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The effect of forearm support on children's head, neck and upper limb posture and muscle activity during computer use

Leon Straker [a,*], Robin Burgess-Limerick [b], Clare Pollock [c], Barbara Maslen [a]

[a] School of Physiotherapy, Curtin University of Technology, GPO Box U1987, Perth, WA 6845, Australia
[b] School of Human Movement Studies, University of Queensland, Brisbane, Australia
[c] School of Psychology, Curtin University of Technology, Perth, Australia

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Abstract

Use of computers by children has increased rapidly, however few studies have addressed factors which may reduce musculoskeletal stress during computer use by children. This study quantified the postural and muscle activity effects of providing forearm support when children used computers. Twelve male and 12 female children (10–12 years) who regularly used computers were recruited. Activities were completed using a computer with two workstation configurations, one of which provided for forearm support on the desk surface. 3D posture was analysed using an infra-red motion analysis system. Surface EMG was collected from five muscle groups in the neck/shoulder region and right upper limb. Providing a support surface resulted in more elevated and flexed upper limbs. The use of forearm or wrist support was associated with reduced muscle activity for most muscle groups. Muscle activity reductions with support were of sufficient magnitude to be clinically meaningful. The provision of a supporting surface for the arm is therefore likely to be useful for reducing musculoskeletal stresses associated with computing tasks for children.

Keywords: Musculoskeletal disorder; Children; Computer use

1. Introduction

The majority of children in affluent countries now use computers both at school and at home. Data from the Australian Bureau of Statistics (2003) illustrate that in 2002, 94% of children aged between 5 and 14 years used a computer at school, with 84% of these children having access to a home computer. Statistics are similar for many other countries. In 2004 in the USA, 86% of homes with children aged between 8 and 18 years had a computer (Roberts et al., 2005) and 98% of 5–18 year old from the UK used a computer at home and/or school in 2002 (Babb et al., 2003). The duration of computer use by children is also increasing. For example, census data indicate that from 2000 to 2002 Hong Kong children aged between 6 and 12 years more than doubled the time spent on a computer each week, with an increase from 3.5 to 8.3 h (Education and Manpower Bureau, 2003).

With such an exposure of children to computer technology, and given the association between postural factors, workstation set-up and musculoskeletal disorders in adult computer users (Marcus et al., 2002) it is appropriate to evaluate the available ergonomic guidelines for children's computer use. Unfortunately, few such guidelines exist, and those that are available tend not to be evidence-based or up to date with newer advancements in information technology (Straker et al., 2006a).

One factor which has been shown to reduce musculoskeletal loading for adults is the presence of a supporting surface for the forearms or wrists, in the form of either an area on the desk, or chair-based arm rests (Straker et al., 2008). Reductions in muscle activity with the presence of

* Corresponding author. Tel.: +61 8 9266 3634; fax: +61 8 9266 3699.
E-mail address: L.Straker@curtin.edu.au (L. Straker).

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a supporting surface have been reported by several authors (Aaras et al., 1997; Cook et al., 2004b; Karlqvist et al., 1999). Further evidence for the benefits of forearm support can be inferred from studies of the prevalence of musculoskeletal discomfort and disorders. In a one year field study of 182 call centre operators, the use of an arm board decreased the incidence of neck/shoulder and upper extremity pain, and reduced by 50% the risk of incident neck–shoulder disorders (Rempel et al., 2006). Similarly, a prospective study of 632 newly employed computer users identified a lower risk of neck and shoulder disorders for those operators who had arm rests on their chairs (Marcus et al., 2002), although the effect was not significant after adjusting for covariates. Cook and Burgess-Limerick (2004a) also described fewer reports of discomfort when forearm support was provided to call centre intensive computer users in a randomized and controlled trial. Whilst the evidence for the efficacy of support during computing tasks is fairly convincing, it is complicated by the particular task and workstation design. Cook et al. (2004b) reported muscle loading benefits from wrist but not forearm support, whilst Straker et al. (2008) found that a curved desk designed to provide support actually resulted in increases in muscle activity.

In summary, the use of forearm support during computing tasks by adults has generally shown positive benefits to the musculoskeletal system, however the issue is complicated by the particular task (mousing, keying and reading) and the type of support (wrist support, forearms on the desk surface or resting on chair arms). A further complication is the 'compliance' with the studied conditions, as it appears that computer users may intuitively seek some form of postural support approximately 40–80% of the time (Grandjean et al., 1983; Straker et al., 2008).

Few studies have evaluated the effects of workstation set-up on posture and muscle activity for children's computing tasks, and no research papers could be found which directly addressed the effects of forearm support for this population. Straker et al. (2002) compared posture and muscle activity obtained at a typical computer workstation to values recorded when the chair and desk height were adjusted to suit the individual child. The adjusted workstation resulted in postures which were closer to 'resting' alignment. Muscle activity results were not definitive – there was a trend towards a reduction in right UT activity and higher CES activity with the adjusted workstation. For the youngest children, adjustment of the work surface to sitting elbow height required that the desk surface be lowered an average of 33.9 cm and this was expected to substantially reduce the required contribution of UT. Whilst there was a trend towards this pattern the results were not statistically significant. The use of forearm support was postulated to be a mitigating factor, although support was not directly addressed in that study.

Other studies of computer workstations for children have generally evaluated workstation set-up in schools. Oates et al. (1998) used the rapid upper limb assessment (RULA) method to evaluate the posture of children in the USA using their usual school computer workstation. This assessment placed all 95 children in either the 'unacceptable' or 'at risk of injury' classifications. Typically the workstation surface and keyboard were too high, the display was too high and/or the chair height was inappropriate. An intervention study by Laeser et al. (1998) showed some improvement in RULA scores when a workstation with a tilt down keyboard system and some adjustability to individual anthropometry was used, however, the scores with the adjusted system were still considered to be outside the optimal range. The adjustability of workstations to suit individuals was also found to be poor in Canadian and Australian schools by Zandvliet and Straker (2001). This lack of optimal workstation set-up and adjustability can be expected to hinder the ability to utilize strategies such as forearm support to reduce musculoskeletal loading and discomfort.

The relationship between reports of discomfort related to computer use and people presenting for treatment at clinics is not well known. Adult computer-related discomfort is known to be most common in the neck and shoulder (45%) followed by the back (32%) and forearm/hand regions (30%) (Karlqvist et al., 2002) and this correlates well with diagnosed musculoskeletal disorders (Marcus et al., 2002). Szeto et al. (2005) have shown differences in muscle activity patterns between adult computer users with symptoms and those without symptoms. Juul-Kristensen et al. (2004) determined that episodes of pain related to computing tasks increased the probability of later pain development, suggesting that the prevention of discomfort during computing is of considerable importance. However there are no reports of posture and muscle activity comparisons between symptomatic and asymptomatic children. The epidemiological studies of computer-related discomfort in children (Harris and Straker, 2000; Jacobs and Baker, 2002; Royster and Yearout, 1999; Sommerich et al., 2007) have not evaluated the health service impact of the discomforts.

From the available research it is clear that computer-related discomfort is experienced by a significant number of children, and that evidence on optimal workstation design for children lags behind evidence for adult workstations. Given the rapid and extensive growth in the duration and prevalence of computer use for even very young children (Straker et al., 2006b), postural considerations and loading during computer use by children need to be rigorously assessed, and guidelines constructed to ensure a minimum of discomfort and disorder during these critical growth years. The aim of this study was to quantify the postural and muscle activity effects of providing forearm support when children use computers at a desktop set-up.