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Effectiveness of an ergonomic intervention on work-related posture and low back pain in video display terminal operators: A 3 year cross-over trial☆,☆☆

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ABSTRACT

This study investigated the effectiveness of a workstation ergonomic intervention for work-related posture and low back pain (LBP) in Video Display Terminal (VDT) workers. 100 VDT workers were selected to receive the ergonomic intervention, whereas 100 were assigned to a control group. The two groups were then crossed-over after 30 months from baseline. Follow-ups were repeated at 5, 12, and 30 months from baseline and then at 6 months following crossover. Outcomes: Work-related posture and LBP point-prevalence using the Rapid Entire Body Assessment method and a Pain Drawing, respectively. The ergonomic intervention at the workstation improved work-related posture and was effective in reducing LBP point-prevalence both in the first study period and after crossover, and these effects persisted for at least 30 months. In conclusion, our findings contribute to the evidence that individualized ergonomic interventions may be able to improve work-related posture and reduce LBP for VDT workers.

1. Introduction

A review of the available literature confirms the association between computer use and musculoskeletal disorders (IJmker et al., 2007). Video Display Terminal (VDT) workers are particularly susceptible to the development of musculoskeletal symptoms, with prevalence as high as 50% (Gerr and Marcus, 2001). A survey conducted on 1428 subjects using a self-reported questionnaire showed the following 12-month prevalence rates: head/neck (42%), low back (34%), upper back (28%), wrists/hands (20%), shoulders (16%), ankles/feet (13%), knees (12%), hips (6%) and elbows (5%) (Janwantanakul et al., 2008). In a recent study on 2431 white-collar workers, the six-month incidence of musculoskeletal symptoms, assessed using a modified version of the Nordic questionnaire, was 18% for the shoulder-neck region, 14.8% for the lower back region, and 21.7% for the upper limb region (Lapointe et al., 2009).

Although these studies show high rates of LBP among office workers, the association between LBP and sitting posture in the occupational setting has been infrequently studied. Available evidence about the association between prolonged sitting and an increased risk for LBP (Fogleman and Lewis, 2002; Nakazawa et al., 2002; Hartvigsen et al., 2000; Lis et al., 2007; Mork and Westgaard, 2009) is contradictory. Moreover, definitive evidence has been difficult to establish by epidemiological methods as both seated posture and LBP are prevalent in the general population. Thus, while an elevated risk of LBP associated with prolonged sitting does not necessarily imply a higher prevalence in VDT workers as compared to other occupational groups, the hypothesis that prolonged sitting is associated with a higher risk for LBP in comparison to workplace conditions that allow more postural variation cannot be excluded (Mork and Westgaard, 2009).

Although the etiology of LBP is complex and multifactorial, an incorrect sitting posture could play a relevant role in determining both an increase of stress within the disc (Nachemson, 1975; Wilke et al., 1999), and a sustained stretch of passive lumbar structures in combination with poor back muscle activity (Mork and Westgaard, 2009). Chair design and the use of backrest and arm support vary by workplace and individual preferences and may influence the level of back strain (Leivseth and Drerup, 1997). Several studies have shown that that two major occupational risk factors for LBP

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symptoms are static muscle load (Bernard, 1997; Hedman and Fernie, 1997) and flexed curvature of the lumbar spine, both of which are involved in seated work tasks (Wilder et al., 1988; Chaffin and Andersson, 1990; Bernard, 1997). Biomechanical studies have shown that an incorrect sitting posture can affect a posterior rotation of the pelvis, resulting in decreased sacral inclination and lumbar lordosis (Andersson et al., 1979; Lord et al., 1997) and increased forces at the discs (Lord et al., 1997; Andersson and Ortengren, 1974). For these reasons, lumbar supports have been proposed as a possible option in therapeutic and preventive strategies for LBP. However, the literature to date provides conflicting evidence on the effectiveness of lumbar supports for primary and secondary prevention of LBP. The first reviews published on this subject concluded that there was no evidence on the effectiveness of primary prevention of LBP in the workplace (Van Tulder et al., 2000; van Poppel et al., 2004). van Duijvenbode et al. (2008), in their review, concluded that there is moderate evidence that lumbar supports are not more effective than either no intervention at all or training in preventing low back pain and that there is conflicting evidence whether they are effective supplements to other preventive interventions. However, more recent studies and reviews are lending support toward belief in their efficacy (Roelofs et al., 2007; Calmels et al., 2009). One persistent methodological issue in many studies that may have contributed to a lack of consensus on the basis of the available evidence is that the terminology employed in the literature is inconsistent, with the term "lumbar support" often used interchangeably with "lumbar belt", thus decreasing the interpretability of results across studies.

It has been reported that the use of a lumbar support increasing lumbar lordosis can reduce LBP (Williams et al., 1991), and that chair backrests also help increase lumbar lordosis and decrease intradiscal pressure (Andersson and Ortengren, 1974; Andersson et al., 1979). Makhsous et al. (2003) provided evidence that a sitting posture with a reduced ischial support enhanced lumbar support, and a backrest-seat pan angle set at 100°, obtained with an instrumented laboratory chair, reduced sitting load on the lumbar spine and decreased lumbar muscle activity, which may in turn potentially reduce sitting-related LBP. Among the postural aspects of VDT work, the forearm position has also been identified as an element potentially affecting LBP. In particular, supporting the forearm could decrease the perceived tension in the low back (Leivseth and Drerup, 1997; Dumas et al., 2008). Moreover, it is recognized that potential risk factors for LBP other than prolonged sitting may exist for these workers, such as work stress and psychosocial factors (Hoogendoorn et al., 2000; Hartvigsen et al., 2004).

Although there is a growing interest among employers to improve the office workplace, few longitudinal field studies have examined the effects of office ergonomic interventions on worker's health (Gerr et al., 1996; Karsh et al., 2001; Brewer et al., 2006). There is some evidence that ergonomic adjustment of the workstation can prevent or reduce musculoskeletal discomfort in office environments (Amick et al., 2003; Aarås et al., 2001; Nelson and Silverstein, 1998; Sauter et al., 1990). However, other studies found no significant improvements in musculoskeletal symptoms after workstation and postural interventions (Gerr et al., 2005; Cook and Burgess-Limerick, 2004). The literature concerning office ergonomic interventions is heterogeneous as to the interventions tested, the study designs employed, the outcomes measured and, consequently, the results obtained. Moreover, in a number of published studies, multiple interventions (e.g. workstation adjustment combined with training in ergonomics, instructing in physical exercises, and improving in the lighting conditions) were implemented simultaneously, thus making the effect of specific components difficult to assess (Aarås et al., 2001; Gatty, 2004; Robertson and O'Neill, 2003; Robertson et al., 2008, 2009). In the review conducted by Punnett and Berqvist (1997), the data on eight of the nine interventions evaluated suggested that a decrease in musculoskeletal illness could be achieved by ergonomic intervention programs. In contrast, a large review on workplace interventions to prevent musculoskeletal disorders among computer users critically analyzed 31 studies and concluded that office-based ergonomic interventions had a negative or deleterious effect on musculoskeletal health (Brewer et al., 2006). Verhagen et al. (2006) similarly concluded that there is conflicting evidence about the effectiveness of ergonomic programs for treating work-related complaints. To our knowledge, no studies exist about ergonomic interventions in the workplace aimed at primary and secondary prevention of LBP symptoms among VDT workers. In order to address this gap in the literature, the purpose of this study was to evaluate the effectiveness of a personalized ergonomic intervention provided in the workplace to VDT workers by a physical therapist to alter work-related posture and influence the point-prevalence of symptoms associated with LBP.

2. Methods

2.1. Study design

The present research reports on the continuation of a previous study (Pillastrini et al., 2007) beyond the original 5 month follow-up using a crossover design and follow-up at 12, 30 and 36 months. Although we had initially planned to carry out a simple comparative experiment (Pillastrini et al., 2007), the apparent success of the intervention prompted us to investigate whether the results were reproducible and persistent over time. This study, with a duration of 36 months, employed a *single-blind, non-randomized, crossover design*. A flow diagram of the study design is shown in Fig. 1.

2.2. Participants

The study population was composed of 200 subjects chosen from a group of 400 administrative employees of the town hall of Forlì (Italy), working in two separate buildings, and using VDTs for at least 20 h a week. In order to avoid possible contaminations between buildings, we randomly selected one building (Building 1) as the group to receive the experimental intervention, while another group (located in Building 2) served as control. We then selected 100 workers from Building 1 to form Group 1, and 100 workers from Building 2 to form Group 2. The randomization process (without replacement) was performed by drawing numbered cards, each associated with a single potential participant. In the first stage of the study, the ergonomic intervention was carried out on Group 1, while Group 2 served as the comparison. After the third follow-up, the two groups were crossed-over (i.e., Group 2 received the intervention) (Fig. 1). The working environment of both groups of workers did not differ and complied with the pertinent Italian legislation regarding furniture, temperature, lighting, office width, humidity and noise (Guidelines for VDT Use. Decree issued by the Ministry of Labour and Social Policies in concert with the Ministry of Health). Subjects were excluded if they were pregnant or had a medical history of serious injury, spinal surgery, malignant pathology or severe disability. The study was approved by the Ethics Committee of the Area Vasta Romagna and written informed consent was obtained from all participants.

2.3. Procedure

Following written informed consent, demographic characteristics and work-related personal data (work experience, number and