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Longitudinal Study of the Effects of an Adjustable Ergonomic Keyboard on Upper-body Musculoskeletal Symptoms

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LONGITUDINAL STUDY OF THE EFFECTS OF AN ADJUSTABLE ERGONOMIC KEYBOARD ON UPPER BODY MUSCULOSKELETAL SYMPTOMS

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A longitudinal study assessed the differential impact of standard and adjustable ergonomic keyboards on musculoskeletal symptoms among 71 computer users over a six month period. A total of 73 subjects participated; 34 subjects used a standard, flat keyboard and 37 used an adjustable, ergonomic keyboard. Subjects completed weekly surveys of perceived keyboard comfort, and body discomfort, along with other items. The ergonomic keyboard was rated favorably and for users there were significantly improvements of neck, shoulder and arm comfort.

Introduction

Issues associated with the health benefits of ergonomic keyboards have received increasing attention in the ergonomics research literature in recent years. Some investigators (e.g., Stevens et al., 2001) have argued that no evidence exists to support the notion that keyboarding is an etiological factor in the onset of severe upper body work related musculoskeletal disorders (WMSD's) such as carpal tunnel syndrome. Others (e.g., Marklin et al., 1999; Tittiranonda et al., 1999) argue that the design of conventional keyboards may indeed play a significant causal role in some upper body musculoskeletal disorders (MSDs). These investigators consider the potential underlying causal factors to be related to prolonged postural deviations in the hands, wrists, arms, and shoulders required by traditional keyboard designs in combination with the repetitive typist and data entry personnel.

Various ergonomic computer keyboards have been designed in an attempt to rectify these deviated postures and, by extension, thereby provide relief from MSD symptoms. These keyboards commonly share two major design features:

1) a "splayed" layout in which the keypad is roughly in half, each section set at angle to the other to minimize the ulnar deviation associated with conventional keyboard designs, and

2) a "tented" layout in which the two sections meet at a central peak, whose purpose is to alleviate excessive pronation of the hands and wrists required by conventional "flat" keyboards.

In addition, two classes of ergonomic keyboards exist:

1) "Fixed" designs, in which the splay and tenting parameters are permanent and unchangeable, and

2) "adjustable" designs in which splay and tenting values can be modified to suit the individual needs or preferences of the user.

The purpose of the current study was to examine the impact on user comfort and well-being of conventional, flat keyboards versus an adjustable ergonomic keyboard over an extended period of time (six months). The intent was to gather data to assess the effectiveness of this style of ergonomic keyboard in the alleviation of symptoms associated with upper body MSDs to provide guidance for individual and organizations considering the implementation of these devices in the workplace.

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METHOD

Study Setting

The study was conducted in a large, urban office setting in which subjects performed a variety of typing and data entry tasks as a regular feature of their jobs.

Subjects

An initial sample of 80 subjects was selected. All were full-time computer workers in a major insurance company. Complete data was obtained on 73 subjects: 37 subjects who used an ergonomic keyboard and 34 subjects who continued to use a standard keyboard.

Study Design

An initial demographic and wellness survey was conducted and results were used to stratify two groups, each consisting of 40 subjects, based on their age, gender and initial MSD reports. After stratification subjects were randomly assigned to either an "ergonomic keyboard" test condition (EK) or a "standard keyboard" control condition (SK).

Apparatus

Subjects in the test condition were provided with an adjustable ergonomic keyboard (Goldtouch™). Subjects in the standard condition used their existing keyboard, which in all cases was a conventional (i.e., non-ergonomic), flat keyboard. A self-report questionnaire survey designed to measure MSDs with repeated administration was constructed. This survey consisted of items intended to assess the approximate number of hours each participant had spent using a keyboard (typing or entering data) during the prior week, frequency and duration of rest breaks, the perceived comfort of their keyboard, the perceived impact of their keyboard on productivity, and perceived level of comfort or discomfort experienced in the neck, shoulder, upper arms, elbows, forearms, wrists, hands, and fingers.

Keyboard comfort rating were assessed using a six-point scale (1=very uncomfortable, 2=fairly uncomfortable, 3= slightly uncomfortable, 4=slightly comfortable, 5=fairly comfortable, 6=very comfortable). Body discomfort ratings were assessed using a seven-point scale (1=great discomfort, 2=moderate discomfort, 3= slight discomfort, 4=neutral, 5=slight comfort, 6=moderate comfort, 7=great comfort).

Procedure

All subjects initially completed a baseline survey to gauge their typing experience and their MSD symptoms. This data was used for group assignment (see above). Subject in the ergonomic condition were given instructions on how to adjust their ergonomic keyboard's splay and tenting settings, and were provided with guidance on how to determine an initial keyboard configuration.

Subjects in both groups received instruction and guidance on how to set up features of their office, such as chair and desk surface height, etc. to optimize ergonomic benefit. This was done to attempt to isolate, as closely as possible, the impact of keyboard design on changes in upper body comfort and discomfort over the ensuing six months.

Over the course of the six months of the study, all subjects were asked to complete a weekly "keyboard evaluation survey." Subjects in the ergonomic keyboard condition were asked to indicate whether or not they had made any changes in the splay and/or tenting settings and if so to record the new settings. All subjects completed the survey once a week at a consistent, predetermined time.

Data Analysis

All survey data was entered into a computer and analyzed using multivariate statistical software (SPSSII).

RESULTS

Of the original sample of 80, only those 73 subjects who completed at least 3 questionnaires were retained (34 subjects from the standard keyboard condition and37 from the ergonomic keyboard condition). A total of 1,442 questionnaires were analyzed.

The results indicated that subjects in this study were, on average, heavy keyboard users (median weekly keyboard use=30 hours). A substantial percentage of subjects indicated moderate or great discomfort in most of the body parts assessed over the course of the six months (e.g., 50.0% reported lower back pain, 43.3% reported neck pain, 40.0% reported shoulder, forearm, or wrist pain, etc.). These results suggest that this sample is representative of worker populations who make heavy use of keyboards and who experience relatively high levels of upper body pain discomfort.

For the standard keyboard there was no significant change in comfort ratings over the course of the study. However, there was a marginally significant improvement in comfort ratings for the ergonomic keyboard. By the seventh week although the magnitude of the difference in ratings was small, the ergonomic keyboard was consistently rated higher than the conventional keyboard.

Post hoc interviews with subjects in the ergonomic keyboard condition indicated that initial unfamiliarity with the ergonomic aspects of the device (i.e., the novelty of the splay and tenting settings) caused them to experience it as less comfortable than their more customary standard keyboard. However, over the course of the first 4-6 weeks most subjects in the test condition began to perceive the adjustable keyboard as being more comfortable than the standard keyboard they had used prior to the study.

Table 1. Effects of the keyboards on mean discomfort ratings by body region (1=great discomfort, 7=great comfort)

		EK				SK		
Body region	**Baseline**	**Week24**	**Z**	**P**	**Baseline**	**Week24**	**Z**	**P**
Neck	3.2	3.9	-2.514	0.012	3.5	3.9		ns
Upper back	3.6	4.1		ns	4	4.1		ns

Lower back	3.4	4.1	-2.543	0.011	3.5	4	-1.726	0.083
Shoulder (left)	3.8	4.5	-2.624	0.009	4.1	4.2		ns
Shoulder (right)	3.5	4.2	-2.383	0.017	4.1	4.2		ns
Upper arm (left)	4.1	4.5		ns	4.5	4.3		ns
Upper arm (right)	3.8	4.4		Ns	4.3	4.3		ns
Forearm (left)	3.9	4.4	-2.034	0.042	4.1	4.4		ns
Forearm (right)	3.9	4.4	-1.65	0.099	4	4.3		ns
Elbow (left)	4.1	4.3		Ns	4.5	4.4		ns
Elbow (right)	4.1	4.4	-1.702	0.089	4.5	4.3		ns
Wrist (left)	3.6	4.2	-2.011	0.044	4	4.2		ns
Wrist (right)	3.6	4		Ns	3.6	3.8		ns
Hand (left)	3.7	4.2	-1.902	0.057	4	4.2		ns
Hand (right)	3.7	4.3	-2.727	0.006	3.9	4.2		ns
Fingers(left)	4	4.2		Ns	4.2	4.3		ns
Fingers (right)	4	4.1		Ns	3.9	4.2		ns

Table 1 shows results from tests (Wilcixon Matched Pairs Rank Sum test) comparing baseline ratings with those after six months. The ergonomic keyboard resulted in statistically significant improvements in comfort level for the neck, lower back, left and tight shoulders, left forearm and right hand. There were marginally significant differences in comfort ratings for the right forearm, right elbow and left hand. Comparable changes were not seen for the conventional keyboard across the six months of the study. However, at the end of the six months there were no significant differences between comfort ratings for the ergonomic and standard keyboards for any other body parts assessed in this study.

DISCUSSION

This study shows that a differential impact of ergonomic and standard keyboards on MSD symptoms may only emerge after an extended period of use. The results indicate that compared to baseline conditions, where all workers were using a standard keyboard, the use of an adjustable ergonomic keyboard resulted in some significant improvements postural comfort for the neck, shoulders, upper back, lower back, lower arms and hands. At the end of six months of use, all users in both groups were rating their comfort levels about the same.

Post hoc interviews with subjects indicated that the ergonomic keyboard was enthusiastically accepted by over 80% of subjects who used it, although several indicated that they might prefer to go back to using the traditional standard keyboard. Of the 37 subjects in the ergonomic keyboard condition, all but one was continuing to use it six months after the completion of the study.

Findings from this study show the importance of monitoring the effects of an ergonomic intervention over long time periods. The results generally agree with those reported by

Tittiranonda et al. (1999) who showed that a fixed-angle split keyboard produced improvements in hand function and pain severity over a 6 month period. In their study, however, there was no comparable change in comfort ratings for those users who were given a completely adjustable ergonomic keyboard of different design to that tested in the present study. This suggests that any benefits that accrue might be product design specific rather that generic to a class of products.

Results from the present study suggest that further research is needed to determine optimal splay and tenting settings for individual users. The angle settings tested here, though generally rated as comfortable by subjects, were not based on the use of a validated psychological model. Greater precision in customized settings for the adjustable keyboard might result in further improvements in user comfort and well being.

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