ORIGINAL ARTICLE

INCREASING BLINK RATES: REDUCING DRIED EYE SYMPTOMS WITH EYE REST-BREAK APPLICATION

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ABSTRACT

Long working hours with video display unit without appropriate breaks could drain the eyes. This study intends to investigate the efficiency of eye rest-break application to reduce dried eye symptoms by increasing blink rates. Blink rates and dried eye symptoms score among laboratory workers before and after the implementation of eye rest-break application were compared. The numbers of blink rates were recorded using a webcam for 5 minutes without the subjects aware when the recording starts or ends. Then, the Ocular Surface Disease Index (OSDI) was used to measure the dried eye symptoms. For eyes rest-break, EyeLeo© application was used. It is computer application that gives reminders to video display unit (VDU) users to take short breaks for their eyes. Six laboratory workers who are constantly working with VDU were selected as subjects. Data was analysed using Wilcoxon Signed-Rank Test, to test the comparison between variables before and after intervention by reporting its median (inter quartile range, IQR). The findings showed that the median after intervention (39.5, 10) is significantly higher (p-value = 0.028) than the median before intervention (7.3, 3). As for dried eye symptoms, median for Ocular Surface Disease Index after intervention (27.9, 8.9) is significantly lower (p-value = 0.027) than the median before intervention (36.5, 9.4). As a conclusion, application such as EyeLeo© eye rest-break is a potential intervention and may be used to increase blink rates and reducing dried eye symptoms among visual display unit workers.

Keywords: *Blink rates, rest break, dried eye symptoms, HCI*

INTRODUCTION

Visual display unit (VDU) had caused an upsurge of computer related health problem[1]. However, working with VDU for long hours may cause health problems with symptoms range from headaches, fatigue to many vision related illnesses including dried eyes[2-3]. Logaraj[4] stated that reduced blink rates when using VDU causes poor tear production and induce stresses on the cornea, resulting in dry eyes. The most common symptoms associated with VDUs work are headaches, blurred vision or difficulty in focusing, eyestrain and dried eyes which affect the worker wellbeing and performance.

Other than long hours, positioning of the VDUs, the screen or sources of documents' legibility and bad lighting could also cause visual problems[5]. Studies showed that blink rate is associated with VDU usage. Users distance from the screen when reading or playing games on the computer were proven to result in poor blinking and caused 3 to 5 folds of reduction in blink rate[6]. The dry eye symptom is a multifactorial disease of the tears and ocular surface which induce discomfort or in more severe occasion, visual disturbance, and tears film instability and could damage the ocular surface. Once this happened, osmolarity of the tear film would increase and inflammation of the ocular surface would get inflamed[7-8].

According to research, blink rate for adults is affected among others by few conditions such as the person's mental state, his attention to the object or work, activity he is involved in, exposure of the ocular surface, and also the environment[9]. Blink rates could vary from less than 1 per min to as high as 176 per min. Tsubota & Nakamori[10] also reported a blink rate of 14.3 per min in adults with healthy eyes, or a blink cycle of 4.2 s (where the blink interval is 4.0 s and a blink time of 0.2 s).

Water evaporation rate from the tears and tear stability could be influenced by eye movements that are constrained during certain visual tasks or special environments[9]. Visual function is influenced by evaporation, which affects the blink rate and blink interval. Many studies have reported the reduction of blank rate during every day visual tasks, such as working at a video display terminal, reading in downgaze, operating monitor-based and handheld video games, and performing surgery[11-12].

Dry eye symptoms are found to be associated with blink rates. Dry eye is one of the most common ocular problems[13]. O'brien & Collum[8] suggested that twenty five percent patients of ophthalmic

clinics report symptoms of dry eye. It can increase the risk of ocular surface infection and can cause viral disturbance[14 - 15]. Dry eyes usually occur when a person already experienced digital eye fatigue [16-17]. Environment conditions such as those with low humidity, air conditioning, or forced-air heating could cause corneal desiccation [18-19]. The most common dry eye symptoms are soreness, itching, and irritation, and the use of digital devices might worsen the frequency or severity of these symptoms. Gazing too long on a visual display unit resulted in reduction of blink rate, therefore increase symptoms of dry eyes among VDU users. This is proved by a study that showed when reading from the digital device, the mean blink rates for the low and high cognitive conditions were 8.34 (SD = 5.12) and 7.43 (SD = 4.92) blinks/min, respectively, i.e., a reduction of 0.91 blinks or 11% [20].

Another study also showed that workers using a VDU for more than 8 hours per day are found to be significantly associated with dry eye disease ($p<0.001$), with odd ratio and confidence interval (OR 2.08, CI 95% 1.33 – 3.27) to compare to those who worked less than 8 hours (OR 1)[21]. Blurry vision is mostly prevalent among dry eye patients although the blurred vision clears temporarily upon blinking[15]. It is obvious that these symptoms could affect comfort, wellbeing and performance of a person[15,22]. Other than the most recommended 20-20-20 rules, it is important that VDU users to increase their eyes blink rates have been suggested in several studies, using both visual and auditory stimuli[23].

One of the suggestions is that software application could be used to remind the VDU user to blink more frequently and hopefully minimize symptoms of dry eye. There are several animation software programs that uses visual and acoustic stimuli or that may lock or darken the VDU screen for brief moments at certain intervals[24]. Computer users are often engaged in various visual tasks. The objective is to provide regular breaks which may help restore and relax the accommodative system, thereby preventing eye strain[25-26]. Eye strain could lead to higher stress and frustration[27].

This study is done with the aim to measure blink rates among laboratory workers before and after implementation of eye rest-break application. This study also meant to measure dry eye symptoms score among laboratory workers before and after implementation of eye rest-break application. Finally, the objective of this study is to compare between blink rates and dry eye symptoms score among laboratory workers before and after implementation of eye rest-break application.

METHODOLOGY

MEASUREMENT OF BLINK RATE

This study was conducted by measuring blink rates as suggested by Cheah et al. [3] recorded blink rate during a reading task through webcam without the initial knowledge of subjects. In our study, instead of during reading, blink rate during VDU laboratory task was recorded also without the knowledge when the recordings start or end. Although the subjects are aware about the webcam installed at the VDU, they were not informed when the recordings were made. From the recordings, the number of blinks in any 5 min was counted and recorded as blinks/min. As a guideline, only complete eye blink or partial blink of more than three-fourth of the exposed cornea area was considered as one blink.

OCULAR SURFACE DISEASE INDEX© (OSDI©)

Subjects were given two sections A and B survey questionnaire. In Section A, a number of demographic information was asked such as age, race and years of service. In Section B, questions regarding ocular surface symptoms such as vision-related function and environmental-trigger symptoms were asked. Ocular Surface Symptoms such as sensitivity to light, gritty sensation, pain or sore eyes, blurred and poor vision were included. The frequency of symptoms during the task was noted as: None of the time (0), Some of the time (1), Half of the time (2), Most of the time (3), All of the time (4). The maximum score of this questionnaire is 20 marks.

OSDI© is assessed on a scale of 0 to 100, with higher scores representing greater disability. The index demonstrates sensitivity and specificity in distinguishing between normal subjects and patients with dry eye disease. The OSDI© is a valid and reliable instrument for measuring dry eye disease (normal, mild to moderate, and severe) and effect on vision-related function.

ERGONOMIC INTERVENTION: EYE REST-BREAK APPLICATION

As to reduce dry eye symptoms among VDU users, eye-rest break application was suggested as an intervention. For our study, an application namely EyeLeo© was used. EyeLeo is a handy PC application that regularly reminds to take short breaks for eyes. It is designed to be used by workers who spend more than an hour per day looking at a display. It is free software and can easily be downloaded by any laptops and computers with Windows operating system.

SUBJECT

This study was conducted in Central Laboratory, Universiti Malaysia Pahang, Gambang, Pahang. Six respondents who are using visual display unit (n = 6, 100%) were asked for their consent to become respondents. Before obtaining consent from workers, permission was firstly asked from Central

Laboratory, Universiti Malaysia Pahang for their authorization to conduct our research.

DATA COLLECTION

Independent variable of this study is blink rate while the dependent variable is dry eye symptoms. After getting permission from the laboratory, consent form and respondent information sheet were distributed to begin data collection. Video recordings were done to obtain the blink rates. Recordings were done using GoPro camera without the initial knowledge of subjects from a common workstation in the laboratory such as in Figure 1. The number of blinks in any 5 min was counted from the video playback and recorded in unit of blinks/ min.
Data for dry eye symptoms were collected using a questionnaire distributed to the respondents shortly after taking their blink rates recording. EyeLeo© was then introduced as an intervention and a brief talk on ocular awareness were given to respondents to enhance knowledge, consciousness and understanding on ocular health.

DATA ANALYSIS

The data collected were analysed using Statistical Package for the Social Sciences (SPSS) version 16.0 for Windows. Since the data were not normally distributed, non-parametric test, i.e. Wilcoxon Signed-Rank Test was used for analysis. We divided our analysis into two parts, which are demographic data and statistical analysis. For demographic data, four variables were studied. They were age, years of service, blink rate and Ocular Surface Disease Index (OSDI) score. Mean and standard deviation (SD) for each variable were reported. Race was not studied since all respondents were Malay.

Statistical analysis was used to test the objective and hypothesis. For our study, Wilcoxon Signed-Rank Test used to test the comparison between variables before and after intervention. It is done by reporting its Median (IQR). The reason why Wilcoxon Signed-Rank Test was used is because repeated measurement was done on same individuals to find results before and after intervention. Besides that, small sample size, which is only six respondents, determines the chosen test. Finally, because of the small sample size, the variables were not normally distributed.

RESULTS

The analysis showed that respondent age range is between 29 - 34 with mean (SD), 31.7 (1.75). Maximum age of respondent is 34 years old and a minimum year of age is 29. Most of respondents have been working in Central Laboratory, UMP between 2 - 8 years with mean (SD), 5.7(2.07). From the research done, blink rate before intervention takes place is measured between 6 – 13 blinks/min with mean SD 8.1 (2.72). Meanwhile, blink rate after intervention takes place is between 31 – 46 blinks/min with mean SD 38.8 (5.81). For dry eye symptoms, Ocular Surface Disease Index (OSDI) score before intervention is recorded among 29.2 – 41.7 with mean SD 35.1 (5.01). While Ocular Surface Disease Index (OSDI) score after intervention is recorded among 20.8 – 37.5 with mean SD 28.1 (5.87). The results above are showed in Table 1.

For statistical analysis, the median for blink rate before is significantly different from median for blink rate after intervention using EyeLeo© application. The median after intervention (39.5, 10) is significantly higher (p-value = 0.028) than the median before intervention (7.3, 3). The median for Ocular Surface Disease Index (OSDI) before is significantly different from median for OSDI after intervention using EyeLeo© application. The median for Ocular Surface Disease Index after intervention (27.9, 8.9) is significantly lower (p-value = 0.027) than the median before intervention (36.5, 9.4). When asked if respondents having any problems with their eyes limited them in performing VDU tasks, all six respondents answered from most of the time before intervention to half of the time or some of the time after an intervention was introduced. Result of comparison between blink rates and dry eye symptoms before commencing intervention and after intervention was commenced using eye rest break EyeLeo© application was tabulated in Table 2.

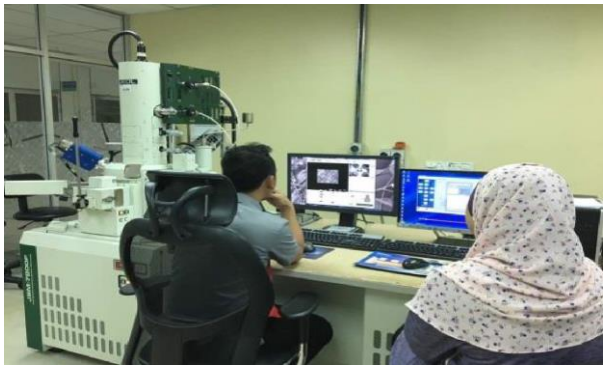

Figure 1: Scanning Electron Microscopy Video Display Unit, the experiment set-up at site

Table 1: Descriptive Data of Respondents

Variable	Range (min-max)	Mean (SD)
Age	29-34	31.7 (1.75)
Years of service	2-8	5.7(2.07)
Blink rate (blinks/min) before intervention	6-13	8.1 (2.72)
Blink rate (blinks/min) after intervention	31-46	38.8 (5.81)
Ocular Surface Disease Index (OSDI) score before intervention	29.2-41.7	35.1 (5.01)
Ocular Surface Disease Index (OSDI) score after intervention	20.8-37.5	28.1 (5.87)

Table 2: Analyses of blink rates and dry eye symptoms before and after application of intervention

Variable	Before Intervention Median (IQR)	After Intervention Median (IQR)	Z-stat	p-value
Blink rate (blinks/min)	7.3 (3)	39.5 (10)	-2.201	0.028
Dry eye symptoms (OSDI score)	36.5 (9.4)	27.9 (8.9)	-2.207	0.027

When asked if respondents having any problems with "their eyes limited them in performing VDU tasks", all six respondents answered from *most of the time*, before intervention, to *half of the time* or *some of the time* after an intervention was introduced. Dry eye symptoms are found to be high before an application of intervention, which is probably because workers who are using VDU are not aware of the risks. This is consistent with the result of a study which proved that the most common visual problems reported were headache, burning sensation in eyes and dry/tired/sore eyes with 53.3% (251/471), 54.8% (258/471) and 48% (226/471)[28]. The intervention has resulted in lower dry eye symptoms. This is likely because workers are now being disclosed to ocular health knowledge and awareness. This finding is comparable to studies which stated that taking regular rest breaks and doing eye exercise had a significant association with a lower rate of eye strain ($p<0.01$) and supplementary breaks reliably minimized discomfort and eye strain without impairing productivity[29 - 30].

DISCUSSION

Blink rate is found to be low before the application of intervention. This is consistent with the result of Logaraj[4] which found that a VDU user who used it for an extended period the blinking is reduced by about 60%. This is probably because workers are not exposed to the knowledge of ocular health and not aware of the risk they are facing. Most of the workers will stare at a long time to a VDU without releasing it and this will contribute to the dryness of the eyes.

After the EyeLeo© eye rest-break application intervention, blink rate is found to be significantly high. This is because workers are now being disclosed to ocular health knowledge and awareness particularly on benefit of blinking. This is similar to a study by Portello, Rosenfield & Chu[27] which stated that the mean blink rates for the uncontrolled and metronome (controlled blink) sessions were 11.29 blinks per minute and 23.45 blinks per minute, respectively ($p < 0.0001$).

EyeLeo© application intervention such as shown in Figure 2 is found to be a successful intervention in increasing blink rates to reduce dry eye symptoms among VDU workers. A similar research indicates that a short rest break enhanced detection accuracy compared to those participants who had no rest[31]. In addition, research done on rest break as intervention to muscle discomfort found that rest-break interventions such as stretching had a positive effect on the recovery of muscle discomfort in VDU operators with complaints in the neck and shoulders[32]. Another study proved that blink rate increased with the program by 6.75 (T3.80) blinks/min ($p < 0.001$)[23]. It was also shown that difference in OSDI score change between the test and placebo version of the animation program was statistically significant ($p < 0.001$; effect size, 1.385)[23].

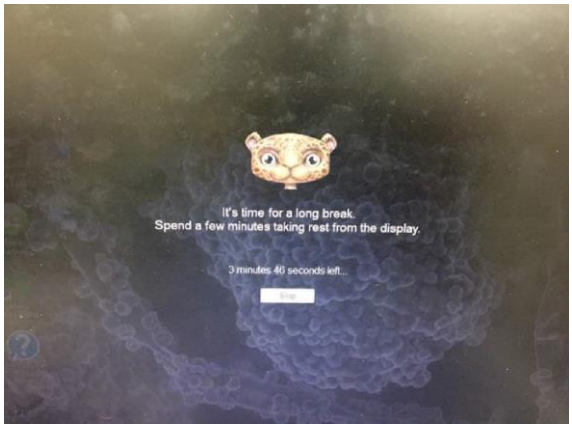

Figure 2: EyeLeo© application intervention

CONCLUSION

As a conclusion, EyeLeo© eye rest-break application is successful to increase blink rates and to reduce dry eye symptoms among laboratory workers who are using VDU. However, more studies should be carried out on subjects with dry eyes with larger respondents and longer duration.

The blink rates among laboratory workers before and after implementation of eye rest-break application are shown in mean (SD); 8.1 (2.72) and 38.8 (5.81). The dry eye symptoms score among laboratory workers before and after implementation of eye rest-break application are 36.5 (9.4) and 27.9 (8.1). The difference between blink rates and dry eye symptoms score among laboratory workers before and after implementation of eye rest-break application were found to be statistically significant.

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COMPETING INTERESTS
There is no conflict of interest.

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