The Feasibility and Accuracy of Using a Remote Method to Assess Computer Workstations

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The Feasibility and Accuracy of Using a Remote Method to Assess Computer Workstations

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Objective: The objective was to test the accuracy of using remote methods (tele-ergonomics) to identify potential mismatches between workers and their computer workstations.

Background: Remote access to ergonomic assessments and interventions using two-way interactive communications, tele-ergonomics, increases the ability to deliver computer ergonomic services. However, this mode of delivery must first be tested for accuracy.

Method: In this single group study, the computer workstations of 30 participants who reported mild to moderate discomfort were remotely assessed using photographs taken by a research assistant and the self-report Computer Workstation Checklist (CWC) completed by the study participant. Mismatches identified remotely by an ergonomics expert were compared to results obtained from an onsite computer workstation visit completed by the same expert.

Results: We accurately identified 92% of mismatches. The method was more sensitive (0.97) than specific (0.88), indicating that experts using the remote method were likely to overidentify mismatches.

Conclusion: These results suggest that an expert using the self-reported CWC combined with workstation photographs can accurately identify mismatches between workers and their computer workstations.

Application: Remote assessment is a promising method to improve access to computer workstation ergonomic assessments.

Keywords: ergonomics, telehealth, validity, musculoskeletal symptoms

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Research supports the effectiveness of ergonomic computer workstation redesigns provided by an expert (Amick et al., 2003; Pillastrini et al., 2010), but there is little evidence that untrained workers have the necessary skills to identify and implement ergonomic changes (Schreuer, Myhill, Aratan-Bergman, Samant, & Blanck, 2009; Shaw & Feuerstein, 2004). Thus, self-directed workstation redesign may fail to reduce risk for musculoskeletal disorders. Unfortunately, most computer operators lack access to experts to assist them.

Telehealth, health care delivery using two-way remote interactive technology, can address this lack of access. Telehealth has been successfully used for assessment, intervention, consultation, and education (Wakeford, Wittman, White, & Schmeler, 2005), and is a cutting-edge method to improve access to health care (Bashshur & Shannon, 2009).

This report describes one aspect of tele-ergonomics: whether a remote standardized assessment method relying only on photographs and surveys can accurately identify mismatches between workers and their computer workstations. To test accuracy we compared the results of the remote assessment with the results of an onsite assessment. We hypothesized that the remote assessment would accurately detect mismatches.

METHOD

Participants

Participants were recruited after completing a prior study that examined the effectiveness of alternative keyboards. Inclusion criteria were Level 2 or greater discomfort on a numerical rating scale (0 = *no discomfort*, 10 = *unbearable discomfort*) in at least one body part, use of work computer at least 20 hours per week, and no serious upper-extremity injury or illness.

We recruited 30 participants (28 female). The mean age was 47 years (± 10.6), and the mean baseline discomfort was 2.2 (± 1.7; range = 1–9). Participants had used computers for 15 years (± 9.3) and used their computers 6.2 hours (± 1.6) per day.

Instruments

A total of 17 photographs were obtained for each participant/workstation: 3 lateral/behind views of participants in computer workstations, 2 lateral views of participants in chairs, 3 lateral/behind head views as participants viewed monitors, 6 lateral/overhead close-ups of participants' hands on keyboards/input devices, and 3 views of the workstation without the participant.

Computer Workstation Checklist (CWC), an 87-item self-report checklist, identifies available workstation equipment and worker/workstation mismatches. Participants answer yes/no questions on the characteristics, placement, and overall fit of their workstation equipment. Chair items include chair height, seat length and width, and position of backrest and armrests. Keyboard/input device items include placement relative to the user and usability. Monitor items include adjustability, placement relative to the user, and visual needs (e.g., whether participants wear bifocals). Environmental factors include clutter, noise, room temperature, and glare, as well as the presence of equipment.

In all, 16 questions on the CWC are "diagnostic" questions used to identify worker/workstation mismatches. An example of these questions is, "Is your chair height adjusted so your feet are flat on the floor (or on a footrest) with your back supported by the backrest?" The remaining questions identify workstation characteristics (Baker, Livengood, & Jacobs, 2013). Psychometric tests have found the CWC highly specific, but not sensitive, prone to false negative reports. Therefore, it was used as an adjunct to photographs, our primary means to identify mismatches. If workers answered yes to diagnostic CWC questions, we considered that they had a mismatch; if they answered no, we used photographs to make a final determination.

Procedure

Institutional review board approval was obtained. A research assistant who did not complete any of the workstation assessments obtained the photographs. She was provided with guidelines for each of the 17 photographs and was provided with a general protocol for each shot. However, as workstations varied in accessibility to specific angles, precise setups for each shot could not be provided. One to two days later participants completed the CWC online. Approximately 3 weeks later the ergonomic expert, who had not visited the worksite, completed a remote standardized assessment of the workstation using photographs and the 16 CWC diagnostic questions to assess 16 priority areas of worker/workstation fit (Table 1). Approximately 1 week later the same ergonomic expert visited the participants' worksites and completed the same standardized assessment (Figure 1). This onsite assessment was the gold standard. The 4-week lag was to obtain baseline data on musculoskeletal discomfort used to examine the effectiveness of an ergonomic intervention (not reported here).

Data Analysis

Data analyses were completed using SPSS 20 and Microsoft Excel. We identified the number of worker/workstation mismatches for both the remote and onsite assessments. We calculated sensitivity, the ability of the remote assessment to correctly identify mismatches when mismatches existed, and specificity, the ability of the remote assessment to correctly identify no mismatches when no mismatches existed, by comparing the results of the remote assessment to the onsite assessment (Fritz & Wainner, 2001).

We also calculated the positive and negative likelihood ratios (Fritz & Wainner, 2001) to determine the overall usefulness of the remote assessment method. If 1 indicates the odds of there being a mismatch prior to the assessment, the positive likelihood ratio identifies the increase in odds that a participant's workstation would have the specified mismatches, whereas the negative likelihood identifies the decrease in those odds.

RESULTS

There were 202 out of 480 potential mismatches (30 participants with 16 possible mismatches; 42%; Table 1), with an average of 7.7

TABLE 1: Percentage of Mismatches Correctly Matched and Sensitivity/Specificity of the Remote Assessment

	Remote Mismatches		Onsite Mismatches		Errors		Sensitivity/ Specificity	
	Yes	No	Yes	No	# error	% error	sens	spec
Chair height	24	6	20	10	4	13	1.00	0.60
Backrest height	16	14	15	15	3	10	0.93	0.87
Arm support height	24	6	19	11	5	17	1.00	0.55
Seat pan depth	15	15	11	19	6	20	0.91	0.74
Seat pan width	2	28	2	28	0	0	1.00	1.00
Keyboard height	23	7	22	8	1	3	1.00	0.88
Keyboard comfort	5	25	5	25	0	0	1.00	1.00
Input device height	27	3	25	5	2	7	1.00	0.60
Input device proximity	15	15	13	17	2	10	1.00	0.88
Input device comfort	5	25	7	23	4	13	0.60	0.92
Monitor height	20	10	21	9	5	17	0.86	0.78
Monitor position (angle)	6	24	5	25	1	3	1.00	0.96
Monitor distance	18	12	16	14	2	7	1.00	0.86
Knee space	12	18	8	22	4	13	1.00	0.82
Work surface	10	20	9	21	1	3	1.00	0.95
Document holder	4	26	4	26	0	0	1.00	1.00
Total	226	254	202	278	40	8	0.97	0.88

(± 2.3; range = 2–12). The greatest percentage of participants had mismatches with input device height (83%), keyboard height (73%), monitor height (70%), and chair height (67%).

We correctly identified 92% of mismatches (Table 1). Of 40 incorrectly identified mismatches, only 7 (18%) were errors because we failed to identify a mismatch existed. Overall, our remote assessment was more sensitive (0.97) than specific (0.88). This pattern of result was generally reflected in the individual item sensitivity/specificity. The overall positive likelihood ratio was 8.08, indicating a moderate increase in odds, and a negative likelihood ratio of 0.03, indicating a large decrease (Fritz & Wainner, 2001).

DISCUSSION

Our results suggest that an expert can use a standardized remote assessment to accurately identify worker/workstation mismatches, with an overall error rate of only 8%. The greatest number of errors occurred identifying mismatches in seat pan depth (20%), monitor height (17%), and arm support height (17%). These errors related to innate difficulties assessing these areas through visual inspection. Seat pan depth errors related to difficulty viewing the seat pan in the photographs. Best monitor height is dependent on several factors including use of bifocals and user preference for the position of the current work (i.e., the bottom, middle, or top of screen). Arm rest height depends on user preference as to resting or floating his or her arms. As we continue to develop methods for remote assessments, we will refine methods to identify mismatches in areas where vision alone is not sufficient. However, even in these areas, remote assessment yielded at least 80% correct identification and had high sensitivity.

Remote ergonomic workstation assessments were more sensitive than specific. Thus, the assessment was better at identifying worker/workstation mismatches than ruling them out. As remote ergonomic assessment relies on identifying mismatches and then working with the

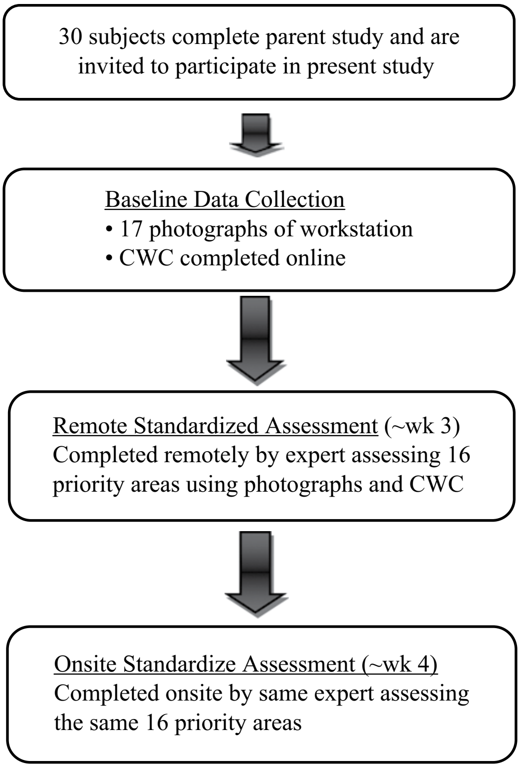

Figure 1. Study flow. CWC = Computer Workstation Checklist.

worker to identify solutions, this skewing toward overidentification of worker/workstation mismatches is not problematic. It will be easier to correct misidentified mismatches during the intervention phase than it will be to find unidentified mismatches.

A significant limitation of the study was that the gold standard and remote assessment were obtained by the same person, which probably inflated the overall accuracy of the results.

Tele-ergonomics has the potential to shift clinical practice paradigms and to provide workers with enhanced access to ergonomic professionals. Tele-ergonomics can increase the impact that ergonomics has on the working population and pave the way for a new method to deliver ergonomic services globally. With increased access, we can expect significant improvements in the musculoskeletal health of computer operators. This study supports the accuracy and feasibility of remote assessment, a necessary component of tele-ergonomics.

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KEY POINTS

- Tele-ergonomics is a proposed health care delivery method to use two-way remote interactive technology to deliver ergonomic assessments and interventions.
- In this single-group study 30 participants' computer workstations were assessed remotely using photographs and self-report.
- Using this remote method, we accurately identified 92% of computer workstation mismatches. The method was more sensitive (0.97) than specific (0.88).
- Using tele-ergonomics to assess computer workstations is a feasible and accurate delivery method.

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