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A Literature Review on Ergonomically Study of VDT Workstation Operators

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***Abstract*—This literature review paper on ergonomically study about various work posture of visual display terminal operator like standing, sitting, combination of standing and sitting, effect of illumination, height of screen on workplace. These factors affects VDT operator on musculoskeletal disorder, neck, shoulder, eye strain and also on alertness, sleepiness, performance of VDT operator. This study was done on subjects both (male and female).**

***Index Terms*— Ergonomically, Posture, Effect of illumination, Musculoskeletal, neck pain etc.**

I. INTRODUCTION

There is an increase in the use of computer technology in industry, office, bank, café hospital etc. This increases the productivity and efficiency but affects the VDT operator's body, face with many problems such as Musculoskeletal disorder, neck, shoulder pain [1,2,3,4].

Due to the improper design of the furniture, VDT operators have arm, hands, wrists pain [5].

Using high illumination system in workplaces increases productivity, efficiency of product but resulted in visual fatigue, eyestrain, headache, physiological stress [2, 6, 7, 8].

VDT operator's sitting and standing position affects the alertness and performance of work [9].Now a days the VDT operators like male, female, data entry operator face mental stress [10, 11].

II. ERGONOMICALLY FACTORS FOR VDT OPERATOR

A. *Posture*

Hundreds of year sitting position affects health of VDT operators like musculoskeletal disorder, neck [5, 12].

Different types of postures like standing, sitting, design of chair, height also affects the VDT operator [13, 14].

B. *Effect of illumination*

High illumination in VDT workplace creates eye strain, eye lids are heavy, eye feel dry, eye burning, headache, difficult in seeing [8].

Terminal background flicker, viewing angle, also affect the neck, eye strain headache of VDT operator [1, 7, 15].

C. *Material for Posture factors*

Right handed ten subjects are taken (8 male and 2 female), 3 screen heights 80,100,120 cm and table height is 67cm, computer with 14-inch cathode ray tube monitor are taken. Video camera, video image analyzer, videotape recorder, electromyography (disposable 8 mm AgCl surface electrode), EMG machine [16].

24 subjects, 12 undergraduates (6 male and 6 female) age are 20-29 (Mean ± SD; 21.2 ±1.1 yr old) and 12 aged subjects (6 male and 6 female subject, Mean ± SD;62.7±1.6 yr old) table height adjustable from 68.5 am to 105.5 cm, English transcription 150 min (40X3sessions),including 5 min for setup after each session[9].

Ten healthy students(5 female and 5 male) age from 18 to 22 years for two kind of workstation for each student, an NPC and DPC.An NPC with10.4 inch color LCD, model PC-9801NC.An DPC with 14 inch color LCD, model PC-9801BX2, 700.0mm desk height, distance of keyboard and desk is 40 mm[13].

D. *Material for effect of illumination*

Ten subjects (5 female and 5 male) age from 21 to 24 year, Optec 2000 vision Tester, Minolta CL-200 chroma meter CS-100AFlicker Fusion system Model 12021, Intel Pentium III desktop computer with 17 inch color screen, resolution was 1024X768 pixels at 70 Hz refresh rate , fluorescent lamp, subject seated 50 cm away from screen.[8]

All women of Medical Secretaries hospital of Stockholm age from 44 to 49, height 1.64 m, median weight 68 ,computer with CTX color screen (325X245),adjustable chair without armrests, skin markers, video camera JVC super-VHS[1].

III. METHOD FOR POSTURE

The subject is engaged with computer game with constant visual monitoring for 20 min at each screen height. Body position's captured by video camera and posture was analysis by video image analyzer every minute of the experiment. Five frames are taken per minute. The neck angle by Reid's line referenced to the horizontal plane. Electromyography and EMG machine are used to record muscle activities per minute. The experiment is performed with three different height of screen of each subject. [16]

The subjects are using word processor and spreadsheet application on computer with keyboard with both hands in three conditions like sitting at workstation as a control group, sitting on chair with work surface elevated to standing position (high chair), combination of 10 min sitting and 5 min

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standing. The subject do English transcription task for 150 min under one condition from 13:30 to 16:00 for each day .software for minimize the learning of English and ergonomic guideline for VDT work with OSHA and ANSI/HES.In this subject report musculoskeletal discomfort and sleepiness after each session by VAMS with 100 mm horizontal line and human body diagram on the display [9].

The subject is engaged with word processor for 30 minute using chair backrest. The work posture and performance of subject are recorded in video camera and analyzed by frame for 10 minute and EMG machine used to recorded neck, shoulder and back muscles activities for 10 minute. [13]

IV. Method For Effect Of Illumination

The subject has 0.9 corrected visual acuity and normal color vision .At the beginning of experiment subject eye adapted for 20 minutes and their visual acuity and CFF values are measured by Optec 2000 vision tester , subject is seated approximately 50 cm away from the screen and asking 8 questions to subject about eyes problem [8].

Each Subject was filmed in two sedentary work postures with different viewing angle at computer workstation. One of the work postures is -20° (11) and other posture is + 3° (11) and subject performed same task they do every day. Skin markers are used to centre of gravity of the head and neck in front of the outer auditory meatus (16-18) and with the help of video camera filmed each work posture of subject for five minute. Video film is analysed by video recorder and TV screen. For five minute sequence stopped and analysis two points one directly at the beginning and second the just before the sequence ended [1].

V. Results

A. Posture

Using statistical analysis method for data gathered and Friedman's one-way repeated measure analysis of variance on rank are used to determine the effect of screen height on posture and muscle activity and correlation study by Spearman's rank and Pearson's analysis method with statically test with ($p<0.05$).The neck angle trunk inclination affected by change in screen height. The neck is more erect in higher screen ($p<0.001$) and trunk also backward learning ($p=0.02$).Newmam-Keul's comparison studies showed that the neck was upright from the lowest to highest screen height. ($p<0.05$).The effect of screen height changes on posture was analyzed in (table 1).The neck muscle activities are significantly decreased in screen height .The decreasing the EMG activities of neck extensor muscle from posture reaction to increase in height[16].

TABLE I
SCREEN HEIGHT AND POSTURAL ANGLES

Subject	*Height and neck angle*	*Height and Throracie bending*	*Height and trunk inclination*
1	0.94^{***}	0.88^{***}	0.86^{***}
2	0.94^{***}	0.58^{***}	0.75^{***}
3	0.94^{***}	0.56^{***}	0.94^{***}
4	0.94^{***}	0.94^{***}	0.94^{***}
5	0.94^{***}	0.35^{*}	0.94^{***}
6	0.94^{***}	-0.10	0.48^{***}
7	0.94^{***}	0.47^{***}	0.94^{***}
8	0.94^{***}	0.74^{***}	0.64^{***}
9	0.94^{***}	0.56^{***}	-0.32^{***}
10	0.94^{***}	-0.07^{***}	0.76^{***}

Spearman's correlation 2-tailed *p<0.05; **p<0.01; ***p<0.001

Using statically two-way analysis of variance (ANOVA) and $p<0.05$ to indicate statically significance. High chair and sit and stand condition result in higher discomfort than standard condition. The subject sleepiness increased with time. Mean score indicate subject sleepiness ($p<0.01$) in standard condition is higher than high chair and sit-stand condition. Work performance is steady all condition [9].

Using statically analysis method with $p<0.05$ to be significant. Difference in work posture between NPC and DPC with viewing distance, viewing angle and head angle as in Table II.Wilcoxon's rank sum test analysis revealed significant difference in IEMG of the neck muscle while using NPC and DPC ($p<0.05$)[13].

TABLE II
VIEWING DISTANCE, VIEWING ANGLE, HEAD ANGLE AND NECK ANGLE

	NPC		*DPC*	
	Average	SD	Average	SD
Viewing distance(L:mm)	329.1	54.4	405.7	43.0^{**}
Viewing angle(ΘV:deg)	-35.0	5.6	0.3	7.5^{**}
Head angle(ΘH:deg)	-22.0	10.0	-5.6	15.7^{**}
Head angle(ΘN:deg)	48.2	13.7	52.0	12.3NS

NS: Not significant **:p<0.01 (n=10)

B. Effect of Illumination

Using ANOVA analyses, the change in CFF values by

color of ambient illumination (red, blue, green and white).The ANOVA showed the effect of of light color on visual acuity change. The effect of level of illumination was found the reaction time, and the 20 lux level of illumination has shorter reaction times than 340 lux.both the color of light and level of illumination had no significant effect on the rate of errors. The subject has minimum visual fatigue with blue light and greatest with red color.

The load on neck and shoulder was lower for the 3º viewing angle than for the -20º viewing angle. [1]

VI. Conclusion

After Literature review on ergonomically study of VDT workstation operators different screen height of computer sitting ,standing posture, effect of illumination affects the VDT operators in Musculoskeletal disorder, neck, shoulder hand, eyestrain, trunk pain. And also in performance, alertness and sleepiness of VDT operators

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