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A Study on the VDT Workstations Usage for Office Workers

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Objective and Background: Due to increase in Musculoskeletal Disorders (MSDs) relating to computer use, a number of ergonomics recommendations have been proposed in order to tackle this problem. However, some of these recommendations have been conflicting.

Method: This study was to survey the VDT (Visual Display Terminal) use of office workers. The subjects were 452 workers at 13 places of business and the data were collected by self-administered questionnaire.

Results: As a result, prevalence of self-reported MSDs of all VDT workers was 90.2% and shoulder took up 57.0% and neck 38.3% by symptom part of body. The population of computer use of more than 6h/day was 84.5%, and 33.8% also reported using the VDT 2~3h/day without the rest time. Desktop computer users were 95.6%, and a 17-inch monitor accounted for 42.0% among the desktop users. As a result of satisfaction survey on overall computer work, 21.1% of the total respondents said satisfied, desk complaint was about 24.6%, and chair complaint was 33.4%. Despite the importance of computer environment, satisfaction was from fair to uncomfortable.

Conclusion and Application: In conclusion, office workers are prone to the MSDs due to their work environment. Additionally, this study found that task was a significant effect for the majority of dependent variables, and therefore, the improvement of computer workstations work environment is urgent, and the improvement of desk height adjustment, chair seat size (length, width), backrest condition, location of keyboard (mouse) and arm rest is required.

Keywords: VDT (Visual Display Terminal), VDT workstations, Musculoskeletal disorders, Types of office work

1. Introduction

The recent diffusion of computers and rapid development of computer technologies have generated the qualitative and quantitative improvement of information, and have enormously affected productivity improvement. The number of workers sitting in front of a desk or a worktable increases furthermore, due to production process automation and increase in computer dissemination. The work using computers is called VDT (Visual Display Terminal) use work. VDT office work includes VDT workstation (peripheral devices for office work), and it consists of keyboard, mouse, monitor and CPU (Central Processing Unit). The work using VDT includes existing office work such as banking, design and precision inspection. In addition, new types

of VDT work including home shopping, securities & credit card companies, and call center consulting work increase like communications companies, computer games and programs development are generated. Current computer use work was concentrated on office workers in the past; however, the VDT environment affects quite a lot, since the use of VDT has spread to young students and general users, as well as office workers.

Concerning the manpower engaged in office work using VDT workstations, the places of business having computers accounted for 72.6% (2,614 places of business) of the total places of business, as of the end of 2013, as a result of survey on 3,602,476 places of business having one and more of employees nationwide. As a result of survey on personnel's average computer use rate targeting the places of business mentioned above, the ratio of performing work using a computer at least once a week took up 88.3%, and the case using computers for more than 80% of daily work was 80.2%, the highest. By business type, professional technology service took up 99.5%, the highest, followed by publication, visual image, broadcasting and information service with 99.0%, manufacturing with 76.6%, which were higher than accommodation and restaurant businesses with 48.3% (NIA, 2014). The Internet use rate was 83.6%, and its rate of the elderly (aged 60 years and over) was 32.8%, up 6.0%p, compared with the previous year. By occupation, office workers, professionals/managers and production workers took up 99.7%, 98.8% and 72.2%, respectively, and it was surveyed that 38.7% of the Internet users used the Internet more than 14 hours a week on average. The purposes of the Internet use were mainly data and information search (91.1%), communication including email and SNS (89.8%) and leisure activity (79.7%) (KISA, 2014).

As the use ratios of computers and the Internet at the places of business to carry out tasks gradually go up, workers are exposed to computers for a long time. If workers are exposed to VDT environment for a long time, they can be exposed to Musculoskeletal Disorders (MSDs), which are called VDT syndrome. Due to office work, workers complaining upper body MSDs including Turtle Neck Syndrome, Cervical Herniated Intervertebral Disc and Carpal Tunnel Syndrome increase. The reason is that the office workers or students, who spend lots of time in front of computers or desks, take a posture of head sticking out forward more than spinal central line, as they have difficulties in maintaining normal spinal posture in a sitting position. Such a posture causes cervical spine lordosis increase, thoracic and lumbar kyphosis, and therefore, they have difficulties in continuing VDT use work for a long time. Office workers using a computer a lot show problems in the muscles related with shoulder pain including supraspinatus muscle and infraspinatus muscle, as well as trapezius and cervical spine muscle, and upper dorsal muscles (Kim et al., 1998). As time passes by, these muscles cause referred pain or distributed to neck and shoulders gradually.

The following factors related to causing the symptoms of MSDs pertaining to VDT have been identified: characteristics of work details such as repetitive work, forceful exertions, mechanical compression, static posture or awkward posture and vibrating tool use; work condition characteristics including working hours, VDT use hours and workload; working environment factors such as VDT peripheral devices like desk and chair, noise, lighting and ventilation; psychological factors including job satisfaction, change in workload and mental stress; individual characteristics such as age, gender and work experience. MSDs are known to develop through complex factors of work related with work details and conditions, and individual characteristics and psychological factors (Shimai et al., 1986; Ong et al., 1987).

As Local Rule on Occupational Safety and Health Standard were enacted in Korea, an action on VDT manipulation work was established for the first time. Also, "*The Visual Display Terminal (VDT) workers handling operations management guidelines*" was established through the Notifications of the Ministry of Employment and Labor (MOEL, 2012). As monitor changed from CRT to LCD monitor together with physical condition change of Korean people including height and weight (KATS, 2010; Size Korea, 2015), the VDT office work environment and technological level have changed quite a lot (NIA, 2014; KISA, 2014). However, the management issues contained in the regulations concerned with VDT use have been maintained for decades. Above all, a review on precise reality on office work environment and on whether the management standards are properly applied is required.

This study aims to contribute to the prevention of VDT use-related diseases by providing the reality, according to the general characteristics of office workers, health status, work-related factors and VDT workstation (peripheral devices for office work), and satisfaction/importance on the computer components through a questionnaire survey on the VDT users engaged in such office work.

2. Method

This study conducted a questionnaire survey targeting 13 places of business for fact-finding survey of VDT office work, and 452 workers responded to the questionnaire survey. The questionnaire consisted of 107 questions containing the following details: ten questions on respondents' general characteristics (gender, age, height, and status of exercise and smoking), eight questions on health status, 21 questions on the currently performing tasks, 12 questions on VDT office environment and 56 questions on satisfaction and importance on the VDT office work environment (desk, chair, keyboard and work environment) (Lee et al., 2008; Kim et al., 1991; Kim et al., 1992; Kim et al., 1993).

3. Results

3.1 Individual characteristics

Table 1 shows general characteristics of the respondents. Males were 41.4% (187 people) and females were 57.7% concerning gender. As for age, 49.6% (224 people) was 30~39, the highest, followed by 24.6% between 40~49, 20.1% between 20~29 and 4.7% over 50. Concerning height, 25th percentile (male: shorter than 169.5cm, female: shorter than 156.8cm) was 16.4%, and 25~74th percentile (male: 169.9~177.5cm, female: 156.8~163.8cm) were the highest with 55.1%. Meanwhile, 75th percentile and more (male: taller than 177.5cm, female: taller than 163.8cm) was 25.4%. There was no special difference according to gender. 99.5% of the respondents were day shift workers, and 80.8% were regular workers.

As a result of estimating BMI (Body Mass Index) using height and weight, the respondents corresponding to normal weight (18.5~less than 25) was the highest with 42.7% (193 people), followed by overweight (over 25) with 40.7% and low weight (less than 18.5) with 7.7%. However, 73.3% of males were overweight, and only 25.1% were normal weight. Meanwhile, 64.9% was standard weight, and overweight was 20.9% in the case of females.

Looking at work experience, 1~9 years accounted for the highest ratio with 43.8% (198 people), followed by 10~19 years with 29.9%, 20~29 years with 10.8% and less than one year with 2.2%. As for marital status, the married were 63.3% (286 people), and the unmarried were 34.7%. Regarding the status of exercise, irregular exercise took up 52.4% (237 people), the highest, and no-exercise was 33.9%, and regular exercise was 13.3%. Concerning the status of smoking, non-smoking was the highest with 67.3% (304 people), and smoking was 22.1%, and smoking in the past was 9.7%.

Table 1. Results of individual characteristics (n=452)

Variable	Categories	N	Percent (%)
Gender	Male	187	41.4
	Female	261	57.7
	NR	4	0.9
Age	20s (20~29)	91	20.1

Table 1. Results of individual characteristics (n=452) (Continued)

Variable	Categories	N	Percent (%)
Age	30s (30~39)	224	49.6
	40s (40~49)	111	24.6
	50s (50~)	21	4.6
	NR	5	1.1
Height Status	~25%tile	74	16.4
	25~74%tile	249	55.1
	75%tile~	115	25.4
	NR	14	3.1
BMI	Under Weight (~18.5)	35	7.7
	Normal (18.5~24.9)	193	42.7
	Over Weight (25~)	184	40.7
	NR	36	7.9
Work Experience	~1 yrs.	10	2.2
	1~5 yrs.	97	21.5
	5~10 yrs.	100	22.1
	10~15 yrs.	85	18.8
	15~20 yrs.	49	10.8
	20 yrs. ~	52	11.5
	NR	52	11.5
Marital Status	Single	157	34.7
	Married	286	63.3
	Divorced/Widowed	4	0.9
	NR	5	1.1
Exercise	Regular	60	13.3
	Irregular	237	52.4
	Non	153	33.9
	NR	2	0.4
Smoking	Smoking	100	22.1
	Non-Smoking	304	67.3
	Former-Smoking	44	9.7
	NR	4	0.9

3.2 Survey on symptom of musculoskeletal disorders and health problems

As a result of survey on individual health status, 47%, 36% and 3% of the total respondents said their health status was fair,

healthy, and very healthy, respectively. The response of not healthy was 13%, and not very healthy was 1%: All in all, the respondents said their overall health status was fair and higher. In relation with MSDs for recent one year, 90.2% of the total respondents replied they experienced pain on the question of experience on pain with numbness, stiffness and burning or aching. According to the survey of pain seriousness targeting those who suffered from pain, it was revealed in the following order: serious pain (29.9%), weak pain (20.6%), no symptom (7.9%) and very severe pain (5.6%). Serious pain and higher took up 35.5% of the total respondents.

Figure 1 shows survey results of the body parts with MSDs: the body parts with MSDs were revealed in the following order: shoulder was 35.0%, neck 23.6%, back 15.3%, wrist/finger 13.2%, knee 5.6%, arm/elbow 4.3% and foot/ankle 3.0%. In a study of Jeong and Yoon (2014), shoulder took up 34.2%, the highest, followed by neck with 30.9% and waist with 22.0% in the experience of pain for the recent one year, which was similar to the results in this study. Figure 2 shows the symptom experienced period ratio: 57.9% of the total respondents experienced pain 1~5 years ago, the highest, followed by 18.6% with 5~10 years and less than one year with 16.6%. As for specific pain period, 21 months was the highest with 11.4%, followed by 33 months with 11.0%, 45 months with 9.7%, 81 months (6.6%) and 69 months with (6.6%). Less than four years of experiencing pain accounted for 71% of the total respondents. 50.1% was the case that eye sight slightly deteriorated, and 22.2% was the deteriorated case, as a result of survey on eye sight change. This meant the respondent's eye sight decline was clear.

3.3 Work-related factors

As a result of classification, according to VDT office work types targeting 452 workers (Figure 3), data search and inquiry took up 48.9% (211 people), data entry was 27.2% and design work was 23.9%.

Regarding working hours a day, eight hours accounted for 58.0%, nine hours 20.2%, and 10 hours 11.5%. As a result of survey on computer use hours during daily working hours, eight hours and more were 47.6%, six to less than eight hours were 36.9%

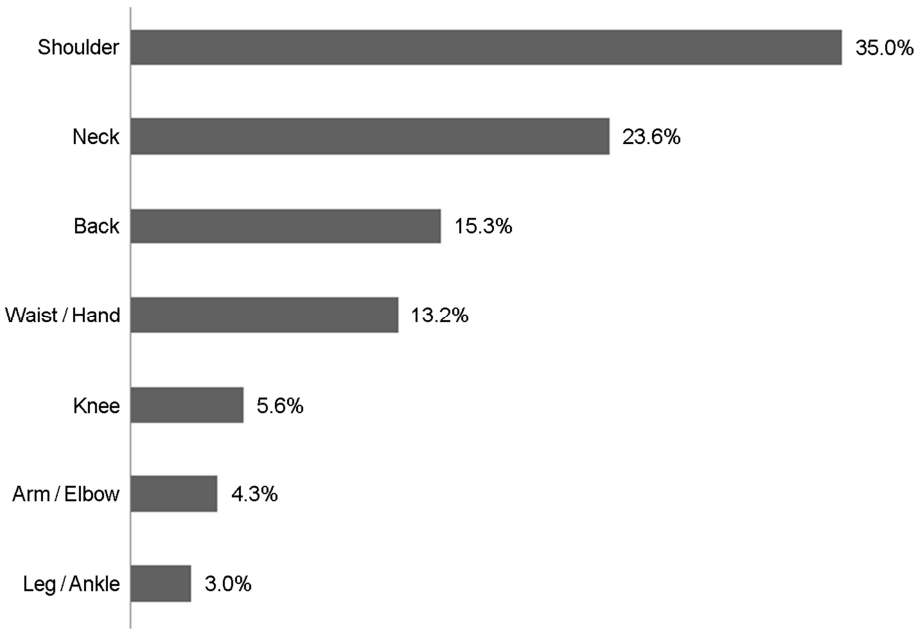


Figure 1. Musculoskeletal disorders by body part

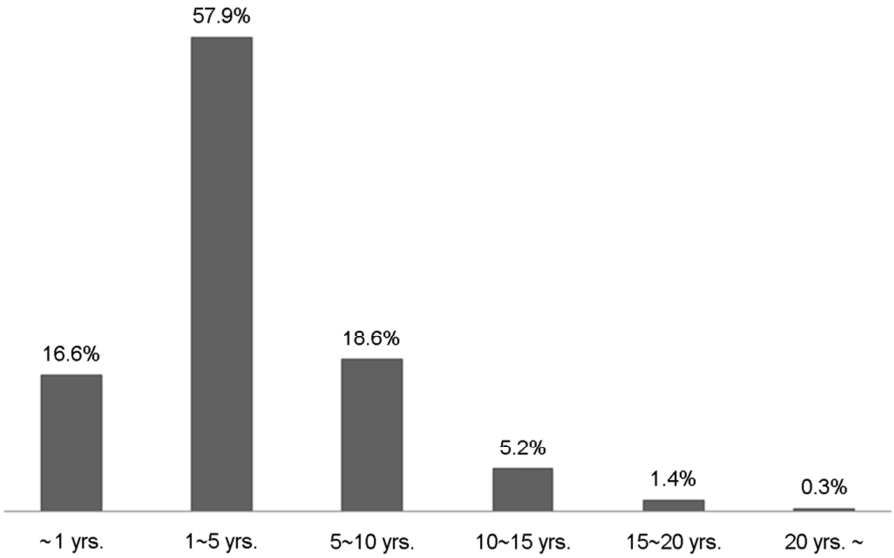


Figure 2. The symptom experienced period of musculoskeletal disorders

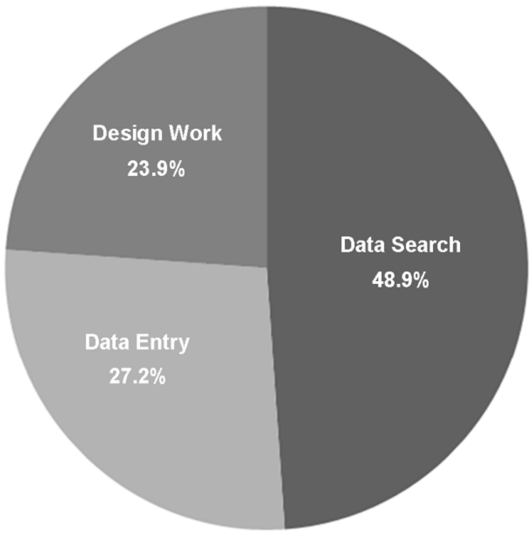


Figure 3. The types of office work

and four to six hours were 12.5% (Figure 4). This shows similar result from the study of Kim and Hong (2004) saying seven hours of computer use was 54.8% (female: 64.7%). According to working hours with computer use without rest, the following order was revealed: two to less than three hours (33.8%), one to less than two hours (27.6%), four hours and more (20.1%), three to less than four hours (13.5%) and less than one hour (5.0%).

According to the questionnaire survey on having regular rest time (break time), 41.7% of total respondent replied yes, and 58.0% said no. In the case of having regular rest time, 30.1% of the total respondents took a rest for ten minutes in every two hours, and 14.8% for the minutes in every hour. 50.4% said they had no resting area, and only 37.6% said they had resting area.

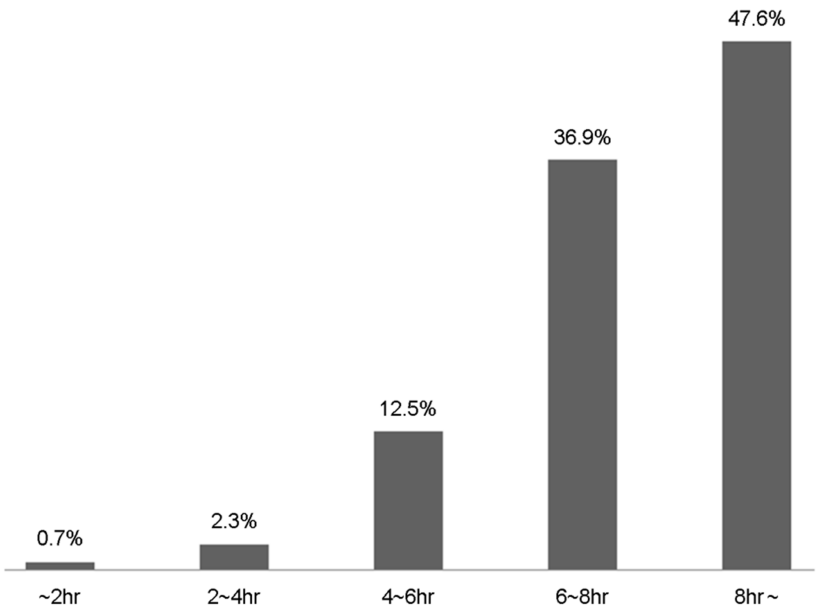


Figure 4. Proportion of daily computer usage

3.4 VDT workstations (peripheral devices for office work)

Personal computers come in two major varieties, desktop and notebook computers. As for the computer type used by the respondents, desktop computer accounted for 96.3%, and 17-inch monitor took up 42.0%, the highest, followed by 19-inch with 27.0%, 15-inch and smaller with 10.5%, and 22-inch with 9.3% (Figures 5 and 6). A wide monitor was low with 8.4%, and the ratio of using dual monitor was 26.7%.

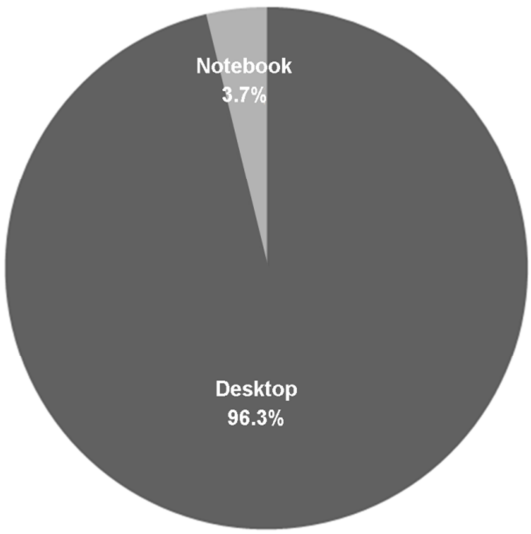


Figure 5. Types of computer usage

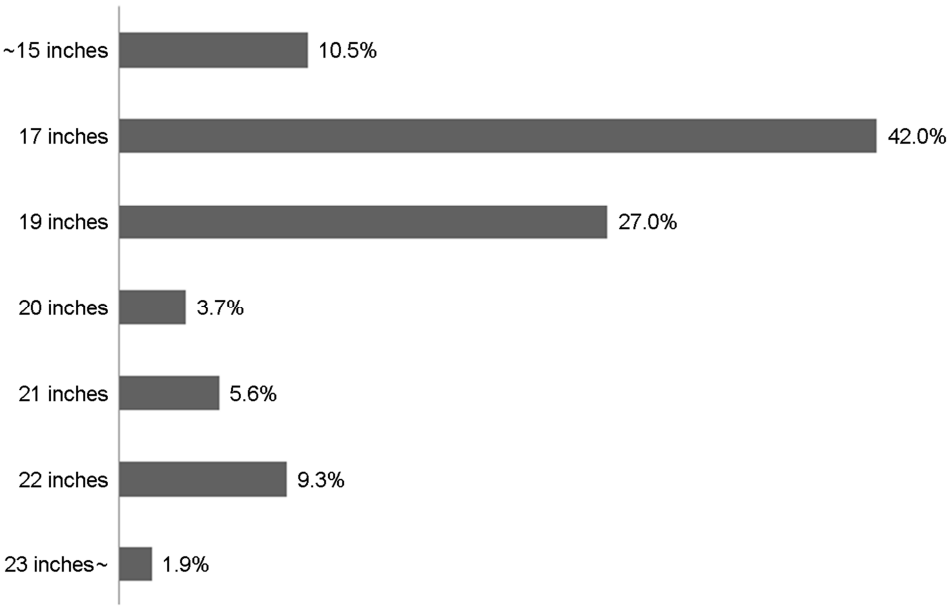
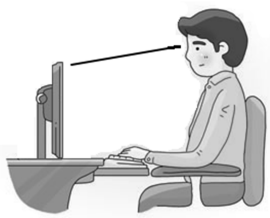


Figure 6. Monitor size of computer usage

The location of a monitor in the VDT office work environment is known to be a typical cause of turtle neck syndrome sticking out user's neck forward, and "below eye level" is known to be desirable as the location of a monitor. Table 2 shows survey results on the height of the top of the monitor: 67.2% was at eye level, and 15.1% was above eye level. The desirable location "below eye level" took up only 17.7%. As for keyboard location, 98.7% was above desk, accounting for most location. Only 1.3% used keyboard tray. In relation with this, as a result of checking keyboard height, 46.2% was at the same level as elbow, and 45.6% was higher than elbow. Concerning mouse, its location on the desk was 98.4%. In general ergonomic design standard, the height of keyboard and mouse is to place a bit below elbow level, and the ratio was just 8.2%.

Table 2. Proportion of screen height

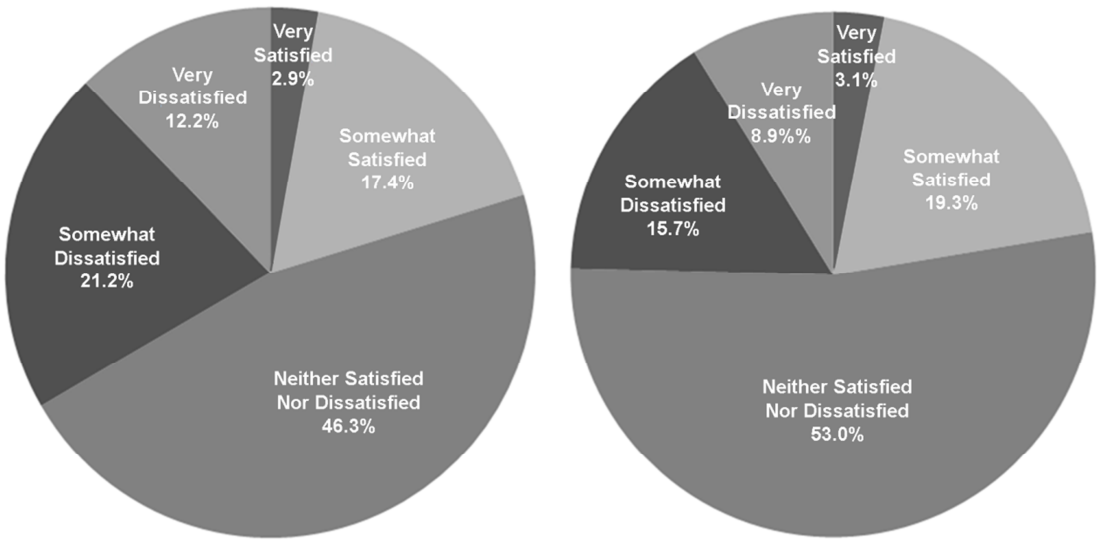
Above Eye level	Eye level	Below Eye level
		
15.1%	67.2%	17.7%

3.5 Satisfaction and importance ratings for VDT usage

As a result of satisfaction survey on computer workstation components, desk height adjustment was a bit uncomfortable, and space on the desk, desk material (glare), edge of desk (lower arm pressing) and leg space under the desk were a bit satisfied. As for chair, the respondents complained of seat size (length, width) and backrest condition a bit, and also complained of the location of keyboard (mouse) and lower arm support space. Concerning work environment, the respondents complained overall, and they complained of ventilation problem within office, irregular resting problem and workload concentration problem as very uncomfortable.

According to the survey on the importance of workstation components, the respondents said overall components were important, especially, leg space under the desk and chair height adjustment were pointed out as very important. Additionally, they replied chair's backrest condition, the height of keyboard (mouse), mouse shape and size, proper height of monitor and glare prevention were very important as well. Above all, work environment like ventilation within office was pointed out as a very important item.

As a result of satisfaction survey on overall computer work, 63.2% of the total respondents said neither satisfied nor dissatisfied, the highest, and 21.1% said satisfied, 13.1% dissatisfied, and 1.6% very dissatisfied. As a result of satisfaction survey on chair, 17.4% was somewhat satisfied, 2.9% was very satisfied: therefore, only 20.3% was satisfied in total. 21.2% said somewhat dissatisfied and 12.2% said very dissatisfied, and thus 33.4% of the total respondents expressed complaints on chair. As a result of satisfaction survey on desk, 22.4% was satisfied, and 24.6% was dissatisfied, which was a bit higher than the case of being satisfied (Figure 7).



(a) Chair (b) Desk

Figure 7. Overall satisfaction with chair and desk

Table 3 shows the importance and satisfaction with computer work environment with 5-point scale. Despite the importance of computer environment (3.9), satisfaction was inclined to be fair to uncomfortable (2.94). Especially, The importance of work environment was 4.13 points, while the satisfaction was low at 2.57. Regarding desk, the importance was 3.8, but satisfaction was 2.92. As a result of satisfaction result considering both desk and chair by Jeong and Yoon (2014), mean was 3.23, which was low

overall. Therefore, the improvement of computer workstations work environment is needed, and also the improvement of desk height adjustment, chair seat size (length, width), backrest condition, location of keyboard (mouse) and arm rest is also required.

Table 3. Subjective levels (5 scales) for the importance-satisfaction analysis by workstations

Workstations	Mean of importance	Mean of satisfaction
Overall average	3.90	2.94
Desk	3.80	2.92
Chair	3.82	3.04
Keyboard (Mouse)	3.87	3.04
Display	3.90	3.13
Work environment	4.13	2.57

4. Discussion and Conclusion

Various diseases recently develop in the non-manufacturing industries, especially in the service industry, and the cases complaining of VDT syndrome known as turtle neck syndrome increase. This study conducted a fact-finding survey targeting 452 office workers in order to provide the results of the general characteristics, health status, work-related factors, VDT workstations, and satisfaction/importance regarding to the computer components.

According to health status survey, 90.2% experienced MSDs and severe pain and higher took up 35.5%. The body parts the respondents experienced were shoulder (57.0%), neck (38.3%), waist (24.9%), wrist/finger (21.5%), knee (9.1%), arm/elbow (7.0%) and foot/ankle (4.9%) in the order. Regarding job, 80% and more of sitting posture accounted for 73% of the total respondents. For daily computer use hours, eight hours and more took up 47.6%, and six to less than eight hours took up 36.9%. Working for 2~3 hours continuously without a rest was 33.8%, which was high.

As for computer type, desktop accounted for 95.6%, and 17-inch monitor was 42.0%, the highest, and the ratio of using dual monitor was 26.7%. As a result of the top part height of monitor, 67.2% was about eye level, the highest, and the location below eye level, which is desirable height, was only 17.7%. As a result of satisfaction survey on overall computer work, 21.1% of the total respondents said satisfied. Despite the importance of computer environment (3.9), satisfaction was from fair to uncomfortable (2.94). Therefore, the improvement of computer workstations work environment is urgent, and the improvement of desk height adjustment, chair seat size (length, width), backrest condition, location of keyboard (mouse) and arm rest is required.

Yang et al. (2004) arranged various preceding studies on VDT syndrome. They pointed out exercise treatment, in which people voluntarily participate, can play a pivotal role in bad posture prevention and health enhancement, as a result of literature review on working postures and exercise effects. According to a study of Kim et al. (2009), MSDs prevention programs are operated, centered on the manufacturing industry, however, there were almost none of those operated for office workers' places of business. Pillastrini et al. (2007) reported that lumbar vertebral and upper body postures improved, and discomfort was also eased, as a result of an ergonomic program execution for posture correction to prevent MSDs targeting 194 VDT workers for five months. In addition, when the pamphlets on the importance of postures and VDT prevention method were placed within an office, they reported an effect for workers to recognize the risk of MSDs. Sim and Lee (2008) pointed out the need of comparative study

considering more detailed items, since the work characteristics of office workers are diverse ones. Consequently, more specific management measures are to be presented through a further study on what differences occur per office work type, based on the results of this study.

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