



Posture and muscle activity of pregnant women during computer work and effect of an ergonomic desk board attachment

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ABSTRACT

The aims of this study were (a) to compare posture and muscle activity in the back and upper extremity of women in late pregnancy and non-pregnant controls, (b) to evaluate the effect of a concave “desk board” on the back and upper extremity of women in late pregnancy.

All participants completed a standard 20-min computer task under two conditions: (1) using a standard desk and (2) using a desk attachment board designed to support the forearms. Bilateral electromyography of the trapezius, multifidus and longissimus muscles and the right anterior deltoid and extensor digitorum muscles was recorded. Three-dimensional (3D) trunk and upper extremity posture was monitored. The participants, 12 pregnant and 18 non-pregnant women, were tested before and after 2 weeks of familiarization with the board in their workplace. Perceived discomfort was recorded before and after use of the board.

Results showed that pregnant women sat with a more upright posture than non-pregnant controls but the posture of their right arm was not different though the activity of the anterior deltoid muscle was higher. The pregnant women also reported more discomfort in the lower back and pelvis area. The desk attachment board increased muscle activity in the right trapezius and extensor digitorum, and decreased muscle activity in some back muscles. The desk attachment board may be a useful tool in reducing discomfort in the low back during computer work, but may have adverse effects on the upper extremities.

Relevance to industry: Many pregnant women perform computer work as their main duty or as re-assignment from heavier physical work. Increased joint loads put them at risk of musculo-skeletal disorders, particularly back pain. An attachment board providing arm support has a potential positive effect for the lower back, but it may have an adverse effect on upper extremities. Interventions using a similar device should carefully monitor both the back and upper extremities.

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1. Introduction

Many jobs now involve sitting at a computer for several hours, particularly in clerical and administrative occupations, occupations typically held by women and in which a large number of women are employed. In addition, data entry and other computer-based jobs are common work re-assignments for pregnant women whose normal responsibilities involve heavy manual work or other job-based risk factors. Computer work is not exempt from the risk of

developing musculo-skeletal disorders (MSDs). In a survey of 72 pregnant women, Cheng et al. (2006) found that sitting was the most frequent problematic task at work because of factors such as getting tired, uncomfortable posture and excessive time in the same posture. This confirmed the results of a previous study (Dumas et al., 1995) where “sitting for long” came first with “standing for long” in a list of 28 functional limitations in relation to back pain. The score decreased substantially when the same participants were surveyed post-partum. Other authors (Hartvigsen et al., 2000) suggested that the occurrence of low-back pain (LBP) while sitting may be dependant on the specific task performed rather than due to sitting itself. Nicholls and Grieve (1992) found that pregnant women tended to lean forward to reach with

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a trunk angle of 10° when sitting at a desk due to the increased volume of the abdomen. This posture may cause pressure on the abdomen, and higher activity in the back extensor muscles and in the shoulder and arm muscles, which could lead to musculo-skeletal problems (Morrissey, 1998). These findings were confirmed by Lee et al. (1999) in a study comparing posture of five pregnant women and five non-pregnant controls. They analyzed the last 10 min of a 50-min sitting session, and found postural differences between pregnant participants and controls. Pregnant participants tended to hold the upper arm further away from the body, to lean forward more and to have more hip extension than controls. In a qualitative video study, Hirao and Kajiyama (1994) also mentioned that it might be difficult for a pregnant woman to maintain an appropriate visual distance from the screen without leaning forward, a posture that should be avoided because it compresses the abdomen. In contrast, Giljeard et al. (2002) found no significant difference between posture during pregnancy and post-partum in nine participants. However, the participants were only sitting for a short period on a stool, not in a functional situation.

Low-back disorders are not the only reported work-related MSDs associated with computer work. More than 50% of workers who use a computer for more than 15 h/week reported musculo-skeletal symptoms in the neck or upper extremities during the first year on a new job (Gerr et al., 2002). Muscle pain in the neck/shoulder area and the upper extremities is common among computer workers, especially women (Oberg and Astrom, 2000). In fact, it has been reported that women were more likely to experience MSDs than were men (Gerr et al., 2002). In computer work, neck and shoulder muscles must be activated in order to stabilize the upper extremity segments to enable controlled typing and mouse use. If there is no mechanical support for the forearms, many upper extremity muscles must contract to support the weight of the forearms (Takala, 2002). It appears therefore important to reduce muscle activity during computer work. Moreover, for pregnant women this is particularly important, as they have to adapt quickly to continuously changing physical constraints that can increase their level of fatigue during computer work.

Biomechanical load can be reduced by ergonomic change of the workstation. One way is to introduce forearm support when using both keyboard and mouse (Feng et al., 1997; Nevala-Puranen et al., 2003; Visser et al., 2000; Wells et al., 1997; Fernandez et al., 1999). Results from measurements over several years both in laboratory and field studies showed that supporting the forearm on the table top had positive health effects in terms of reduced shoulder and back pain (Aaras et al., 1997, 1998, 2001). Forearm support appears therefore an appropriate ergonomic intervention to reduce the shoulder load. However, the design of the support may be critical. In a recent study (Tepper et al., 2003), use of an inclined forearm support showed no significant effects on trapezius muscle activity. The explanation proposed by the authors for their unexpected results was that the angle of the support forced the arm into a less ergonomic posture with an elbow angle below 90°. Similarly, Delisle et al. (2006) found conflicting results in evaluating three workstations, all providing forearm support. While EMG amplitude of the trapezius and deltoid muscles seemed little affected by the type of workstation, EMG variability was larger when using a workstation that provided forearm support on a height-adjustable work surface (A). This was interpreted as a positive effect, but, for the same workstation (A), EMG amplitude for the extensor digitorum muscle was found to be higher. Aaras et al. (1998, 2001) performed a workplace intervention in which new tables and chairs were installed. The new tabletop had a concave shape in the corner to better accommodate the workers' trunk and to provide support for the forearms. The concave shape is interesting because it gives

the worker the option of supporting the forearms without being too far from the keyboard and the monitor. The authors found a reduction in back pain after the intervention. Another author (Karlqvist, 1998) tested four models of worktables suitable for VDU work (A–D). Interestingly, the models (C and D) that provided arm support resulted in the lowest activity in the trapezius muscle. Moreover, the “D” model had a square shape as opposed to a concave shape, and enabled the worker to get closer to the computer task. Furthermore, the “D” model had an adjustable table slope, which was appreciated by most participants. In summary, providing forearm support on the work surface seems to have a positive effect for the shoulder muscles and may also reduce back pain during computer work.

In the case of pregnant women, working at a computer workstation for long periods of time may be particularly problematic both for the back (flexed posture to reach past their larger abdomen) and the shoulders and upper extremities if they are not supported. A concave shape of the work surface, in addition to providing support for the forearms, could be more appropriate for a pregnant woman who may have difficulties moving close to the workstation because of her physical constraints. A newly designed desktop, the Workplace™ board (Life With Ease), formerly known as the Butterfly board (Metamorphosis Design and Development Inc.), looked particularly promising for this population, as it provides forearm support and its concave shape is meant to allow the worker to get close to the work surface and to promote the use of the chair backrest. It also has a small forward slope and had not yet been evaluated. Therefore the objective of this study was to evaluate the effect of improving a conventional desk by adding a concave “desk board” designed to provide arm support during computer work on the back and upper extremity of women in late pregnancy. A control group of non-pregnant women was included for comparison. Posture and muscle activity in the back and upper extremity were monitored for the two groups.

2. Methods

2.1. Study design

The study had a mixed design with two groups; a group of participants in late pregnancy and a group of matched non-pregnant controls (group effect). The study evaluated the effect of two different desk setups, workplace or standard (desk effect) on muscle activity of eight selected upper extremity and back muscles and on arm and trunk angles during a standardized computer task. The participants were tested twice at a 2-week interval to evaluate the effect of familiarization with the board (visit effect). At each visit, all subjects were tested on both desks but in different testing orders. A counterbalancing design was used to assign the desk order that each subject would experience. Since the desk order remained the same on both visits, subjects could only be assigned to one of two conditions, therefore a counterbalancing design seemed the most appropriate. Despite strong efforts to recruit a large group of women with equal sample sizes, at the time of completion, the study was short six pregnant women to even out with the control women. However, considering the small difference in sample size and variability between the groups, no special measures were undertaken in the statistical analysis.

2.2. Participants

The pregnant group consisted of 12 women in their 32nd week of pregnancy (± 2 weeks) employed in jobs involving work at a VDU for at least 15 h/week. A control group of 18 non-pregnant women was used for comparison (Table 1). Controls were also employed in

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