Arh hig rada toksikol 1992;43:219–226

Original Scientific Paper
UDC 613.65:681.3:159.072

PSYCHOLOGICAL AND ERGONOMIC ASPECTS OF WORK WITH VIDEO DISPLAY TERMINALS

Goldoni J., Bobić J. and Šarić M.

Institute for Medical Research and Occupational Health University of Zagreb, Zagreb, Croatia

Received November 22, 1991.

Forty-nine operators of video display terminals were administered a questionnaire on subjective complaints in connection with work conditions. Measurements of non-ionizing and ionizing radiation emissions during normal operation of video display terminals showed them to be within permissible levels. A detailed ergonomic analysis of equipment and workstations was also performed. Results showed a high occurrence of subjective complaints, significant differences between age subgroups in a few variables, and significant correlation between sets of variables of some perceived ergonomic features and subjective complaints.

Key words: computer–human interaction, individual characteristics, working conditions.

Much has been said about high technology impact on human health. One of the problems involved concerns the possible health hazard connected with the use of video display terminals (VDTs). Firstly, attention was placed on the potential health effects of exposure to non-ionizing radiation, and secondly, on the ability of humans to adapt to new technologies (1, 2). Recently, more attention has been directed to psychological and ergonomic factors related to work with VDTs (3–6).

Many authors have reported a frequent occurrence of different subjective complaints in VDT operators (7, 8). Most complaints refer to eye problems (9–12), muscular/skeletal problems (13, 14), and psychological problems (15–17).

SUBJECTS

Subjects were 49 persons aged 19–35 years (M=26.0) working with VDTs from three to 169 months (M=43.3). Forty-two subjects were women. They all had secondary education. Thirty-six subjects worked only in the morning, whereas 16 worked in shifts (morning and/or afternoon). The whole group worked in the same room, entering data into computers 6–8 hours a day.

METHODS

The study consisted of three parts: administration of a questionnaire on subjective complaints, radiation measurement, and ergonomic analysis. A specially prepared questionnaire was administered to all subjects. The questions pertained to general data and working history, satisfaction with job, psycho-physical discomfort connected with ergonomic features of the workplace, and frequency of the occurrence of eye, muscular/skeletal, and psychological problems related to work with VDT.

The investigation included workstation inspection, workload analysis, and measurements of ionizing and non-ionizing radiation emissions from VDTs. Measurements were performed during normal VDT operation, on the screens and other VDT surfaces. For measuring weak X-radiation a Victoreen 471 survey metre was used. The intensity and distribution of electromagnetic radiation were estimated by Raham 4A. Ergonomic analysis of equipment (monitors and keyboards) and workstations was carried out according to the recommendations of The Central Organization of Salaried Employees in Sweden (TCO 1986). For statistical evaluation descriptive statistics, chi-squared test, analysis of variance, and canonical correlations were used.

RESULTS

The results of the study are shown in Tables 1–7. The first three tables present the occurrence of operators' subjective complaints. Subjective complaints are placed into three groups: eye problems, psychological problems (mood disturbances), and muscular/skeletal problems.

Among the eye problems the one reported most often was eyestrain (Table 1). As many as 59.3% of the interviewed persons experienced it daily. The symptoms of irritated eyes with headache, and burning eyes were also reported very often.

Table 1

Eye problems

Problem	Occurrence							
	Daily		Often		Sometimes		Never	
	f	%	f	%	f	%	f	%
Eyestrain	29	59.2	9	18.4	10	20.4	1	2.0
Burning eyes	4	8.2	18	4.7	15	30.6	12	24.5
Irritated eyes and headache	7	14.3	15	30.6	20	40.8	7	14.3
Double vision	0	0	2	4.1	22	44.9	25	51.0
Changed colour perception	0	0	0	0	14	28.6	35	71.4

f = frequency

As expected, psychological problems were extremely frequent (Table 2). The ones most often reported were fatigue, exhaustion, inertness, and dissatisfaction with the job.

Table 2

Psychological problems

Problem	Occurrence							
	Daily		Often		Sometimes		Never	
	f	%	f	%	f	%	f	%
Fatigue	28	57.1	11	22.4	10	20.4	0	0
Depression	7	14.3	8	16.3	15	30.6	19	38.8
Inertness	11	22.4	16	32.7	11	22.4	11	22.4
Dissatisfaction with job	11	22.4	15	30.6	14	28.6	9	18.4
Exhaustion	17	34.7	22	44.9	18	16.3	2	4.1
Lack of interest for job	9	18.4	8	16.3	15	30.6	17	34.7

Among the muscular/skeletal problems those of painful/stiff neck and shoulders were predominant (Table 3). As many as 75.6% of the operators experienced it daily or often. The occurrence of neck and head pressure, and also painful/stiff arms, back and legs, was also very high.

Table 3

Muscular/skeletal problems

Problem	Occurrence							
	Daily		Often		Sometimes		Never	
	f	%	f	%	f	%	f	%
Painful/stiff neck and shoulders	21	42.9	16	32.7	11	22.4	1	2.0
Neck and head pressure	17	34.1	10	20.4	17	34.7	5	10.2
Painful/stiff arms, back and legs	20	40.8	15	30.6	12	24.5	2	4.1
Swollen muscles and joints	8	16.3	9	18.4	19	38.8	13	26.5

Although all our subjects were relatively young, we placed them into two age subgroups: the younger, aged 19–25 years (n=24), and the older, aged 26–35 years (n=25). The older subjects appeared to be »more often depressive« than the younger subjects (Table 4). With regard to ergonomic factors at the workplace the younger subjects more often complained of inappropriate lighting (keyboard reflections – 66.7% of »yes« answers, and monitor glitter – 87.0% of »yes« answers), although they reported fewer visual problems with burning eyes. While 41.7% of the younger subjects answered that they had

never had symptoms of burning eyes, 92% of the older operators reported to have had them sometimes (44.0%), often (40.0%) or daily (8%). The younger operators complained more often about temperature conditions at the workstations (too cold or too warm). Only 25.0% of them stated that the microclimate was adequate for their type of job, while 68% of the older subjects considered temperature conditions to be suitable.

Table 4

Variables with significant differences according to age subgroups

Variables	Answers	Age (years) 19–25 (n=24) f	%	26–35 (n=25) f	%	P
Depression	daily and often	2	8.3	13	52.0	0.0027
Burning eyes	never	10	41.7	2	8.0	0.0320
Microclimate	suitable	6	25.0	17	68.0	0.0017
Keyboard reflections	yes	16	66.7	7	28.0	0.0153
Monitor glitter	yes	21	87.5	9	36.0	0.0007

Tables 5–7 contain significant canonical correlations between different sets of variables. Table 5 shows correlations between »Ergo I« variables (subjective perception of selected

Table 5

Canonical correlations between variable sets »Ergo I« and »Eye problems«

Variable set	Coefficients for canonical variables
Ergo I	
Monitor glitter	0.29941
Monitor reflections	0.25193
Character sharpness	0.06968
Line distance	–0.58531*
Keyboard reflections	–0.74584**
Eye problems	
Eyestrain	0.69816**
Burning eyes	0.52368*
Irritated eyes and headache	–0.52368*
Double vision	0.33870*
Changed colour perception	0.16618

Coefficient of canonical correlations R = 0.5748
Sigificance level = 0.0184
* P<0.05; ** P<0.01

ergonomical monitor and keyboard characteristics) and »eye problems« variables. In the »Ergo I« set, the most representative variable is »keyboard reflections« and the most inappropriate one »line distance«. »Eyestrain«, »burning eyes« and »double vision« variables are strongly correlated with the »Ergo I« set.

Table 6

Canonical correlations between variable sets »Ergo I« and »Psychological problems«

Variable set	Coefficients for canonical variables
Ergo I	
Monitor glitter	0.38442*
Monitor reflections	0.03483
Character sharpness	–0.16966
Line distance	0.03926
Keyboard reflections	0.82723**
Psychological problems	
Fatigue	–0.19393
Depression	–0.77238*
Inertness	–0.17007
Dissatisfaction with job	0.68371*
Exhaustion	0.26816
Lack of interest for job	–0.82723**

Coefficient of canonical correlations R = 0.6172
Significance level = 0.0469
* P<0.05, ** P<0.01

Psychological problems are in correlation with the same set of variables. The frequent occurrence of »depression« and »lack of interest for job« are connected mostly with »keyboard reflections« and »monitor glitter« variables (Table 6).

Table 7 shows the »monitor glitter« variable to be significantly correlated with the symptoms of neck and head pressure. Accordingly, fewer complaints about keyboard reflections are connected with reports about painful/stiff neck and shoulders.

Canonical correlations between other sets of ergonomical variables and subjective complaints variables were not significant.

Non-ionizing and ionizing radiation emissions were within permissible levels at all measuring sites.

Out of 39 ergonomic features contained in TCO recommendations, six were found to be inappropriate: unstable chair, work surfaces reduced, screen too small for data entry, lack of monitor vertical adjustment, unstable keyboard, lack of local illumination which is needed for monitors with negative contrast.

Table 7

Canonical correlations between variable sets »Ergo I« and »Muscular/skeletal problems«

Variable set	Coefficients for canonical variables
Ergo I	
Monitor glitter	0.79094**
Monitor reflections	0.06868
Character sharpness	0.30510*
Line distance	–0.20922
Keyboard reflections	–0.40515*
Muscular/skeletal problems	
Painful/stiff neck and shoulders	–0.42654*
Neck and head pressure	1.29755**
Painful/stiff arms, back and legs	0.03841
Swollen muscles and joints	–0.06875

Coefficient of canonical correlations R = 0.6287
Significance level = 0.0180
* P<0.05, ** P<0.01

DISCUSSION AND CONCLUSIONS

Many authors have already focussed on the importance of constellations of working conditions and individual characteristics in the appearance of physical and psychological disturbances (15, 16). A factor that may help understand the complexity of the problem and variety of possible health effects is as *Caplan* (17) calls it »misfit« between the individual perception of the working conditions and actual conditions. Thus we found that three variables which ergonomically corresponded to the recommendations were falsely perceived by our subjects as »uncomfortable«, in percentages as high as 28.6–61.2. Although the monitors did not glitter, 61.2% of our operators perceived them as glittering. The same was true for the variables »monitor reflection« and »keyboard reflection«, with percentages of 28.6 and 46.9 of incorrect subjective perception.

High percentages of misperception in connection with the monitor glittering and reflection may be explained in purely psychological terms. The subjects may be disturbed by actual inappropriate ergonomic features such as the small screen, lack of monitor vertical adjustment, and lack of illumination needed for monitors with negative contrast. These factors may influence a worker's perception of workplace conditions, without his realizing the actual cause. They may also cause a high percentage of visual problems. Prolonged work with monitors without the possibility of vertical adjustment usually causes eyestrain, as well as a painful/stiff neck and shoulders, due to incorrect posture of the head.

Ergonomic analysis showed six inappropriate features: unstable chair, reduced work surface, too small screen, lack of monitor vertical adjustment, unstable keyboard, lack of

needed local illumination. It was interesting to discover that the first five variables listed above were falsely perceived as appropriate in very high percentages (46.9–98.0%). For example, even the very obvious fact that none of the monitors were vertically adjustable was overlooked by 81.6% of the subjects. The results obtained from canonical correlations corroborate this. Significant correlations were found between the variable set »Ergo I« and »psychological«, »eye« and »muscular/skeletal« problems.

The results of our study show a high incidence of subjective complaints which is in accordance with data from literature (1, 2, 7, 8). Obviously, the dominant subjective complaints require further efforts to be undertaken to adapt work processes and environment to man. We believe that the complex interaction between the physical, ergonomic, and psychological factors associated with computerization of office jobs may also call for radical restructuring of jobs.

REFERENCES

1. *Knave B,* ed. 1st International Scientific Conference: Work with Display Units. Proceedings, part I and II, Stockholm: Swedish National Board of Occupational Safety and Health 1986.
2. *World Health Organization.* Visual Display Terminals and Workers' Health. WHO Offset Publication No 99. Geneva, 1987.
3. *Devole N, Queinnec Y.* Operator's activities at CRT terminals: a behavioral approach. Ergonomics 1983;26:329–40.
4. *Grandjean E.* Fitting the task to the man. Taylor and Francis Ltd. London, 1985.
5. *Evans J.* Office conditions influence VDU operators' health. Health and Safety at Work 1985;12:34–6.
6. *Knave BG, Wibom RI, Voss M, Hedström LD, Bergqvist UOV.* Work with video display terminals among office employees. I. Subjective symptoms and discomfort. Scand J Work Environ Health 1985; 11:457–66.
7. *Evans J.* VDU operators display health problems. Health and Safety at Work 1985;11:33–7.
8. *Šarić A.* Subjektivne smetnje operatera na videoterminalima u odnosu na ergonomske uvjete rada (Magistarski rad). Zagreb, Medicinski fakultet Sveučilišta u Zagrebu, 1988. 87 str.
9. *Böös SR, Calissendorff BM, Knave BG, Nyman KG, Voss M.* Work with video display terminals among office employees. III. Ophthalmologic factors. Scand J Work Environ Health 1985;11:475–81.
10. *Smith MJ.* Correlates of ocular and somatic symptoms among video display terminal users. Hum Factors 1984;26:143–56.
11. *Seaber JH, Fisher B, Lockhead GR, Wolbarsht ML.* Incidence and characteristics of McCollough aftereffects following video display terminal use. J Occup Med 1987;29:727–9.
12. *Hedman LR.* VDT users and eyestrain. Tele 1986;1:18–21.
13. *Hünting W, Läubli Th, Grandjean E.* Postural and visual loads at VDU workplaces. I. Constrained postures. Ergonomics 1981;4:19–23.
14. *Läubli I.* Review on working conditions and postural discomfort in VDT work. In: Knave B, ed. 1st International Scientific Conference: Work with Display Units. Proceedings, part I. Stockholm: Swedish National Board of Occupational Safety and Health. Stockholm, 1986:3–9.
15. *Smith MJ, Carayan P, Miezio K.* VDT Technology: Psychosocial and stress concerns. In: Knave B, ed. 1st International Scientific Conference: Work with Display Units. Proceedings, part II. Stockholm: Swedish National Board of Occupational Safety and Health. Stockholm, 1986:695–712.
16. *Cooper S, Marshall J.* Occupational sources of stress: A review of the literature of relating coronary heart disease and mental ill health. Journal of Occupational Psychology, 1976;49:11–28.
17. *Caplan R et al.* Job demands and worker health. US DHLW Publication No. (NIOSH), Washington D.C. 1976, 75–160.

Goldoni, J., Bobić, J., Šarić, M.: Psychological and Ergonomic Aspects of Work with Video Display Terminals.
Arh hig rada toksikol, Vol 43 (1992) No 3, pp. 219–226

Sažetak

PSIHOLOŠKI I ERGONOMSKI ASPEKTI RADA UZ VIDEOTERMINALE

Skupini od 49 operatera zaposlenih uz videoterminale podijeljen je upitnik o subjektivnim smetnjama u vezi s uvjetima rada. Emisija neionizirajućeg i ionizirajućeg zračenja tijekom normalnog rada videoterminala bila je u okviru dopuštenih vrijednosti. Izvršena je detaljna analiza opreme i radnih mjesta. Rezultati pokazuju visoku učestalost subjektivnih smetnji, značajnu razliku između dobnih podskupina u pojedinim varijablama, kao i značajnu korelaciju između seta varijabli percipiranih ergonomskih parametera i subjektivnih smetnji.

Institut za medicinska istraživanja i medicinu rada Sveučilišta u Zagrebu, Zagreb, Hrvatska

Ključne riječi: interakcija kompjutor–čovjek, osobine ličnosti, radni uvjeti.