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Musculoskeletal, visual and psychosocial stress in VDU operators after moving to an ergonomically designed office landscape

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Abstract

This study investigated the effect of moving from single occupancy offices to a landscape environment. Thirty-four Visual Display Unit (VDU) operators reported significantly worsened condition of lighting and glare in addition to increased visual discomfort. For visual discomfort, the difference with 95% confidence interval was 10.7 (1.9–19.5) Visual Analog Scale (VAS) as group mean value.

The most reasonable explanation for these results may be that the operators were glared from high luminance from the windows, when the Venetian blinds were not properly used. Glare was significantly correlated with visual discomfort, $r_s = 0.35$. Both illuminance and luminance in the work area, and contrast reduction on the VDU screen were in line with recommendations from CIE for VDU work. In a regression analysis, the visual discomfort explained 53% of the variance in the neck and shoulder pain. In the office landscape, the eye blink rate during habitual VDU work was recorded for 12 randomly selected operators from the 34 participants. A marked drop in eye blink rate during VDU work was found when this was compared to "easy conversation" (VDU work, mean = 9.7 blinks per minute; "easy conversation," mean = 21.4 blinks per minute).

Participants reported many of the organizational and psychosocial conditions and work factors worse when landscape office was compared to single occupancy office. These factors may have influenced the musculoskeletal pain. However, the pain level was still low at 6 years and not significantly different when compared with the start of the study period, except for a small but significant increase in shoulder pain. In this study, visual discomfort is clearly associated with pain in the neck and shoulder area.

Keywords: VDU workplaces; Lighting conditions; Visual conditions; Visual discomfort; Musculoskeletal illness; Eye blinking

1. Introduction

Both lighting conditions and optometric corrections have been shown to be related to visual discomfort. These factors must, therefore, be optimized to keep the visual discomfort at an acceptable level (Aarås et al., 1998, 2000, 2001; Horgen et al., 2002, 2004). Screen and surface glare have been found to correlate significantly with eye focusing problems and tired eyes (Hedge et al., 1995). Further, visibility may be reduced if objects with high luminance are seen directly, or reflected in the screen (Bjørset, 1986). Sheedy (1995) has documented that corrections of hypermetropia and astigmatic errors reduced the visual discomfort for Visual Display Unit (VDU) workers.

Optometric corrections, if needed, must be given according to work task analysis (Horgen and Aarås, 1993). Optometric corrections may influence both body posture and postural load as shown by Horgen et al. (1989, 1995). When prescribing optometric corrections, the visual distance to the screen for a work posture of 10–15° backward leaning should be considered. This posture is known to give low static muscle load in the neck and shoulder (Harms-Ringdahl et al., 1986; Schüldt et al., 1986). Laboratory studies by Horgen et al. (1989, 1995) have shown that single vision (monofocal) lenses give less muscle load in the neck and shoulder compared with ordinary progressive addition lenses (PALs). This result is supported by Bergquist et al.

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(1995), who found that VDU operators wearing monofocal glasses had lower risk for tension neck syndrome compared with those wearing bifocals or progressive glasses. However, more recent studies of specially designed PALs for VDU work showed no significant differences regarding trapezius and infraspinatus muscle load compared with monofocal lenses (Horgen et al., 1995, 2004; Selenow et al., 2002; Horgen and Aarås, 2003).

Aarås et al. (1998) reported a relationship between visual discomfort and pain in the neck and shoulder for VDU operators. This result supports Bergquist et al. (1992), who documented a positive dose–response association between eye discomfort and VDU use.

Punnet and Bergquist (1997), in their review of epidemiological studies of VDU work, found that VDU work indicated higher risk of neck, shoulder, arm, wrist and hand musculoskeletal illness compared with non-VDU work. Many factors were associated with musculoskeletal discomfort in the neck and shoulder; rapid work pace, stereotyped keyboard work, total time used at the computer and mouse use. Further, stressful work posture, as well as insufficient recovery time in terms of limited opportunity for rest breaks, are important factors. A decrease in variability of the muscle activity was found when comparing VDU work with non-VDU work (Wærsted and Westgaard, 1997). Karlqvist et al. (1996) found an association of neck and upper extremity symptoms with hours per day of mouse use. This is also supported by Aarås et al. (1998) who found a relationship between the pain level in the forearm and the total time using the mouse. Several studies have documented increasing risk of upper extremity symptoms with increasing time at the VDU (Oxenburg, 1987; Karlqvist et al., 1996; Punnet and Bergquist, 1997). It is assumed that the work-related portion of the total occurrence of musculoskeletal disorders, i.e., the part which could be avoided by a proper work environment, contributes to 50–90% for some occupations (Hagberg and Wegman, 1987). Lighting design, ergonomic workplaces and optometric corrections are important elements in the current intervention study.

The study investigates the following questions:

(1) Will a good lighting design, ergonomic workplaces and optometric corrections in the new office landscape, still keep the visual discomfort, headache and musculoskeletal pain at the same level compared with corresponding results from an ergonomically designed one person office.
(2) Further, what is a typical eye blink rate during habitual VDU work in an office landscape?

2. Design of the study

In a previous study (Aarås et al., 2001), three groups performing software engineering were tested on a range of measures of visual discomfort in 1999. In 2004, 34 male VDU workers from these three groups were still working in the company. Since there were no significant differences concerning the outcome parameters between the groups studied in 1999 (Aarås et al., 2001), the three groups were collapsed into one study group. The mean age of the subjects was 53.2 years SD 5.7 (range 43–62 years). In March 2004, Alcatel Norway moved from ergonomically designed single occupancy offices to new offices arranged as an office landscape (Table 1). New luminaries and ergonomic workplaces were already installed when the workers moved in. In September 2004, all subjects underwent an optometric examination and corrections were given if needed. Six months later, a questionnaire was administered (Table 1). For 12 randomly selected workers among the 34 participants, the eye blink rate was recorded using a digital video camera, and postural load on the musculoskeletal system was assessed by electromyographic recordings (EMG) from muscle trapezius and muscle infraspinatus. Movements of the head, upper arm and back were recorded using inclinometers (Hagen, 1994). Participants worked at their personal workstations for approximately 30 min while EMG and inclinometer measurements were taken. During this time, participants' eyes were videotaped to record eye blink rate. During these recordings, which took place in February/March 2005, the mean indoor temperature and air humidity was 21.6 °C (range 18.5–23 °C) and 25% (range 21–33%), respectively. The study was performed in concordance with the Declaration of Helsinki.

3. Methods and procedures

Questionnaires which dealt with headache, visual conditions and discomfort as well as musculoskeletal pain, all

Table 1
Time span of the project

Intervention/activity	April 1999[a]	March 2004	September/October 2004	February/March 2005
Lighting intervention		X		
Ergonomic intervention		X		
Optometric intervention			X	
Eye blinks and EMG measurements				X
Questionnaires	X			X

[a]Used as basline.