Effect of Computer Use on Tear Film Production Among Commercial Computer Operators.

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Abstract

The study was aimed at investigating the effect of computer use on tear film production among commercial computer operators in Owerri Municipal Council, Imo State, Nigeria. The study was an experimental study that adopted a purposive sampling technique to collect relevant data from 50 randomly-selected commercial computer operators in Owerri Municipal Council, Imo state, Nigeria. The Standardized Patient Evaluation of Eye Dryness (SPEED) questionnaires were administered to 50 participants aged 18-50 to elicit relevant information; whereas the Schirmer 1 test was administered to determine the level of tear production. Findings revealed a significant decline in tear production after 2 hours of uninterrupted computer use showing that increase in age results in a greater decline in the mean tear production as shown among ages 41-50. Results across gender lines shows that the mean tear volume of females at all testing times was greater than in their male counterparts. Mean tear production at baseline and after 2 hours in female subjects were 38.92mm and 33.40mm respectively in contrast to the mean baseline tear production of their male counterparts at 31.66mm and 30.20mm after 2 hours. Tearing, blurry vision and irritation were the major symptoms cited by computer users over time. The use of the computer results in prolonged visual concentration and this was shown to affect the rate of tear production over time. The study under consideration has shown that apart from long-term computer use, factors like age and gender contribute significantly to decline in tear production. These have proved to be major contributors to symptoms of dry eye disease. This demonstrates the need to observe eye health precautions while using the computer over a long-term duration.

Keywords: Tear production, dry eye, computer operators, ICT, Owerri Municipal Council.

Introduction

Over the years, Information and Communication Technology (ICT) has dominated the way information is conveyed. The rise in information demand and the seamless access to internet services have made communication easier and work less burdensome, making information access easy and timely across the world. The developing countries are not excluded from the benefits that this brings, as there is an increase in the knowledge of its usage.

The computer in its varied forms (desktops, laptops, palmtops and other digital devices) through the instrumentality of its visual displaying component displays the information on the screen (monitor). Virtually, every sector of the economy (banking, education, health, companies and business establishments) utilize computers for smooth operation of its vast database, putting into

use its functionalities to enhance work as well as relay and store relevant information. With prolonged use of these devices, their vision-related challenges have become a major concern to the operators[1].

Visual Display Unit (VDU) operators have been shown to demonstrate higher incidences of musculoskeletal disorder, eyestrain, and dry eyes[2]. With the eye being the organ of sight, its importance in this era of ICT cannot be overemphasized. Its constant exposure and the demand placed on it by virtue of the lengthy working hours and years of active engagement on information exploration have become a significant health issue affecting the quality of life.

As a consequence of frequent use and habitual exposure including reduced blink rate associated with aging, the tear film may be compromised resulting in a condition known as Dry Eye Syndrome (DES) or Dry Eye Disease (DED)[3]. This is colloquially known as Keratoconjunctivitis Sicca (KCS); which is a term denoting insufficient quality tears to lubricate and nourish the eye. There are two broad classifications of dry eye; aqueous deficient dry eye disease, and evaporative dry eye disease: both characterized by instability of the tear film. The former is due to insufficient amount of tear production, while the latter is due to poor quality of tear film and results in increased evaporation of the tears. Some of the symptoms of dry eye disease include: ocular irritation, redness, fluctuating vision, ocular discomfort, decreased tear meniscus or break-up time etc.

With most research focused on the increased evaporation of tears as the major contributing factor for dry eyes, little is known about the aqueous deficient dry eye[4-7]. With recent developments, as well as, classification of DED at the International Dry Eye Workshop, dry eye is defined as a multi-factorial disease of the tears and ocular surface that result in symptoms of discomfort, visual disturbance, and tear film instability with potential damage to the ocular surface. It is accompanied by increased osmolarity of the tear film and inflammation of the ocular surface[8].

Aqueous tear-deficient dry eye implies that dry eye is due to a failure of the lacrimal tear secretion. In any form of dry eye due to lacrimal acinar destruction or dysfunction, dryness results from reduced lacrimal tear secretion and volume[9]. This causes tear hyperosmolarity, because although the water evaporates from the ocular surface at normal rates, it is from a reduced aqueous tear pool. Tear film hyperosmolarity causes hyperosmolarity of the ocular surface epithelial cells and stimulates a cascade of inflammatory events involving mitogen-activated protein (MAP) kinases and nuclear factor-kB (NF-kB) signaling pathways [10,11]. When lacrimal dysfunction is due to lacrimal gland infiltration and inflammation, inflammatory mediators generated in the gland are assumed to find their way into the tears and be delivered to the ocular surface.

Tear hyperosmolarity is regarded as the central mechanism causing ocular surface inflammation, damage, and symptoms, and the initiation of compensatory events in dry eye. Tear osmolarity is defined as a function of the balance between rate of tear production and tear loss from the eye. It arises as a result of water evaporation from the exposed ocular surface, in situations of a low aqueous tear flow, or as a result of excessive evaporation, or a combination of these events. It has demonstrated wide variation of tear film thinning rates in normal subjects, and it is reasonable to conclude that, for a given initial film thickness, subjects with the fastest thinning rates would

experience a greater tear film osmolarity than those with the slowest rates[12]. This is experienced in the case of computer usage in what is known as "Computer Vision Syndrome" (CVS). Computer Vision Syndrome is a complex disorder of the eye and vision related to activities which stress the near vision and which are experienced in relation or during the use of computers[13]. In most cases, the symptoms occur because the visual demands of the task exceed the visual abilities of the individual for comfortable performance of the task. The eye strain can as well be linked to the workplace ergonomics involving the positioning of the computer systems, distance from the computer, lighting, filters to reduce glare, screen brightness, as well as, the observance of frequent breaks while using the computer [14]. Estimates show that 75% of all jobs in year 2000 involved the use of computers[15]; since then, the number has increased, particularly when these statistics are combined with the non-vocational use of computer devices for various activities. It has been observed that Computer Vision Syndrome (CVS) is common among long-term computer users with about 74% of the participants experiencing at least one of the CVS symptoms with the most experienced symptoms being headache and eyestrain which together accounted for 61.8%[16]. Symptoms associated with computer use include: headache**,** blurred vision**,** eyestrain**,** redness**,** dry eyes**,** double vision**,** watery eyes**,** irritation**,** gritty sensation**,** burning**,** eye fatigue**,** and photophobia.

The accommodative mechanism is associated with symptoms of blurring of vision, double vision, presbyopia, myopia and slowness of focus change. Many people may have slight accommodative problems or binocular problems which do not usually cause symptoms when they are doing ordinary less strenuous visual tasks, but these problems are worsened in prolonged periods of computer usage[17].

It is estimated that nearly sixty million (60,000,000) people suffer from computer vision syndrome globally, and that a million new cases occur each year [18]. It has been shown that vision-related problems are the most frequently reported health-related problems occurring in over 70% of computer users[19].

Another factor that may contribute to problems of computer use is the ergonomics of the computer environment and the computer system itself. When the Visual Display Unit (VDU) is placed at a lower height and the screen tilted upward, the width of the palpebral fissure and the exposed ocular surface area will be decreased [20]. It has been shown that an association between computer vision syndrome symptoms and the risk factors exist, where increased odds ratios (eye strain) for certain eye symptoms were observed when the computer operators kept the computer monitor at about the eye level instead of below the eye level [16]. All too often, computer equipment is installed in traditional offices with little or no redesign of the workplace. In many cases, computer operators have witnessed the implementation of computers in their work environment without proper consideration of ergonomic factors (illumination, temperature, humidity) [17].

There has been no proposed mechanism that accounts for progressive worsening of dry eye in visual display terminal users [18]. A study carried out in Japan mimicked an environmental setting similar to visual display terminal setting using a novel animal model to create a dry eye working environment; lack of blinking, low humidity occupational environment and sustained static

posture during repetitive tasks. Statistically significant reduction in Schirmer test values were found among the various groups of models used as supported by human subjects (office workers) in a cross-sectional study of 1025 Japanese office workers aged 17 to 73 years [18]. There was no positive relationship between VDT working duration and changes in tear film stability and lipid layer status therefore negating the widely held fact that excess evaporation of tear fluid due to extended blinking interval while gazing is the exclusive causative factor in VDT-associated dry eye [18].The studyshowed that the duration of VDT use has an etiologic association with a decrease in tear secretion and indicates that lacrimal hypofunction (impairment of lacrimal gland function and morphology) was the critical mechanism involved in the deterioration of dry eye. This was evident from observation that disuse dysfunctions of the secretory system in the lacrimal gland occasioned by infrequent blinking led to suppressed stimulation resulting in reduced tear secretion [18].

In the light of all the factors related to computer use, the ocular surface system has been constantly exposed to unfavourable conditions occasioned by the uncontrolled and unchecked impact from information and communication technology. The incidence of dry eye syndrome which has resulted from hyperosmolarity of the tear system has triggered a cascade of reactions leading to deterioration of eye health. This has led to recent probes into ways to mitigate the impact of dry eye syndrome while on the other hand, advances are made to improve eye health. This research therefore evaluates the factors associated with sustained computer use. It is geared towards ascertaining the impact of long-term computer use on tear production level.

Methodology

Study-area

The study was carried out in Owerri Municipal Council, a local government area in Imo State, Nigeria. It is headquartered in the city of Owerri. It has an area of 58km^2 and a population of 127,213 according to the 2006 census. The two major institutions of higher learning and major cybercafes in Owerri Municipal were used.

Study design

A cross sectional experimental study was carried out using a structured questionnaire. The questionnaire captured information on the demographics as well as the prevalent symptoms associated with computer use. This study was carried out to determine the tear production volume after periods of using the computer among computer operators in Owerri Municipal. Tear production volume was measured using Schirmer strip.

Ethical clearance

Ethical approvals were obtained from the Thesis Committee of the Department of Optometry, Imo State University, Owerri, Nigeria. All procedures carried out were in keeping to the principles of Helsinki Declaration regarding research on human subjects while informed verbal consent was obtained from the subjects who participated in the study.

Study population, sample size and sampling technique

Participants were drawn using the purposive sampling technique in this study. The participants were commercial computer operators in Owerri Municipal Council, Imo State, Nigeria drawn from Imo State University and Alvan Ikoku College of Education. Out of more than 10 cybercafes existing in the city, 5 were selected and a total of 50 subjects were utilized. The cybercafes were selected because they have access to uninterrupted power supply and would require the operators to stay on the computer for a prolonged period.

Inclusion criteria

Subjects were selected on the basis of those who met the criteria of symptoms associated with eye strain due to use of the computer. This is because the symptoms of Computer Vision Syndrome can be determined subjectively.

Procedures for data collection

The tear production levels of 50 commercial computer operators, aged 18-50 years in Owerri Municipal Council, Imo State, Nigeria were evaluated using the Schirmer1 test before the use of computer, one hour after use and two hours after use. The rate of tears produced was determined at the various testing times with the aim of finding out if prolonged concentration on the computer will result in a significant change in the tear rate. The Standardized Patient Evaluation of Eye Dryness (SPEED) questionnaires were administered on the study participants and data were collected based on the degree and frequency of symptoms. The test was performed using standardized sterile 5x 35mm strips. to relieve apprehension, the patient is informed about the importance of the test and that the test was simple and painless. There are no known risks associated with Schirmer's test. Next, the subject was asked to look upward and the rounded, bent end of the strip was placed gently in the lower eyelid cul-de-sac by pulling the subject's lower lid gently downwards and temporally. The subject was instructed to close the eyes gently and keep them shut for five minutes. The stopwatch was then started and after five minutes, the strip was removed and the length of wetting of the paper strip measured. To avoid abnormal test findings, the subject is instructed to avoid rubbing or closing the eyes tightly during the test. First, the baseline tear production was assessed using the Schirmer strip, this is done before the subject starts out on the use of the computer system. After utilizing the computer system for 1 hour, Schirmer score was recorded, with the subject returning back to work, a slight reduction in tear level was noticed. Another evaluation of the tear production volume was done after 2 hours with a significant drop from the baseline.

Statistical analysis

Data was analyzed using the two-way Analysis of Variance (ANOVA) at 95% level of significance. P-value was considered significant at 0.05.

Results

The results of the study revealed a reduction in tear production with increased duration of computer use (Table 1). The baseline mean tear value for male respondents was 31.36mm which dropped to 30.20mm. On the other hand, the baseline mean tear value of their female counterparts was 38.92mm which reduced to 33.40mm after 2 hours.

Table 1: **Gender distribution of mean tear production with different work duration of commercial computer operators. in Owerri Municipal.**

A presentation of the various mean tear production volumes across gender revealed that the females had a higher tear production rate at the various working intervals. (The mean tear volume at baseline for the female respondents was 38.92mm as against 31.36mm for the male respondents and after 2 hours it was 33.40mm as against 30.20mm) with p-value at 0.05.

Gender	Freq.	Baseline value of mean tear prod.(mm)	Mean tear prod. after 1 hour(mm)	Mean tear prod. after 2 hours(mm)
Male	**25**	**31.36**	**32.96**	**30.20**
Female	**25**	**38.92**	**40.00**	**33.40**

Table 2: **Age distribution of mean tear production of commercial computer users with different work duration. in Owerri Municipal ranging from (18-50 years).**

The results also showed that peak values were recorded one hour after computer use in ages (18-35), which dropped significantly below the baseline value two hours after. The total mean baseline value was 33.25mm with a standard deviation of ±7.80mm after 2 hours, the total mean value recorded was 28.37±7.80mm with p-value at 0.05.

ıge (Years)	Freq.	mean baseline(mm)	1 hour post prod.	2 hours post prod.
16-20	**12**	**37.00**	**38.58**	**31.08**
21-25	**14**	**38.07**	**40.57**	**33.57**
26-30	**9**	**23.67**	**31.11**	**29.33**
31-35	**9**	**40.33**	**34.89**	**30.78**
36-40	**2**	**53.00**	**53.00**	**38.50**
41-45	**3**	**28.67**	**24.67**	**18.33**
46-50	**1**	**12.00**	**19.00**	**17.00**

Table 3: **Prevalence of symptoms associated with commercial computer users in Owerri Municipal.**

The results below show the prevalent symptoms among computer users with their frequency of occurrence in the subjects used in the study. Some of the subjects reported more than one of these symptoms, with tearing being the most frequent symptom, followed by distant blurry vision after prolonged near work. The least symptoms noted were head tilt, peppery sensation, dizziness, diplopia and dryness of the eye. The chief complaints were body pain, blurry vision and tearing having a record of 17%, 19.6% and21.3% respectively.

Symptom	Frequency	%
Eye ache	**4**	**8.5**
Irritation	**7**	**14.9**
Grittiness	**2**	**4.3**
Blurry vision	**9**	**19.6**
Tearing	**10**	**21.3**
Body pain	**8**	**17.0**
Head tilt	**1**	**2.1**
Peppery sensation	**1**	**2.1**
Dizziness	**1**	**2.1**
Diplopia	**1**	**2.1**
Glare	**2**	**4.3**
Dryness	**1**	**2.1**
Total	**47**	**100**

Discussion

The results pooled from the research were a deliberate attempt to compare the impact of computer use on tear production across gender and age lines. Men and women alike are actively engaged in information scouting as well as making use of the same as a business venture. From the study, the impact of computer usage on tear production took a toll on both genders with a significant effect on the male folks at all testing times. Studies have revealed a prevalence of decreased tear production over time and significantly observed among females as a result of hormonal changes during menopausal periods [20-21]. This is accounted for the significant drop in tear production among women between the ages of 41-50 years. A particular study by Schaumberg *et al* [22] on the prevalence of dry eye in gender distribution indicated that the prevalence of symptomatic dry eye in the US is about 7% in women and 4% in men over the age of 50 years. However, in the present study, the majority of female participants for this study were under the age of 50, in which this level of decline in tear production may not be evident because they have not attained their menopause, thereby accounting for the higher values of mean tear volume at all testing times in females than in males.

Variation in age showed a decline in tear production as age groups 41-45 and 46-50 had the lowest recorded mean tear volume at all testing times; baseline tear volume, one hour after computer and two hours after computer use. This is consistent with previous findings that the rate at which the eye produces tear as one advances in age drops, this is because the lacrimal gland suffers significantly from aging due to histopathologic changes such as acinar atrophy [24]. Another study ascribed that aging affects tear production due to the progressive involution of lacrimal glands and nerve activities that regulate them[25].

The results obtained demonstrate that prolonged computer use has a significant effect (P=0.05) on tear production. From the statistical analysis, a significant decrease was noticed two (2) hours after the use of the computer below the baseline production with time. It has been proven from past research studies that computer use over an extended period of time has been implicated in decrease of tear production [9, 10, 18] The reduction in tear volume below the baseline value in this study lends credence to an earlier study and is in agreement with the findings that there were statistically significant reductions in Schirmer test values among the human subjects (office workers) of ages 17-73 years used in the cross-sectional study by Nakamura *et al*[7].It also showed that lacrimal hypofunction was the critical mechanism involved in the progressive worsening of the computer-users' dry eye. The findings from previous studies show that the incidence of dry eye has been on the increase with computer use and it is associated with an increase in the number of working periods [9,11]. However, the slight difference in the present study was that there was no decline in the tear production after 1 hour of computer use but the decline was noted 2 hours after the use of computer. This is in line with the observation that the prevalence of visual symptoms increased significantly in individuals who spent more than 4 hours daily working on a computer [19]. Longer periods of computer use (more than 4 hours) were associated with an increased risk of dry eye syndrome and this was found to be more prevalent among females, contact lens wearers and prolonged visual display users [1].

A wide range of symptoms were noted to be associated with prolonged use of the computer in this study, notable among them are irritation, eye ache, blurry vision and tearing. The most prevalent were tearing and blurry vision. This outcome is validated by a study by Akinbinu *et al*[11] that reported 10.8% of the population experienced watery eye. The continuous and consistent decrease in basal tear secretion and the resulting eye irritation often lead to an excessive production of reflex tears. One of the possible explanations for watery eyes during computer use could be dry eye in which reflex tears are produced; ocular surface dryness stimulates the reflex arc of the 5[th] and 7[th] cranial nerves producing excess tears[23].

It is worth noting that this study sought to accentuate the prevailing eye care needs in these times as records of dry eye syndrome are currently a prevailing health issue. However, this study was conducted on a limited number of individuals due to limited resources hence the need to expand the study on a larger scale for better assessment of the impact of long-term use of computer on eye health. The sample size is too small to generalize findings outside the target population used for this research and also because a purposive sampling technique is likely to result in substantial bias.

Conclusion

As the number of hours one is employed in computer use increases, the incidence of dry eye will continue to be on the rise across gender and age lines, creating a public health concern in this era of ICT boom. In the coming decades, most cases reporting to eye care professionals will have an underpinning of computer related dry eye syndrome. There is a need to educate the public more about deliberate eye health practices like frequent blinking, intermittent breaks (20-20-20 rule), use of UV blockers and eye exercises as well as therapeutic interventions during work with the computer.

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

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