Mini Break Intervention in Preventing Asthenopia among Drawing Workers using Standard and Widescreen Size VDT at Construction Company in Jakarta

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Abstract
Background,Minibreak intervention may solve asthenopia which has a main problem among workers using VDT. Asthenopia is measured with near point convergence (NPC). The purpose of this study was to determine convergence power difference that mini break produces between workers using standard VDT and widescreen VDT. **Methods,** Sixty six workers were divided into four groups: minibreak and no minibreak intervention in standard VDT users and widescreen VDT users. The difference of NPC before and after 4 hours of VDT exposure and 4 hours of exposure with a 15 minute minibreakwere measured in all groups using RAF ruler. **Results,** Minibreak intervention resulted in a significant difference of convergence power between workers using standard VDT (p=0.000) and widescreen VDT (p=0.000). But the differences of convergence between standard VDT and widescreen VDT were not significant in those given minibreak (p=0.9694) and those not given (p=0.6251). **Conclusion,** Mini break intervention produced significant differences in convergence power between both groups but the size of the VDT had no effect.

Keywords: Asthenopia, VDT, near point convergence, mini break

Intervensi Mini Break dalam Pencegahan Asthenopia pada Juru Gambar yang Menggunakan Standart and Widescreen VDT pada Perusahaan Konstruksi di Jakarta

Abstrak
Latar Belakang, *Mini break dapat menjadi solusi untuk kelelahan mata yang menjadi masalah utama pada pekerja dengan pekerjaan menggambar menggunakan VDT. Kelelahan mata dapat diukur dengan mengukurnear point convergence (NPC). Tujuan penelitian ini untuk mengetahui perbedaan NPC yang dihasilkan oleh mini break pada pekerja yang menggunakan VDT standar dan wide screen.* ***Metode,*** *Enam puluh enam pekerja dibagi menjadi empat kelompok: mini break dan tanpa mini break pada pekerja VDT standar dan wide screen. Perbedaan NPC sebelum dan sesudah pajanan VDT selama 4 jam terus-menerus tanpa mini break dan pajanan selama 4 jam dengan mini break 15 menit di tengah-tengah diukur pada semua grup menggunakan RAF ruler.* ***Hasil,*** *Intervensi mini break menghasilkan perbedaan bermakna pada kekuatan konvergensi antara pekerja yang menggunakan VDT standar (p=0.000) dan VDT widescreen (p=0.000). Namun perbedaan konvergensi antara VDT standar dan widescreen tidak berbeda bermakna pada grup yang diberikan mini break (p=0.9694) dan tanpa mini break (p=0.6251).* ***Kesimpulan,*** *Intervensi mini break menghasilkan kekuatan konvergensi yang berbeda antara dua kelompok pekerja, namun hal tersebut tidak dipengaruhi oleh ukuran VDT.*

Kata kunci: *Mata lelah, VDT, pekerja gambar, near point convergence, mini break*

Introduction

Asthenopia or visual fatigue is a common problem among computer or Video Display Terminal (VDT) workers.[1] According to American Optometric Association (AOA), asthenopia is a group of subjective visual disorders associated with near work which has a variety of symptoms such as dry eyes, burning sensation, eye iritation, blurred vision, and visual fatigue which appear after working with a computer monitor for three hours or more in one day.[2]

Visual fatigue can be classified into internal symptoms and external symptoms according to the type of sensation, location and condition that induces it. Internal symptoms are fatigue and muscle ache in the eye ball which are induced by refractive error, increased convergence, and accomodation.[3,4] Extenal symptoms can be associated with iritation of the cornea caused by dry eye. The outer surface of the eye is covered by a precorneal tear film (PTF) which protects the outer surface from external factors. PTF consists of fatty layer (outer), water layer, and mucin layer (inner) which is applied to the outer surface every time the eye blinks. Alteration is the thinning of the PTF which can lead to rupture of the PTF caused by low humidity and high temperature, low blinking rate, tear gland dysfunction, and use of contact lens. This condition can cause progressive thinning of the PTF and lead to dry eye.[3,5]

Visual symptoms can be measured objectively by measuring near point convergence (NPC) which is an indicator of convergence power that measures eye muscle power and lens elasticity.[6]Near point convergence is measured by putting an object close to the nose and observes if the subject experiences double vision or if one of the eye deviates aside. Break and recovery points are subjectively measured in centimeters.[7]Measurement of NPC uses a penlight with the subject wearing red or green eye glasses or an accommodative target ruler (Royal Air Force point ruler). The RAF ruler is used by sliding a small object slowly approaching the eye until the object is not seen.[8]The NPC is used as a parameter of convergence in the study of eye fatigue.[9]Various studies show a significant difference of convergence power in VDT workers compared to non-VDT workers.[10]

Video display terminal (VDT) is an output device in a computer which functions to display the results of data processing from the Central Processing Unit (CPU) into a media that can be read by man.[11,12] The standard ratio for a computer monitor is 4:3. Wide screen monitors (ratio of 16:9 or 16:10) are widely used in laptops and desktops and for computer aided design (CAD) for drawing large pictures.Liquid Crystal Display (LCD) which has a non-emissive flat screen panel display with a longer lifetime and a more efficient electric consumption are more used rather than Cathode Ray Tube (CRT).[13]

A computer monitor consists of a serial of dots called pixel which is a result of electron rays that hit the phosphor layer behind the monitor. Every pixel is sharpest in the center and gets blurred in the edges, so the eye has to keep accommodating in order to view the picture clearly.[14] As a result, the diaphragm of the lens shifts forward causing spasm of the ciliary muscles.[6]The blinking rate is reduced and induces external symptoms of asthenopia.

Drafters draw construction pictures with a computer using the Computer Aided Design (CAD) that develops into Computer Aided Designing and Drafting (CADD) or Building Information Modeling (BIM) software. Drafters can spend as much as 40 hours a week in front of a computer drawing intricate details swiftly and cause eye fatigue, dry eye and other health problems. Studies show that CAD users complain of eye problems more frequently than any other type of VDT.[15]

The National Institute of Occupational Safety and Health (NIOSH) advises that computer users should check their eyes before working with the computer and at least once every year.[16] Factors that affect visual comfort while working with a computer are the height and inclination of the computer monitor[17], the space between the eye and the monitor[18], the amount of light, air humidity, etc. It is advised to use a computer and a chair in an ergonomic position. The space between the eye and monitor is recommended to be 20-28 inches and the height of the characters on screen should be 3.3 mm.[19]The right amount of light from the monitorshould not cause photosensitivity and is recommended to be half than the normal room light.[20] Low air humidity may cause evaporation of tears and can cause dry eyes that may lead to eye fatigue.[2]

Besides environmental and ergonomic factors, break intervention is a beneficial and economic approach to minimize problems associated with VDT. There is no consensus about how long an individual has to work to experience eye fatigue. The classic rule is the 20/20/20 rule which is after working for 20 minutes in front of the computer, one should look far away more than 20 feet for as long as 20 minutes.[21]

Method

This study is an experimental cross over design that uses a mini break and no mini break intervention to VDT 4:3 and VDT 16:9 workers in a construction company. Before the study all subjects were informed to sleep at least 6 hours the night before and the room temperature, humidity, viewing angle and viewing distance to the VDT was measured by the observer. The NPC was measured in all subjects using the RAF ruler in centimeters at their work station before and after intervention. In the no intervention group all subjects were given 4 hours of VDT exposure, whereas in the intervention group, all subjects were given a 15 minute mini break after 2 hours of VDT exposure and then continue their work with the VDT for another 2 hours. In the 15 minute mini break, subjects did other work that did not need eye convergence or did an eye exercise by blinking their eyes, gazing to a distance of more than 5 meters to relax their eye muscles. The next day, the mini break intervention group is switched to the no mini break and vice versa in the wash out phase.

Characteristics of the study samples can be seen by descriptive analysis of the sex, visual abnormality, the average age, the average working period, and ergonomic characteristics. Statistical analysis to look at the convergence power with mini break compared to no mini break and to compare convergence power between VDT 4:3 and VDT 16:9 users use the unpaired T test if the data had normal distribution and use Mann Whitney test if the data had abnormal distribution.

Results

Descriptive analysis of the characteristics of each subject is shown in Table 1.

Table 1. Demographic and Ergonomic Characteristics of Subjects (n=66)

	VDT ratio 4:3 (N)	VDT ratio 16:9 (N)
Sex		
Male	33	31
Female	0	2
Visus abnormality		
Normal	30	11
Myopia	3	12
Age (mean ± SD years)	32.67±6.31	28.73±5.78
Working period (mean ± SD years)	5.41±3.94	1.15±1
Viewing distance (mean ± SD cm)	61.7±6.38	63.45±7.67
Viewing angle (°)	10.52±3.68	12.64±3.69
Light (mean ± SD Lux)	261±47.91	271.64±34.21

There was no significant difference in room temperature and humidity in both groups (mini break and no mini break) as is shown in Table 2.

Table 2. Characteristics of Environment in Both Groups

	Without mini break	With mini break	P*
Temperature (°C)	26.61±0.91	25.33±0.82	0.063
Humidity (%)	52.29±2.84	52.42±3.48	0.806

* Independent t test

The convergence power distribution of subjects exposed to VDT is shown in Table 3.

Table 3. Convergence Power in Both Groups

	Mean ± SD	Median	Minimum	Maximum
ΔNPC no mini break in VDT 4:3	2.89 ± 1.11	2.8	1	5
ΔNPC with mini break in VDT 4:3	1.42 ± 1.01	1	-0.8	4
ΔNPC no mini break in VDT 16:9	3.02 ± 1.04	3	1	4.8
ΔNPC with mini break in VDT 16:9	1.41 ± 1.1	1.3	-1	3.7

In this study mini break intervention made a significant difference of Δ NPC in the VDT 4:3 and VDT 16:9 users as is shown in Table 4 and 5.

Table 4.NPC Difference in VDT 4:3 (N=33)

	Mean ± SD (cm)	P
NPC before VDT exposure	10.06 ± 2.817	0.582
ΔNPC without mini break	2.89 ± 1.11	<0.001
Δ NPC with mini break	1.42 ± 1.02	paired t test

Table 5. NPC Difference in VDT 16:9 (N=33)

	Mean ± SD (cm)	P
NPC before VDT exposure	11.36 ± 2.407	0.243
ΔNPC without mini break	3.02 ± 1.04	<0.001
Δ NPC with mini break	1.41 ± 1.1	paired t test

The difference of ΔNPC without mini break intervention in VDT 4:3 and VDT 16:9 users are shown in Table 6.

Tabel 6. Difference of ΔNPC without Mini Break in VDT 4:3 and VDT 16:9 users

ΔNPC	N	Mean ± SD (cm)	P
VDT 4:3 users	33	2.89 ± 1.11	0.625
VDT 16:9 users	33	3.02 ± 1.04	Independent T test

From the table it is shown that there is no significant difference between ΔNPC when no mini break was given to VDT 4:3 and VDT 16:9 users. The same happened when subjects were given a mini break intervention (Table 7).

Table 7. Difference of ΔNPC with mini break in VDT 4:3 and VDT 16:9 users

ΔNPC	N	Mean ± SD (cm)	P
VDT 4:3 users	33	1.42 ± 1.01	0.972
VDT 16:9 users	33	1.41 ± 1.10	Independent T test

Discussion

In some subjects, insufficient lighting when measuring NPC with the RAF ruler may cause bias and add the elongated ΔNPC. The viewing distance and viewing angle consistent since each subject has their own comfort distance and angle and result in different convergence power. Blinding was difficult to do because the subjects were measured in turns. Ergonomic factors such as the height of the desk and chair were not measured because each subject had their own comfort working position.

Workers using VDT 4:3 worked longer (5.41±3.94 years) as a drafter compared to VDT 16:9 users. The working period may portray the pathology process of asthenopia VDT 4:3 workers were exposed earlier than VDT 16:9 workers because wide screen computers were available to use in the company for the last 2 years.

The minimal ΔNPC of -0.8 in VDT 4:3 workers and -1 in VDT 16:9 workers that were given a mini break (**Table 3**) shows improved ΔNPC. The ΔNPC was significantly improved by giving a mini break after 2 hours of work in VDT 4:3 and VDT 16:9 users. Regarding to this, the hypothesis that convergence power were significantly different in the group that was not given a mini break compared to those that were given a mini break in VDT 4:3 and VDT 16:9 workers has been proven. A study done by Balci and Aghazadeh showed that asthenopia and blurred vision were more frequently found in those that worked for 60 minutes with a 10 minute break and least found in those that worked for 30 minutes with a 5 minute break followed by 15 minutes work with a 3 minute break.

The VDT exposure period in this study refer to recommendations by the Swedish National Board of Occupational Safety and Health where the limit of working with a VDT is 1-2 hours. This study uses the mini break format that was done by Fauzia with different parameters of asthenopia. Fauzia measured the accommodation amplitude as an objective parameter of asthenopia and found a 95.38% prevalence of asthenopia in workers that work with a computer for 4 hours continuously. When a 15 minute mini break was given after 2 hours of work, the prevalence decreased to 31.25%. The researcher in this study used the convergence parameter instead of accommodation amplitude since the stress caused by convergence contributes significantly to asthenopia.

In a study by Rosenfield et al the mean difference NPC before and after 10 minute VDT exposure is 2.25±1.26 D. Visual discomfort was obtained subjectively from a scale of no eye strain, very very weak, to very very strong and maximal eye strain. It was concluded that there is no relationship between subjective eye complaints with convergence. Complaints associated with computer vision syndrome consist of various causes such as dry eye, which is pathophysiologically different from visual fatigue caused by oculomotor tone.

The results in this study show that convergence power is significantly different between workers given a mini break and those not given a mini break and therefore mini break intervention may reduce visual fatigue symptoms in VDT workers. However the mini break intervention or no mini break did not make the convergence power different among VDT 4:3 and VDT 16:9 workers. Therefore the convergence poweris not significantly different in VDT 4:3 and VDT 16:9 workers without mini break and with mini break. Recently there is no study that proves widescreen computers may reduce eye strain in computer workers.

Conclusion

Mini break intervention may reduce visual fatigue in VDT workers by increasing the convergence power. However the convergence power were not different among VDT 4:3 and VDT 16:9 workers. This study recommends that VDT workers should take a 15 minute. break after 2 hours of work.

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