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Ergonomic Problems and Their Improving Measures in Office Environment of General Hospitals

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Objective: The purposes of this study are to investigate ergonomic problems and to propose their improving measures in office environment of big general hospitals.

Background: Office tasks have varying risk factors of work-related musculoskeletal disorders (WMSDs). The first symptom resulted from the office work was recognized as an occupational disease in Korea in 1986. Although the symptoms have increased since its first recognition, there has been few study on the effect of office work environment settings.

Method: First, the author took pictures of working scenes performed in three big university hospitals. Next, the pictures were analyzed in view point of ergonomics. Based on the analysis, their improving measures were proposed for reducing work stress.

Results: The results showed that most physical office environment settings such as dimensions of tables/desks and chairs, leg room, thigh, knee and foot clearances, and chairs used did not satisfy the ergonomically recommended design guidelines. In addition, some clerks placed personal belongings under their desks, put monitors in high position and did not lean against the backrest of chairs in seated tasks, which resulted in poor working postures of leg, back, neck etc. It is recommended that the hospital management should provide their clerks with ergonomically designed office furniture and continuously perform ergonomics training program for raising clerks' recognition for office ergonomics.

Conclusion: Most office environment settings investigated in this study were not in good condition in view point of ergonomic design for the settings.

Application: It would be useful as basic data for establishing ergonomically good office environment in hospitals.

Keywords: Office environment, General hospital, Ergonomic improvement

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1. Introduction

The introduction of VDT (visual display terminal)s has changed the nature of work and probably increased the burden of work-related musculoskeletal disorders (WMSDs) among workers working in offices. Many studies pointed out that the prevalence of WMSDs is closely related to the VDT work (Hagberg, 1981; Knave et al., 1985; Yun et al., 2001).

In Korea, VDT syndromes were first recognized as an occupational disease in 1986

(Korea Industrial Safety Corporation/Korea Welfare Corporation, 1996). Since the number of VDT syndromes is increasing, without effective ergonomic prevention, the VDT syndromes can negatively affect Korean industry and the well-being of Korean workers (Park et al., 2000). Many ergonomic studies for VDT workstations have been conducted to reduce the incidence of VDT syndromes. There have been studies of Villanueva et al. (1997) for the backward-leaning trunk, Tougas and Nordin (1987) for the chair inclination angle, Grandjean et al. (1984) for the adjustable VDT workstation chair, Saito et al. (1997) for non-adjustable VDT devices, and Park et al. (2000) for evaluation of a new VDT workstation chair with keyboard-mouse support.

Fogleman and Lewis (2002) found that office workstation variables such as improper monitor and keyboard position were significantly associated with head/eye and shoulder/back discomfort, respectively. These emphasized the importance of workstation ergonomics. Shuval and Donchin (2005) demonstrated that through a cross-sectional study for VDT workers in a Hi-Tech company of Israel, an intervention program focusing on arm/wrist posture was needed for upper extremity musculoskeletal symptoms.

The literature survey showed that how to design and configure office workstation is an important factor for reducing VDT syndrome in office environment. However, there has been few study on the survey of office workstation configuration in Korea. In addition, most tasks performed in office environments were excluded in 'Eleven Tasks' that the business owners should examine the WMSDs risk factors, which were legalized in 2002 (Kee et al., 2011). Consequently, clerical tasks have received less attention than other physical tasks in the safety and health field. Therefore, this study aims to investigate ergonomic problems and to propose their improving measures in office environment of three general hospitals.

2. Method

This study was conducted mainly based on observations for office environments in three general hospitals. The hospitals were located in S and D cities of Korea. Two of them had over 1,000 beds and the other over 700 beds. The observations were reviewed in the laboratories in view point of ergonomic guidelines found in the relevant references (Kroemer et al., 1994; Niebel and Freivalds, 1999; Pheasant, 1990; Sanders and McCormick, 1987). The data of the 6th Size Korea Project results of Korean Agency for Technology and Standards were used for proposing improving measures related to human size (Size Korea Home Page, 2014).

3. Results and Discussion

3.1 Reception tables

The reception tables are where patients or their guardians apply to medical treatment. They are generally located in the first floor of hospitals and each ward by medical departments. They are composed of tables for customers, and desks, computers, printers, drawers containing documents, etc. for hospital's clerks. Most tables for customers are for standing, the heights of which ranged from 1,000.0mm to 1,150.0mm (Figure 1(a)). The heights for all ten tables surveyed exceeded female's average elbow heights of 981.3mm (age: 30~34). This means that the tables' heights are higher for females, which causes the female customers' upper arms abducted and consequently leads to shoulder fatigue (Niebel and Freivalds, 1999). It is recommended that the height be lowered to around 950.0~970.0mm for females (Sanders and McCormick, 1987). The heights of the desks for seated hospital clerks were between 690.0mm and 800.0mm. This indicated that while some desks satisfied the ergonomically recommended heights for seated workers of 700.0~750.0mm, the others did not (Figure 1(b)) (Niebel and Freivalds, 1999). In other words, some desks were higher than the recommended height, and a few desks were lower.

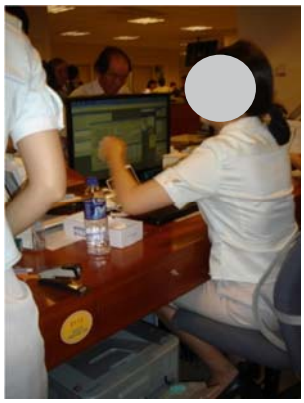
The other problem was that there were computers, printers, personal belongings, etc. under the clerks' desks. It may be attributed to restricted space of hospitals to place them on (Figure 1(b), (c)). Due to this, there were no sufficient leg rooms of minimum

space of 500.0mm (width) x 660.0mm (depth) from the frontal edge of desk (Niebel and Freivalds, 1999). As a result, it was difficult for clerks to assume ergonomically good postures with less physical stress.

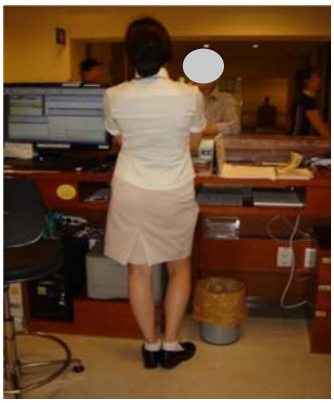
The horizontal distance from the frontal edge of clerks' desks to that of customers' desks (i.e., depth of customers' tables + that of clerks' desks) often exceeded 1,200.0mm, which caused unnatural upper limb postures with arms extended and elevated, and sitting on the edge of chairs or bending the back when exchanging documents with customers (Figure 1(d)). This may be attributed to the depth of tables/desks of both customers and clerks. It is not easy to reduce the depth of clerks' desks because space for computer, telephone, documents, etc. is needed on the desks. The depths of customers' tables were over 500.0mm, which is thought to be deep for tasks just handling paper documents. Although there is no numerical design guideline for the depth, the depth of customers' tables should be reduced as much as possible so that the horizontal distance is minimized. This may allow for both customers and clerks to take more natural postures with less stress.

The widths between clerks' desks were so narrow that there was not sufficient space for computer, monitor, telephone, stationary, documents, etc (Figure 1(e)). The width is recommended to be over 1,200.0mm (2,400mm is more desirable) following the ergonomics guideline (Eastman Kodak Company, 1983), but due to restricted space of hospitals, it is almost impossible to give such wide space for clerks. However, more space should be provided as wide as possible.

(a) standing table for customers



(b) seated desk for clerks



(c) desk for clerks

(d) upper limb postures

(e) narrow working space

Figure 1. Reception tables/desks

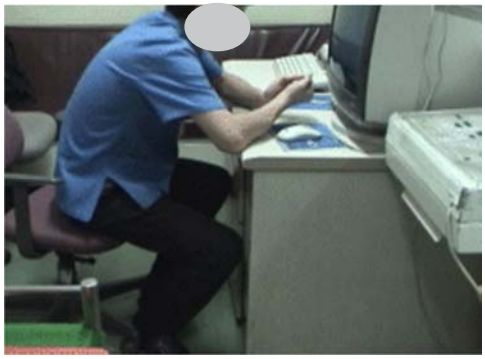
3.2 VDT settings

Although the VDT environment consists of several elements including chair, desk, computer, monitor, etc., this section focuses on desk and monitor. There were several ergonomic problems in VDT settings in three hospitals investigated. Firstly, although the heights of most desks were around 720.0mm recommended in the ergonomics guidelines, those of some desks were higher than 800.0mm (Figure 2(a), (b)). Secondly, although it is recommended that the top of the computer screen should generally be no higher than about eye level (MacLeod, 1999), many computer screens' heights were higher than workers' eye levels. Furthermore, some monitors were placed on small props on desks, which made the monitors much higher. This may inevitably have workers extend their neck during VDT tasks (Figure 2(c)). Thirdly, the leg room were not sufficiently secured in most VDT settings (Figure 2(d), (e)). Fourthly, the notebook computers were often used in some fixed desks, not moving desks. The notebook computers are inherently very ergonomic, because they can be moved so easily and located to fit the user's posture, ranging from on top of a counter when standing, to one's lap when lying in a recliner. However, the notebook computers have some shortcomings: 1) the keyboard is attached to the monitor, thus making it difficult to work with both the neck and arms in their neutral postures simultaneously; and 2) the keyboard is short, which tends to place a sharper bend in the wrist than the bigger desktop versions (MacLeod, 1999). The notebook computers should be replaced with the desktop computers in the fixed desks (Figure 2(b)). Fifthly, the keyboard holders were used in many VDT settings, but their heights were unadjustable. This makes it impossible to adjust their heights to workers' elbow heights for reducing postural load during VDT tasks (Figure 2(f)). Finally, some clerks habitually

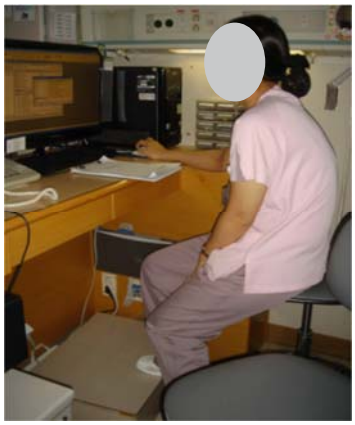
(a) high desk

(b) high chair with foot ring

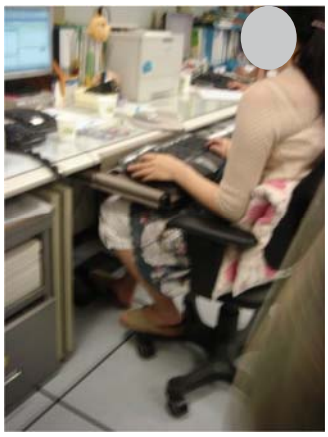
(c) monitor height



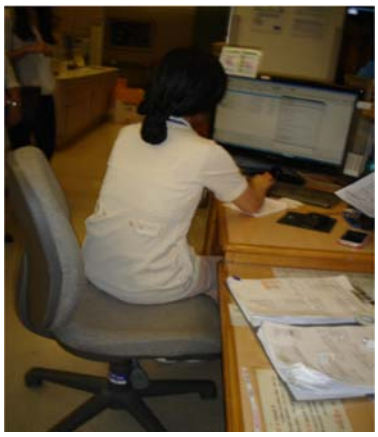
(d) desk clogged with perpendicular foreside



(e) desk with insufficient leg room



(f) eye-screen distance



(g) poor working posture

Figure 2. Ergonomic problems in VDT settings

assumed poor working postures, irrespective of whether or not the VDT workstations were ergonomically designed. In Figure 2(g), a female nurse sits forward on chair without leaning on the chair's backrest, which develops higher postural stress in the low back compared to when sitting back on chair (Kroemer et al., 1994). In conclusion, the problems should be corrected following the ergonomics guidelines stated in the above.

3.3 Leg room and thigh clearance

Seated workers should approach the edge of desks as close as possible in order to take good back and arm postures during VDT tasks. For doing this, sufficient leg room and thigh clearance should be provided under the work desks. As stated before, the leg room should be at least 660.0mm in depth from the edge of desks in front of workers and 500.0mm in width. The thigh clearance

(a) thick drawer

(b) thick keyboard holder

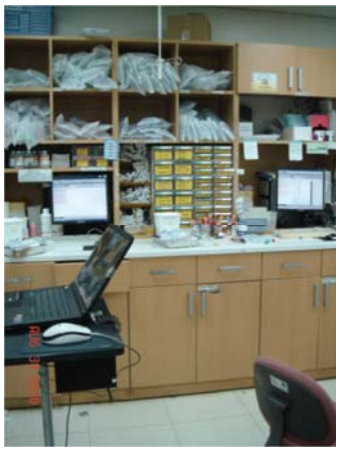
Figure 3. Examples of insufficient thigh clearance

should be at minimum 200.0mm, which is defined by the height between the bottom of desks and the top of seat pans when seated (Niebel and Freivalds, 1999; Pheasant, 1990). However, most seated work environments including VDT settings did not satisfy these ergonomic guidelines of the leg room and thigh clearances (Figure 1(b), (c), (d), Figure 2(d), (e), Figure 3). Insufficient leg room makes clerks assume stressful postures with bending back and sitting on the edge of chair without leaning against chair's backrest, which put high postural load on the lumbar region. Things such as computers, personal belongings, etc. located under desks should be moved to other spaces for sufficient leg rooms. For securing sufficient thigh clearance, the thickness of tables should be less than 50.0mm. In the VDT settings of the hospitals investigated, most tables had thick drawers or keyboard holders below desks, which resulted in the thigh clearance of much less than 200.0mm. Since workers could not come closer to the desks when seated due to insufficient thigh clearance, they had no choice but to sit forward on chairs, which produced stressful postures with elevating or extending arms. Insufficient thigh clearance also causes contact stress on the thigh compressed by the thick drawers, keyboard holders or desks. A clerk in Figure 1(b) used back support in front of the chair's backrest for reducing stress in the lower back. Desks without drawers or with thin drawers or keyboard trays are suitable for office environment. If drawers are needed for storing documents or belongings, moving racks are recommended.

3.4 Knee and foot clearances

Most reception tables for customers (Figure 4(a)) and desks with storage space and shelf (Figure 4(b)) had vertical foresides perpendicular to the floor. This often brings about customers' or workers' discomfort with their knees and toes stubbed against the foresides, when they come closer to the tables. This is attributed to lack of knee and foot clearances. It is recommended that the knee clearance is over 100.0mm in depth from the edge of tables, and that foot clearance is at minimum 130.0mm in depth from the edge of tables and 100.0mm in height from the floor. A good example is illustrated in Figure 4(c). This has sufficient knee and foot clearances as well as attractive good appearance.

(a) reception table



(b) desk with storage space

(c) well-designed table

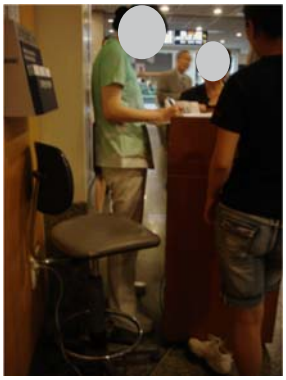
Figure 4. Knee and foot clearances

3.5 Chairs

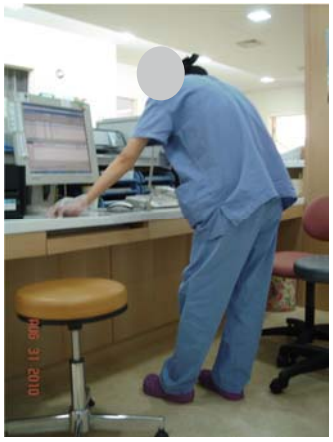
The chairs used in the three hospitals had also some ergonomic problems. Firstly, the depth of chairs often exceeded ergonomic

guidelines of 380.0~430.0mm. For example, some chairs were too deep for clerks, especially women, the depths of which were over 450.0mm. In this situation, some women clerks used back supports for compensating the deeper chairs. Otherwise, clerks sat forward on chairs without leaning against the chair's backrest, which are stressful in the low back (Figure 5(a)). Secondly, some chairs were so high that clerks' feet were in the air or dangling (Figure 1(b), Figure 5(b)). These high chairs were used for high tables, and often had foot rings which forced the clerks to flex their knee (Eastman Kodak Company, 1983). These made the tissues in the back of the knee pressed. The chairs also had risk of fall of clerks. So, it is better not to use these chairs, if possible. In the situations requiring high chairs, the sit-stand stools are recommended rather than the high chairs (Figure 5(d)). Thirdly, the chairs without backrests were used (Figure 5(c)), which induced high stress in the low back compared to those with backrests. Villanueva et al. (1997) found that a backward-leaning trunk decreased the trapezius muscle activity in VDT tasks.

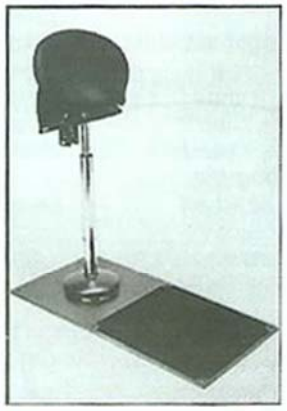
(a) deep chair



(b) high chair



(c) chair without backrest



(d) sit-stand stool

Figure 5. Chairs in hospitals

4. Conclusions

This study investigated office environments of three general hospitals, which focused on reception tables/desks, VDT settings, leg room and thigh clearance, knee and foot clearances and chairs. As stated above, most office environments were not in

accordance with the ergonomic design guidelines found in the relevant literatures. This may be attributed to low recognition of both management and labor for importance of ergonomic design in office environment. Consequently, old office furniture such as desk, chair, etc. which were used before introducing VDT environment have still been used in the hospitals. Desks with thick drawers and/or high or low heights are examples for this. In addition to this poor furniture, recognition for working posture was also so low that some clerks often sat forward on chairs without leaning against the chair's backrest even in ergonomically good VDT settings. Some clerks placed their personal belongings under their desks, which resulted in insufficient leg room and in turn poor back and arm postures. Therefore, it is recommended that the hospital management should provide ergonomically designed furniture. For doing this, all office furniture should be checked in view point of ergonomic design guidelines from purchasing to installation. It should be noted that while the corrections for the problems are needed in all VDT relevant departments, they are more urgent in the departments such as hospital administration, insurance inspection department, etc., where clerks spend most work hours with performing VDT tasks. In addition, the management should repeatedly provide education and training for good working postures in office environment with their clerks so that they take good postures when working. This is proved by Lewis et al.'s study (2001) that the VDT ergonomics training program was effective in changing reported workstation configuration/ posture, which resulted in a reduction of musculoskeletal symptom severity.

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