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International Journal of Industrial Ergonomics 34 (2004) 237–241

International Journal of Industrial Ergonomics

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Short communication

Validation of a commercial software package for quantification of computer use

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Received 23 January 2004; received in revised form 2 April 2004; accepted 7 April 2004

Abstract

The aim was to validate measurements of the duration of computer use by a commercial software package in relation to video-based observations. Twenty-two computer users with computer-based work tasks primarily consisting of data entry, word-, and data processing participated in the study. During 1 h, when the subjects performed their normal work, the duration of computer use was estimated simultaneously by the software program WorkPace and by video-based observations. Two observers analyzed the video-recordings independently. Pearson correlation showed *r*-values above 0.9 for both observers in relation to the software and between the observers. A significant difference was found between one of the observers and the software program, but judged by 95% confidence intervals and limits of agreement the measurements of the duration of computer use based on the software WorkPace appear to be in agreement with the video-based observations.

Relevance to industry

The software may be used as a valid tool to measure exposure in large epidemiological studies or to provide objective feedback on time spent at the computer and the usage of keyboard and mouse to the computer user.

Keywords: Video-based observations; Computer work; VDU

1. Introduction

Musculoskeletal symptoms are common among computer users (Gerr et al., 2002; Jensen et al., 1998, 2002a), and a variety of work-related and personal factors may play a role in the development of these symptoms (Jensen, 2003; Jensen et al., 2002b; Punnett and Bergqvist, 1997; Marcus et al., 2002). A number of epidemiological studies have reported an exposure–response relationship between duration of computer use and musculoskeletal symptoms (Jensen, 2003; Jensen et al., 2002a; Fogleman and Lewis, 2002; Karlqvist et al., 1996). In these studies self-reported information has been used to gather data on the total duration of computer use and the duration of keyboard and

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doi:10.1016/j.ergon.2004.04.003

mouse use. The advantage of using self-reported information is low expense and minimal time commitment for data collection and analysis. However, the validity of self-reported information can be questioned, and may be a limiting factor in exposure assessment and the exposures relation to health effects. Some studies have shown that self-reported duration of computer use was reported to be up to two times higher than objectively measured (Faucett and Rempel, 1996; Homan and Armstrong, 2003). In light of this, there is a need for new low-cost methods for quantification of computer usage, which can be used to validly measure exposure in large epidemiological studies.

Currently, commercial software programs, e.g. WorkPace, are available that record mouse and keyboard use and also estimate the total duration of computer use (including reading on the screen) (Blangsted et al., 2003; Van den Heuvel et al., 2003). The software package WorkPace has also been used to estimate computer, mouse, and keyboard use among 2148 computer users (Butcher et al., 2003). This study showed that the mean self-reported hours of computer usage were more than double the estimated hours by the software. However, it is not known if this is partly due to the software underestimates the duration of computer use and therefore, it is necessary to compare the method to more accurate methods as, e.g. video-based observations.

As the software program is a simple and inexpensive method to obtain an estimate of computer use, which may be used in large-scale epidemiological studies, the aim of the present study was to validate software-based estimates of the duration of computer use in relation to video-based observations during work tasks primarily consisting of data entry, word-, and data processing.

2. Methods

2.1. Subjects

Sixteen women and 6 men from a municipal administration and a research institute participated in the study after having provided written informed consent. The work of all participants consisted of office work using a computer for the majority of the work tasks, and all subjects used a keyboard and an ordinary PC-mouse without a scroll button. The computer-based work tasks were primarily data entry, word processing, and data processing. The study was approved by the local ethics committee (KF 01-298/00).

2.2. Procedures

The duration of computer work measured simultaneously by a commercial software package (WorkPace, Niche Software Ltd., New Zealand) and video-based observations was obtained for 1 h while the subjects performed their normal work.

The software package, WorkPace, calculated the total duration of computer use and the default settings of the software were used. All keystrokes, mouse clicks, and mouse movements were recorded by the software, and the calculation of the total duration of computer use was based on the duration of the interval between the keystrokes, mouse clicks and/or mouse movements. If the interval was shorter than 30 s it was recorded as time spent using the computer, while intervals of a longer duration was recorded as breaks in the computer use. The software was installed at the computer of the subjects and it did not interfere with their work. There was no financial relationship between the provider of the software package and the authors.

Simultaneously, the subjects were videotaped using a video recorder (Panasonic S-VHS Movie AG-455ME). The video recorder was placed next to the subjects desk with special focus on the computer work station at a position where it was possible to see the screen and to observe the subjects hands and head. Subsequently, the video-recordings were independently analyzed by two trained observers. The data were continuously collected using a minicomputer and predefined keys were pressed each time a change in the work task was observed. Two different work tasks were observed: 1) computer use, i.e. time spent at the computer with or without (reading on the screen) using the keyboard and mouse, and 2) work tasks not involving the computer (paper work, out of office, etc.). Thus, both active use of the keyboard and mouse and reading from the computer screen was registered as "computer work". No effort was done to distinguish the duration of "active" use of input devices from "passive" reading as the active movement of input devices was directly measured by the software and was a priori considered correct. The observers were not aware of the method by which WorkPace was estimating the duration of computer work.

For both methods the recorded periods of computer use were subsequently summed up and converted to percentage of the total recoded work time of 1 h.

2.3. Statistics

In order to evaluate the duration of computer use measured by either video-based observations of two observers or the software, WorkPace, different statistical methods were used as suggested by Bland and Altman (1986). Pearson correlation was calculated to give information about the association between the two methods. The paired *t*-test was used to test for significant differences between the video-based observations and the estimate provided by the software. Finally, 95% confidence intervals and limits of agreement for differences were calculated in order to evaluate the degree of agreement between the two methods (Bland and Altman, 1986). The confidence intervals represent the degree of agreement on group level, and the limits of agreement make it possible to interpret on individual basis.

3. Results

The duration of computer use measured by the software, WorkPace, and by video-based observations analyzed independently by two observers is shown in Table 1 and Fig. 1. Pearson correlation coefficients showed high *r*-values for both observers in relation to the measurements of the software ($r = 0.94$ and 0.93) as well as between the two observers ($r = 0.97$). No significant difference was found between observer no. 1 and the software ($p = 0.386$), while there was a significant difference between observer no. 2 and the software measurements ($p = 0.005$) and between the two observers ($p = 0.001$). The 95%

Table 1
Duration of computer use (% time) for the 22 subjects estimated by video-based observation of the two observers and by the software WorkPace

Subject	Video-based observations		WorkPace
	Observer no. 1	Observer no. 2	
1	63	62	69
2	86	83	84
3	63	66	59
4	83	73	70
5	90	89	70
6	84	83	87
7	33	32	30
8	15	15	19
9	100	100	100
10	55	54	32
11	44	31	36
12	55	38	39
13	72	71	77
14	78	73	75
15	51	46	49
16	75	63	59
17	62	59	60
18	60	60	58
19	67	64	59
20	56	54	57
21	88	82	81
22	99	90	90
Mean	67.2	63.2	61.8
SD	21.2	21.4	21.3

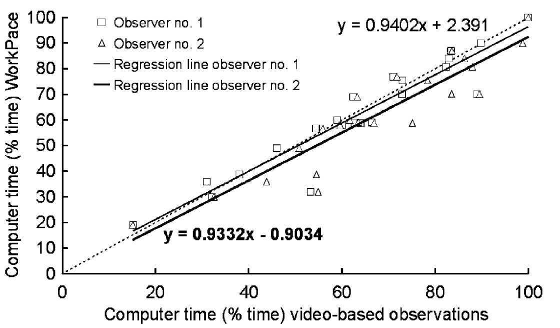

Fig. 1. Estimated work time at the computer by video-based observation of the two observers and by the software WorkPace, registering keying, mouse clicking, and mouse movements. The two solid lines illustrate the best fit of observer no. 1 and observer no. 2, respectively, while the dotted line represents the line of equality.

confidence interval and limits of agreement were (−1.8% to 4.5)% time and (−12.9% to 15.6)% time for observer no. 1 and the software; (1.8–8.9)% time and (−10.6% to 21.3)% time for observer no. 2 and the software, and (1.7–6.3)% time and (−6.2% to 14.2)% time, respectively, for observer no. 1 and observer no. 2.

4. Discussion

The measurement of the duration of computer use based on a software program that uses the duration of the interval between active events (i.e. keying, mouse clicking, or mouse movements) to estimate the total time at the computer seemed in agreement with the video-based observations.

The Pearson correlation coefficients of above 0.9 showed that the video-based observations and the estimates by the software were linearly related. However, the Pearson correlation does not show bias or systematic difference and therefore, paired *t*-tests were performed. The paired *t*-tests showed significant difference between observer no. 1 and the software and between the two observers, showing that observer no. 1 systematically observed the duration of computer use to be longer compared to the estimates by the software and by observer no. 2. Even though systematical differences were found in the present study, the 95% confidence intervals and the limits of agreement give the possibility to take the systematic error into account as a co-variant whenever using the software for estimating the duration of computer use. Judged from the confidence intervals the software is quite accurate on group levels, where the mean differences between the software and the video-based observations are below 5–10%. On the individual level, the software is less accurate, and the individual differences between the two methods could be up to 15–20%. According to these results, the degree of agreement between the software and the video-based observations seemed acceptable for work tasks, where the computer-based tasks consists of data entry, word processing, and data processing.

The software program used an interval threshold of 30 s to discriminate between use and non-use of the computer. Obviously, the computer user may perform other work tasks during 30 s where the keyboard or mouse is not activated, but reading on the computer screen may on the other hand sometimes take longer than 30 s. Thus, on average the total time working at the computer including active keying, mouse clicking, mouse movements, and reading on the screen, was reasonably well estimated by this method when assessing work periods of at least 1 h. However, from the video-based observation data in this study the software seemed to slightly underestimate the duration of computer usage and therefore, the ideal interval threshold should possibly be higher than 30 s.

As the software may be used to collect data for almost indefinite time periods, this way of measuring exposure during computer work has far reaching potentials. In research it may be used as a valid tool to measure exposure in large epidemiological studies with only little extra effort in data collection. It may also be used as a practical tool for the computer user to provide objective feedback on time spent at the computer and the usage of keyboard and mouse at the individual level.

In conclusion, measurements of the duration of computer use based on the software, WorkPace, appear to be in agreement with the video-based observations.

References

Bland, J.M., Altman, D.G., 1986. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 307–310.

Blangsted, A.K., Hansen, K., Jensen, C., 2003. Muscle activity during computer-based office work in relation to self-reported job demands and gender. European Journal of Applied Physiology 89, 352–358.

Butcher, I., Mikkelsen, S., Andersen, J.H., Brandt, L.P.A., Lassen, C.F., Kryger, A., Thomsen, J.F., Overgaard, E., 2003. Assessment of self-reported computer usage by computer usage measured by software programme in the NUDATA study. Proceedings of the 27th International Conference on Occupational Health, Iguassu Falls, Brazil, 23–28 February, PO18.5.

Faucett, J., Rempel, D., 1996. Musculoskeletal symptoms related to video display termial use: an analysis of objective and subjective exposure estimates. American Association of Occupational Health Nursing Journal 44, 33–39.

Fogleman, M., Lewis, R.J., 2002. Factors associated with self-reported musculoskeletal discomfort in video display terminal (VDT) users. International Journal of Industrial Ergonomics 29, 311–318.

Gerr, F., Marcus, M., Ensor, C., Kleinbaum, D., Cohen, S., Edwards, A., Gentry, E., Ortiz, D.J., Monteilh, C., 2002. A prospective study of computer users: I. Study design and incidence of musculoskeletal symptoms and disorders. American Journal of Industrial Medicine 41 (4), 221–235.

Homan, M.M., Armstrong, T.J., 2003. Evaluation of three methodologies for assessing work activity during computer use. American Industrial Hygiene Association Journal 64, 48–55.

Jensen, C., 2003. Development of neck and hand-wrist symptoms in relation to duration of computer use at work. Scandinavian Journal of Work Environment and Health 29 (3), 197–205.

Jensen, C., Borg, V., Finsen, L., Hansen, K., Juul-Kristensen, B., Christensen, H., 1998. Job demands, muscle activity and musculoskeletal symptoms in relation to work with the computer mouse. Scandinavian Journal of Work Environment and Health 24 (5), 418–424.

Jensen, C., Finsen, L., Søgaard, K., Christensen, H., 2002a. Musculoskeletal symptoms and duration of computer and mouse use. International Journal of Industrial Ergonomics 30, 265–275.

Jensen, C., Ryholt, C.U., Burr, H., Villadsen, E., Christensen, H., 2002b. Work-related psychosocial, physical and individual factors associated with musculoskeletal symptoms in computer users. Work and Stress 16 (2), 107–120.

Karlqvist, L., Hagberg, M., Köster, M., Wenemark, M., Ånell, R., 1996. Musculoskeletal symptoms among computerassisted design (CAD) operators and evaluation of a self-assessment questionnaire. International Journal of Occupational Environment Health 2, 185–194.

Marcus, M., Gerr, F., Monteilh, C., Ortiz, D.J., Gentry, E., Cohen, S., Edwards, A., Ensor, C., Kleinbaum, D., 2002. A prospective study of computer users: II. Postural risk factors for musculoskeletal symptoms and disorders. American Journal of Industrial Medicine 41 (4), 236–249.

Punnett, L., Bergqvist, U., 1997. National Institute for Working Life-ergonomic expert committee document no 1. Visual display unit work and upper extremity musculoskeletal disorders. A review of epidemiological findings. In: Kjellberg, A. (Ed.), National Institute for Working Life. Solna, Sweden.

Van den Heuvel, S.G., de Looze, M.P., Hildebrandt, V.H., Thé, K.H., 2003. Effects of software programs stimulating regular breaks and exercises on work-related neck and upper-limb disorders. Scandinavian Journal of Work Environment and Health 29 (2), 106–116.