60	27.1
E-book	28	12.7	9	4.1	4	1.8	180	81.4
Tablet	50	22.6	16	7.2	10	4.5	145	65.7
Game console	9	4.1	28	12.7	11th	5.0	173	78.2
Other digital display	9	4.1	30	13.6	27	12.2	155	70.1

It was found that 164 participants (74.2%) used smartphones, 89 participants (40.2%) used LED TVs and 128 participants (57.9%) used computers for more than 5 hours a day.

Table 4. The distribution of the adjusted screen brightnesses in electronic devices.

Variable (N=221)	Low		Moderate		High		Not using	
	n	%	n	%	n	%	N	%
Smartphone	8	3.6	85	38.5	128	58.0	-	-
LED TV	11	5.0	59	26.7	131	59.3	20	9.0
Computer	9	4.1	62	28.1	81	36.6	69	31.2
E-book	29	13.1	8	3.7	6	2.7	178	81.5
Tablet	25	11.3	37	16.7	14	6.3	145	65.6
Game console	4	1.8	27	12.2	18	8.2	172	77.8
Other digital display	4	1.8	27	12.2	35	15.8	155	70.2

It was found that 128 participants (58.0%) used smartphones, 131 participants (59.3%) used LED TVs and 81 participants (36.6%) used computers with high screen brightness.

Table 5. The distribution of the OSDI scores.

Scale (N=221)	Mean	SD	Median	Min.	Max.
OSDI scores	21.40	19.59	16.7	0.0	97.9

The descriptive findings of the participants regarding their OSDI scores are given in the table. It was found that the mean OSDI score of the individuals was 21.40±19.59.

Table 6. The distribution of the reliability coefficients for OSDI scores.

Scale (N=221)	Number of items	Cronbach-α coefficient
OSDI score	12	0.920

The reliability coefficients of the OSDI scores of the participants are given in the table. It was found that the answers given to the OSDI questionnaire had a very high-reliability level.

It was also found that the mean amount of dryness in the right eye of the subjects was 18.38±7.08 and the average amount of dryness in the left eye was 19.46±7.35.

Table 7. The comparison of the total scores according to the findings.

Variables (N=221)	n	OSDI scores	Statistical analysis* Possibility
			Median [IQR]
Age <25 (1)	47	11.92±18.11	6.3 [14.6]

$\chi^2=52,677$

25-34 (2)	66	17.77±16.83	12.5 [20.8]	p<0.001 [1-2,3,4] [2,3-4]
35-44 (3)	43	19.19±19.61	14.6 [16.7]	
≥45 (4)	65	33.40±17.75	29.2 [27.1]	
Gender				
Female	122	22.51±21.15	16.7 [26.0]	Z=-0.480
Male	99	20.04±17.50	16.7 [22.9]	p=0.631
Chronic disease status				
Yes				
No	67	30.85±18.19	27.1 [29.2]	Z=-5,600
	154	17.29±18.79	12.5 [20.8]	p<0.001
Smoking status				
Yes				
No	116	22.38±18.65	18.8 [20.8]	Z=-1.727
	105	19.91±20.81	12.5 [29.2]	p=0.084
Contact lens use status				
Yes				
No	46	16.81±17.08	12.5 [18.8]	Z=-1.806
	175	22.39±20.14	17.7 [25.0]	p=0.071
Chronic eye disease status				
Yes				
No	70	33.81±18.12	30.2 [29.2]	Z=-7,280
	151	15.25±17.53	11.5 [19.3]	p<0.001
History of ocular trauma				
Yes				
No	45	29.91±18.06	27.1 [30.2]	Z=-3.986
	176	18.94±19.44	14.6 [22.9]	p<0.001
Ocular surgery status				
Yes				
No	89	25.63±17.23	22.9 [22.9]	Z=-4.036
	132	18.15±20.64	12.5 [22.9]	p<0.001
Long-term use of topical medication forthe eye				
Yes				
No	60	33.41±18.82	29.2 [30.7]	Z=-6.146
	161	16.63±18.03	12.5 [20.3]	p<0.001
Wearing permanent glasses				
Yes				
No	136	26.58±19.13	22.9 [24.5]	Z=-6.065
	82	13.03±17.68	6.3 [19.3]	p<0.001

* For non-normally distributed data, the “Mann-Whitney U” test (Z-table value) was used to compare the measurements of two independent groups, and the “Kruskall-Wallis H” test (χ 2 -table value) was used to compare three or more independent groups.

Statistically significant differences were detected in the OSDI scores according to the ages ($\chi^2=52.677$; $p<0.001$). As a result of the Bonferroni Corrected Pairwise Comparisons made to determine which group caused the significant difference, significant differences were detected between those in the <25 age group and those in the 25-34, 35-44, and ≥ 45 age groups. The OSDI score of those in the 25-34, 35-44, and ≥ 45 age groups was significantly higher than those in the <25 age group. Similarly, significant differences were detected between those in the 25-34 and 35-44 age groups and those in the ≥ 45 age group. It was determined that the OSDI score of those in the ≥ 45 age group was significantly higher compared to those in the 25-34 and 35-44 age groups.

Statistically significant differences were detected in the OSDI scores according to chronic disease status ($Z=-5.600$; $p<0.001$). The OSDI score of the participants who had chronic diseases was significantly higher than those without chronic diseases.

Statistically significant differences were detected in the OSDI scores according to chronic eye disease status ($Z=-7.280$; $p<0.001$). It was found that the OSDI scores of the participants who had chronic eye diseases were significantly higher than those without chronic eye diseases.

Statistically significant differences were detected in the OSDI scores according to ocular trauma history ($Z=-3.986$; $p<0.001$). The OSDI scores of those who had a history of ocular trauma were significantly higher than those without a history of ocular trauma.

Statistically significant differences were detected in the OSDI scores according to ocular surgery status ($Z=-4.036$; $p<0.001$). The OSDI scores of those who had ocular surgery were significantly higher than those who did not have ocular surgery.

Statistically significant differences were detected in the OSDI scores according to long-term topical medication use for the eye ($Z=-6.146$; $p<0.001$). The OSDI scores of those who used long-term topical medication to the eye were significantly higher than those who did not use topical medication to the eye for a long time.

Statistically significant differences were detected in the OSDI scores according to permanent glasses use ($Z=-6.065$; $p<0.001$). The OSDI scores of those who wore permanent glasses were significantly higher than those who did not use permanent glasses.

No statistically significant differences were detected in the OSDI scores according to gender, smoking, or contact lens use ($p>0.05$).

Table 8. The relationships between the scales of right and left eye .

Correlation* (N=221)		OSDI scores
Right eye dryness amount	<i>r</i>	-0.403
	<i>p</i>	<0.001
Left eye dryness amount	<i>r</i>	-0.404
	<i>p</i>	<0.001

* Spearman Correlation Coefficient was used to examine the relationships of two quantitative variables that did not have normal distributions.

A negative, weak, and statistically significant relationship was detected between the OSDI scores and the amount of dryness in the right and left eyes ($p<0.05$). As the amount of dryness increases in the right and left eyes, OSDI scores will decrease.

Results and Discussion

To reveal the effects of digital screens on lacrimal activity 221 participants were included in the study.

Primarily, all cases were separated into the certain different groups and categories according to the applied statistical model. The statistical analyses were made to determine whether there was any relevance or difference between the groups and categories.

The first statistically significant difference was found between the OSDI scores and the age groups ($\chi^2=52.677$; $p<0.001$).

Besides the long-term topical ocular medication for eyes was found in higher OSDI scores as statistically significant too ($Z=-6.146$; $p<0.001$).

In the previous studies, performed by OSDI questionnaire, Schirmer test, and tBUT (tear break up time) on computer users with a history of using computers at least 6 hours in the day were found in mild to severe ocular surface disease.

The internet addiction is another dry eye causing digital factor. In a study with an average OSDI score as 21.63 ± 17.86 , a significant weak relationship was reported in the young internet addicts [8,9].

The tBUT (tear break up time) test was not included in this study because of the compatible results with the Schirmer test.

According to DEWS (Dry Eye Workshop) II report, increased evaporation in tear film is the main cause of dry eye with a ratio of 50%. The second is the mixed type and the third one is characterised by hyposecretion of tear with a ratio of 14%.

Digital screens can cause dry eye either through the hyposecretion of tear due to damaged sensory excitation of corneal nerve plexus because of electromagnetic irradiation and excessive evaporation due to decreased blinking.

The distinction of this study is in the comparative statistical analyses of each categories, groups and added novel patterns such as chronic ocular diseases, wearing contact and etc.

Conclusions

The prolonged use of digital monitoring devices such as smartphones especially in high screen brightness is a common and unfavourable habitual behavior.

The ocular surface should be protected from these harmful effects by using blue light filters, blinking more frequently, or resting the eyes.

References

1. RE Shore. **Radiation** impacts on human **health**: certain, fuzzy, and unknown. **Health physics**, 2014.
2. FR Tang, K Loganovsky .**Low dose or low dose rate ionizing radiation-induced health effect in the human**. Journal of environmental **radioactivity**, 2018.
3. ZA Ratan, AM Parrish, SB Zaman, **Smartphone addiction and associated health outcomes in adult populations: a systematic review**. **Public health**, 2021.
4. Günes F. From Paper to Screen Developments in the Field of Reading. Bartın University Faculty of Education Journal. 5(1):1. 2016.
5. Bostancı B. Digital Eye Strain Syndrome and Dry Eye. **MN Ophthalmology**, (1):96-9, 2023.
6. R Emanuel, R Bell, C Cotton, J Craig. **The truth about smartphone addiction**. *College student journal* **49** (2), 291-299, 2015.
7. Çelik T. Evaluation of the tear film layer in computer users with dry eye symptoms using ocular surface disease index, tear breakup time, and Schirmer test. 2017.
8. Wu H, Wang Y, Dong N, Yang F, Lin Z, Shang X, et al. Meibomian gland dysfunction determines the severity of the dry eye conditions in a visual display terminal workers. **PLoSOne**, 9(8), 2014.
9. Sağlan R, Atay E, Demirtaş Z, Öcal Ee. Evaluation of Internet Addiction and Dry Eye Disease Among Secondary and High School Students. **Eurasian Journal of Family Medicine**. 6(3):117-26, 2017.
10. Heus P, Verbeek JH. Optical correction of refractive error for preventing and treating eye symptoms in computer users. **Cochrane Database Syst Rev**. 4(4), 2018.

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