

The Relationship Between Psychosocial Work Factors, Work Stress and Computer-Related Musculoskeletal Discomforts Among Computer Users in Malaysia

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Increasing numbers of workers use computer for work. So, especially among office workers, there is a high risk of musculoskeletal discomforts. This study examined the associations among 3 factors, psychosocial work factors, work stress and musculoskeletal discomforts. These associations were examined via a questionnaire survey on 30 office workers (at a university in Malaysia), whose jobs required an extensive use of computers. The questionnaire was distributed and collected daily for 20 days. While the results indicated a significant relationship among psychosocial work factors, work stress and musculoskeletal discomfort, 3 psychosocial work factors were found to be more important than others in both work stress and musculoskeletal discomfort: job demands, negative social interaction and computer-related problems. To further develop study design, it is necessary to investigate industrial and other workers who have experienced musculoskeletal discomforts and work stress.

Malaysia musculoskeletal discomfort work stress psychosocial work factors
office worker

1. INTRODUCTION

Work-related musculoskeletal disorders (WRMDs) are increasingly prevalent in the Malaysian workforce. The Social Security Organization of Malaysia reports that the number of cases involving musculoskeletal injuries is very high at 10000 per year [1].

If the risk of developing musculoskeletal symptoms is attributed to computer-related work, it definitely affects numerous workers since 61.4% of the workforce are highly dependent on computers in the workplace, according to a report from the National Institute of Occupational Safety and Health (NIOSH), Malaysia [1].

The increasing popularity and use of computers, with their flat, light-touch keyboards, and related

peripheral technologies (mouse, touch pads, etc.), have caused more common reporting of injuries and health problems. Over the years, computer-based technology has increased work intensity and created stressful and unhealthy working conditions inadvertently leading to an increase in WRMDs. Rapid increase in the use of advanced technology in the workplace has raised concern for the health and well-being of computer workers.

Numerous studies showed that computer users experienced musculoskeletal discomfort [2, 3, 4, 5, 6, 7, 8] and psychological stress [8, 9, 10]. WRMDs can significantly affect the occupational functions of all performance areas since the upper body, neck, back, and hand are vital parts of the body. Symptoms arising from underlying musculoskeletal disorders, which include pain,

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tingling, and numbness during use, are caused by “neural compression, inflammation of the muscle-tendon unit, and vascular alteration” (p. 767) [11]. In severe cases, symptoms can occur all the time [12].

In addition, the World Health Organization (WHO) characterized work-related diseases as multifactorial to indicate that a number of risk factors (physique, work and organization, psychosocial, individual, and social culture) contributed to these ailments [13]. Many studies showed an association between the psychosocial work factors and adverse health effects in general, including musculoskeletal symptoms. Some recent reviews concluded that there was evidence of significant associations between psychosocial work factors (work demand, job control, job contentment, etc.) and musculoskeletal disorders among workers in general [14, 15, 16, 17, 18, 19] and also among office workers and computer users [5, 20, 21, 22, 23, 24, 25, 26, 27]. However, other researchers, e.g., Warren [28], found the result somewhat contradictory. According to Warren, evidence for the relationship was inconclusive and the role of psychosocial work factors in the development of WRMDs symptoms was not yet clearly understood.

Additionally, many researchers indicated that the relationship between psychosocial work factors, work stress, and musculoskeletal discomfort could not be successfully examined in a cross-sectional study [31, 32], and the relationship among these factors should be examined over time. Bongers, de Winter, Kompier, et al. recommended using longitudinal studies in studying this topic [31]. Sauter and Swanson [32] agreed with Bongers et al.’s recommendation. According to Bongers et al. a cross-sectional study did not allow the examination of causality, whereas in longitudinal studies where data was collected over time, stress symptoms could be measured before the onset of musculoskeletal symptoms. According to Teuchmann, Totterdell, and Parker [33], a longitudinal design with frequently collected data could be useful in studies in this area. If we are interested in investigating the longterm relationship between psychosocial work factors;

work stress and musculoskeletal discomfort data have to be collected daily to keep track of those variables. Such a design makes an evaluation of dynamic relationships possible.

The views of Bongers et al. [31], Sauter and Swanson [32], and Teuchmann et al. [33] led to the research design for this study. A diary study where the participants filled in questionnaires daily for a certain period was adopted. Diary studies have been used to study exploratory learning [34], the use of paper in organizations [35], work-related reading [36], information capture at work [37], and stress [33, 38, 39]. In addition, diary studies have been used to study computer use and worker stress [40], and to examine the cumulative and chronic effect of computer users’ daily hassles, e.g., computer-related problems, worker stress, and psychosocial work factors.

In view of the contradictory evidence and the fact that WRMDs can have a major impact on a worker’s health, function, performance, and productivity [29, 30], this study was carried out to examine the relationship among psychosocial work factors, work stress, and work-related musculoskeletal discomfort. The objectives of the study were to determine

- the relationship between psychosocial work factors and work stress;
- the relationship between psychosocial work factors and work-related musculoskeletal discomfort;
- the relationship between work stress and musculoskeletal discomfort; and
- whether work stress mediated the relationship between psychosocial work factors and work-related musculoskeletal discomfort.

2. MATERIAL AND METHODS

2.1. Sampling

Thirty office workers in a university in Malaysia participated in a diary study of computer-related musculoskeletal discomfort, psychosocial work factors, and work stress. In this university, there were many types of jobs requiring computer use. Seventy-eight percent of administrative

employees were office workers (i.e., data entry, records, and forms officers, etc.); the sample was selected from that population.

There were 21 female (73.3%) and 9 male (26.7%) respondents. Out of this group, 56.7% were single and 43.3% married. Their mean age was 29.8 years (*SD* 4.33). The mean time of computer use per day was 8.8 h (*SD* 2.0). All participants worked full-time.

A survey questionnaire was designed and tested. The study took 4 weeks. This time was long enough to observe the relationship and fluctuation of variables but not long enough to create drop-out and attrition problems.

2.2. Questionnaire

The questionnaire used in this study consisted of questions that measured daily the psychosocial work factors taken from University of Wisconsin-Madison (UW) Office Worker Survey (OWS), specifically developed for office workers, particularly computer users [7]. The diary survey had to be short and fit on one page. Table 1 lists the different subdimensions of psychosocial work

factors. The responses were marked on a 1–4 scale (1—*none*, 2—*a little*, 3—*some*, 4—*a lot*).

Also measured was the stress factor taken from the profile of a mood states survey [10, 41]. In this profile, fatigue and tension were used to measure stress since several studies showed a relationship between them and several psychosocial work factors [26, 42, 43]. The measure of three scales was developed from the profile of mood states [41]. The questions asked the participants to explain their feeling on the day of the study. The responses were marked on a 1–5 scale (1—*not at all*, 2—*a little*, 3—*moderately*, 4—*quite a bit*, 5—*extremely*).

Since this study mainly focused on work-related musculoskeletal discomfort, the measurement had to measure the intensity of discomfort in the back, neck, shoulder, left and right elbows, and left and right hand/wrists. The questions, scales, and the diagram showing the body part were adapted from the standardized NORDIC questionnaires [44], which were used to study musculoskeletal symptoms and disorders. Their application was found to be useful in the evaluation of the various body stressors involved in the workplace.

TABLE 1. Factor Analysis and Scale Reliabilities: Psychosocial Work Factors

Name	Item	Factor Loading	Variance Explained (%)	Scale	<i>M</i>	<i>SD</i>	Reliability
Job demands (4 items)	fast work	.87	20.84	1–4	3.17	0.28	.76
	workload	.76					
	backlog	.62					
	deadline	.58					
Social support (3 items)	relying on supervisor	.82	12.92	1–4	2.81	0.27	.77
	understaffing	.79					
	relying on coworker	.68					
N-social interaction (2 items)	hostile customer	.82	11.36	1–4	2.67	0.29	.75
	contact with upset people	.80					
Job control (3 items)	work pace	.64	8.30	1–4	2.83	0.30	.73
	task order	.64					
	short rest	.55					
Computer problems (2 items)	breakdown	.87	7.57	1–4	3.11	0.32	.76
	slow response	.70					
Job content (2 items)	challenge	.65	6.68	1–4	2.42	0.16	.78
	attention	.61					
total			67.69				

Notes. N-social—negative social.

The questions were directly related to the level of discomfort experienced by the individual worker. The subjects were asked to assess the level of discomfort, which was defined as pain, aching, stiffness, burning, tingling or numbness for each part of their body. The scale was the same as that for the stress factor. The questions asked the participants to explain their feeling on the day of the study. The responses were marked on a 1–5 scale (1—*not at all*, 2—*a little*, 3—*moderately*, 4—*quite a bit*, 5—*extremely*).

Finally, all three groups of questions were put together in a page-long questionnaire which comprised 30 questions: 16 on psychosocial work factors, 6 on work stress, and 8 on musculoskeletal discomfort. Each part of the survey was developed from existing questionnaires as described in the preceding paragraphs and was believed to be a suitable measure to examine the relationship among psychosocial work factors, work stress, and musculoskeletal discomfort.

2.3. Procedure

The procedure for the study included obtaining approval from the president of the university and selecting a random sample of computer workers. Thirty employees participated in this research. They received instruction and proper training in completing the questionnaires, which they then filled out during their normal working hours for four 5-day workweeks (i.e., for 20 days). The questionnaires were collected at the end of each day. Thus, there were 600 observations. Data were collected to make factor and regression analyses possible for the whole period. Regression analysis was done together for each variable.

3. RESULTS

Following the collection of data, descriptive statistics, reliability coefficients and factor analysis were used to examine the association among the psychosocial work factors (job demands, job control, job satisfaction, social interaction, and computer-related problems), work stress (fatigue and tension), and work-related

musculoskeletal discomfort. In addition, multiple regression analysis and hierarchical regression were used to examine the relationship among these factors and to ascertain the predictors of work-related musculoskeletal discomforts. Analyses were carried out in SPSS version 13.

3.1. Factor Analysis and Reliabilities

Prior to examining the relationship among the factors and ascertaining the predictors of these factors, a principal component factor analysis with varimax rotation was carried out on the 16 items measuring psychosocial work factors. The result indicated six significant factors with a total variance explained of 67.69%. The Keizer-Meier Oklim (KMO) was .539, indicating sufficient intercorrelation to proceed with factor analysis; Bartlett's test for sphericity was significant ($\chi^2 = 3274.675$, $P < .001$). These factors were job demands (4 items), social support (3 items), negative social interaction (2 items), job control (3 items), computer-related problems (2 items) and job content (2 items). Table 1 summarizes the results of factor analysis.

Another factor analysis was undertaken to see the dimensionality of work stress. A single-factor solution emerged explaining 61.48% of variance in the stress. The KMO measure of sampling adequacy was .830 indicating sufficient intercorrelation, and Bartlett's test of sphericity was significant ($\chi^2 = 1913.78$, $P < .001$).

Finally, another factor analysis was carried out to confirm the dimensionality of work-related musculoskeletal discomfort. A one-factor solution was revealed explaining 58.76% of the variance in musculoskeletal discomfort. The test of sphericity was significant ($\chi^2 = 3857.088$, $P < .001$), and the KMO measure of sampling was .855, indicating sufficient intercorrelation.

Cronbach's α scores measure the internal consistency reliability for each factor. They are listed in Table 1.

3.2. Hierarchical Regression Analysis

The relationships among psychosocial work factors, work stress and musculoskeletal disorders were tested using a multiple hierarchical

TABLE 2. Summary of Regression Analysis for Psychosocial Work Factors With Musculoskeletal Discomfort

Independent Variable	Dependent Variable							
	Step 1				Step2			
	β	t	Sig.	VIF	β	t	Sig.	VIF
Job demands	0.21*	6.79	.01	1.43	0.16*	5.05	.01	1.66
Job content	0.03	1.46	.14	1.02	0.04	1.58	.11	1.02
Job control	−0.03	−1.34	.17	1.26	−0.02	−0.81	.41	1.29
Social support	−0.02	−0.96	.33	1.37	−0.00	−0.13	.89	1.45
N-social interaction	0.76*	26.97	.01	1.20	0.74*	25.70	.01	1.27
Computer problems	−0.14*	4.82	.01	1.29	0.18*	5.86	.01	1.52
Stress					0.11*	3.543	.01	1.58
<i>R</i> ²		.60				.61		
Adjusted <i>R</i> ²		.60				.60		
<i>F</i>		150.73				133.50		
<i>R</i> ² change		.60				.00		
<i>F</i> change		150.73*				12.55*		

Notes. *—significant at *P* < .01; β—standardized coefficient; *n* = 600; Durbin-Watson = 1.525; N-social—negative social; VIF—variance inflation factor; sig.—significance.

regression analysis. This analysis presented the relationship between the variables in two steps. Firstly, psychosocial work factors were entered in step 1. Secondly, work stress was entered in step 2. Musculoskeletal discomfort was used as the dependent variable in the regression analysis. Table 2 summarizes the results of the analysis: six psychosocial work factors variables explained 60% of the variation on musculoskeletal discomfort. Three variables of psychosocial factors were found to have significant positive relationship with musculoskeletal discomfort: job demands, negative social interaction, and computer-related problems ($\beta = -0.14$, $P < .01$). When work stress was added in step 2, the additional variance explained was 61%. The Durbin-Watson value of 1.525 also fell between the acceptable ranges of 1.5–2.5, implying that there might be no autocorrelation problem in data. In other words, it indicated that the error term was independent. The results indicated variation inflation factors (VIF) were all under 10. The results in step 2 also indicated that job demands, negative social interaction, computer-related problems, and work stress were positively associated with musculoskeletal discomfort.

3.3. Multiple Linear Regressions Between Psychosocial Work Factors and Work Stress

The results of the regression analysis for the relationship between psychosocial work factors and work stress indicated that three elements of psychosocial work factors (job demands, negative social interaction, and computer-related problems) were positively associated with work stress, and two elements (social support and job control) were negatively associated with work stress (Table 3). The results also indicated that the six psychosocial work factors variables explained 37% of the variation in work stress. The Durbin-Watson of 1.85 fell between the acceptable range ($1.5 < D < 2.5$). All five significant variables had very low VIF values (<10).

TABLE 3. Multiple Linear Regressions Between Psychosocial Work Factors and Work Stress

Independent Variables	β	<i>P</i> Value	VIF
Job demands	0.38*	.01	1.43
Job content	−0.02	.46	1.02
Job control	−0.13*	.01	1.26
Social support	−0.21*	.01	1.37
N-social interaction	0.20*	.01	1.20
Computer problems	0.38*	.01	1.29

Notes. *—signifcant at *P* < .01; *n* = 600 (*F* = 57.82, *P* < .01); *R*² = .37; N-social—negative social; β—standardized coefficient; VIF—variance inflation factor.

3.4. Single Liner Regression Between Work Stress and Musculoskeletal Discomfort

Regression analysis between work stress and musculoskeletal discomfort found there was significant positive relationship between these two variables ($\beta = 0.26$, $P < .01$). Work stress explained 68% of the variation in musculoskeletal discomforts. The significant variable was found to have very low VIF values (<10). The Durbin-Watson value of 1.83 also fell between the acceptable ranges of 1.5–2.5, implying that there might be no autocorrelation problem in data.

4. DISCUSSION

This study represents one of the first diary study investigations of the relationship among psychosocial work factors, work stress and WRMDs. It is the first study to explore the association between psychosocial work factors, work stress and musculoskeletal discomfort in computer users in Malaysia.

The objective of the study was to examine the direct and indirect relationships between psychosocial work factors, work stress, and musculoskeletal discomfort. The results of the study support the direct relationship between psychosocial work factors and work stress, and between work stress and musculoskeletal discomfort. They also partially support the indirect relationship between psychosocial work factors and musculoskeletal discomfort.

The results of the reliability test show all the six variables that constitute psychosocial work factors have Cronbach's α score higher than the satisfactory level. Nunnally proposes that it is safe to work with reliabilities of .70 or higher [45]. The reliability tests and the factor loading on single items (work stress and musculoskeletal discomfort) could not be calculated because it stands a stand a single item for measurement [46].

The result of this study points out five elements of psychosocial work factors (job demands, lack of job control, social support, negative social interaction, and computer-related problem) have significant association with work stress. Workers who report low job control or low social support

are likely to report high work stress. In addition, participants who report high work demand, high negative social interaction or high computer-related problems report high work stress.

The findings of the relationship between psychosocial work factors and work stress are consistent with some earlier studies. Previous studies on psychosocial work factors suggest that job demands [47, 48, 49], job control [26, 50], computer-related problems [42, 47] and social support [22, 51, 52] are related to work stress.

An important finding of this study is the relationship between negative social interaction and work stress. Very few studies have examined negative social interaction among computer users. Negative social interaction focuses on staff and client interaction. Maslach points out that staff–client interaction could lead to emotional exhaustion in which the staff person no longer has positive feeling, sympathy, or respect for clients [53]. Therefore, the significant relationship between negative social interaction and work stress (fatigue and tension) in our study of computer users and office workers is consistent with Maslach's suggestion. It is interesting to note that there was no significant association between job content and work stress in this study.

In addition to the relationship between psychosocial work factors and work stress, the relationship between psychosocial work factors and musculoskeletal discomfort is partially supported by the result of statistical analysis. Participants who experience high job demands, high negative social interaction or high computer-related problem reported high musculoskeletal discomforts. Regarding the relationship between work stress and musculoskeletal discomforts, the findings show that work stress influences musculoskeletal discomforts. This finding is similar to the study by Conway [26] and Haufler, Feuerstein and Huang [54] who found a significant relationship between work stress and musculoskeletal discomforts.

The result shows that negative social interaction, computer-related problem, and job demands have a direct effect on musculoskeletal discomforts and also a direct effect on musculoskeletal discomforts through work stress.

Job control and social support have only a direct effect on musculoskeletal discomforts through work stress. Job content in our study does not have direct effect on musculoskeletal discomforts and musculoskeletal through work stress.

In this study, work stress serves as a mediator between psychosocial work factors and musculoskeletal discomforts. The mediator role of psychological work stress between psychosocial work factors and musculoskeletal discomfort seems consistent with the findings of Lim and Carayon [23] and Bongers et al. [31]

In summary, traditional ergonomic risk factors such as repetition, force and posture have been postulated as the major contributors to WRMDs [55, 56, 57]. This study has demonstrated that psychosocial work factors can also have an effect on musculoskeletal discomforts and work stress. However, we feel that to fully understand the relationship between the variables help to prevent or control musculoskeletal discomforts, it is necessary to examine simultaneously musculoskeletal discomforts, psychosocial work factors and stress.

5. LIMITATIONS OF THE STUDY

There are limitations to this study. The subjects were from the same university department. There were only 30 of them and most of them were female. These workers worked in a closed environment; it is possible that they enjoyed their work and found job satisfaction in their day-to-day activities. Therefore, this situation might limit the extent to which the results can be generalized.

REFERENCES

1. Lee LT. Opening address of chairman, NIOSH Malaysia. In: Halimahtun MK, editor. Proceedings of the Agriculture Ergonomics Development Conference. Kuala Lumpur, Malaysia: IEA Press; 2007. p. 6.
2. Sauter SL, Schleifer LM, Knutson SJ. Work posture, workstation design, and musculoskeletal discomfort in a VDT data entry task. *Hum Factors*. 1991;33(2):151–67.
3. Waersted M, Bjørklund R, Westgaard RH. Shoulder muscle tension induced by two VDT-based tasks of different complexity. *Ergonomics*. 1991;34:137–50.
4. Bergqvist U, Wolgast E, Nilsson B, Voss M. Musculoskeletal disorders among visual display terminal workers: individual, ergonomic, and work organizational factors. *Ergonomics*. 1995;38(4):763–76.
5. Jensen C, Ryholt CU, Burr H, Villadsen E, Christensen H. Work-related psychosocial, physical and individual factors associated with musculoskeletal symptoms in computer users. *Work Stress*. 2002;16(2):107–20.
6. Wahlström J. Ergonomics, musculoskeletal disorders and computer work. *Occup Med (Lond)*. 2005;55:168–76.
7. Carayon P, Haims M, Hoonakker P, Swanson N. Teamwork and musculoskeletal health in the context of work organization interventions in office and computer work. *TIES*. 2006;17:36–96.
8. Lindström K. Well-being and computer-mediated work of various occupational groups in banking and insurance. *Int J Hum Comput Interact*. 1991;3(4):339–61.
9. Smith MJ, Carayon P, Sanders KJ, Lim S-Y, LeGrande D. Employee stress and health complaints in jobs with and without electronic performance monitoring. *Appl Ergon*. 1992;23(1):17–27.
10. Schleifer LM, Galinski TL, Pan CS. Mood disturbances and musculoskeletal discomfort: effects of electronic performance monitoring under different levels of VDT data-entry performance. *Int J Hum Comput Interact*. 1996;8(4):369–84.
11. Trombly CA. Occupational therapy for physical dysfunction. Baltimore, MD, USA: Williams & Wilkins; 1997.
12. Apley AG, Solomon L. Concise system of orthopedics and fractures. London, UK: Arnold; 2000.
13. World Health Organization (WHO). Identification and control of work-related diseases (Report No. 714). WHO Technical Report Series Geneva, Switzerland: WHO; 1985.
14. Kuorinka I, Forcier L, Hagberg MC, Silverstein B, Wells R, Smith MJ, et al. Work related musculoskeletal disorders

- (WMSDs): a reference book for prevention. London, UK: Taylor & Francis; 1995.
15. Carayon P, Smith MJ. Work organization and ergonomics. *Appl Ergon*. 2000;31:649–62.
 16. Lundberg U, Forsman M, Zachau G, Eklof M, Palmerud G, Melin B, et al. Effect of experimentally induced mental and physical stress on motor unit recruitment in the trapezius muscle. *Work Stress*. 2002; 16:166–78.
 17. Theorell T, Hasselhorn HM, The MUSIC Norrtälje Study Group. Endocrinological and immunological variables sensitive to psychosocial factors of possible relevance to work-related musculoskeletal disorders. *Work Stress*. 2002;16:154–65.
 18. Kjellberg A, Wadman C. The role of the affective stress response as a mediator of the effect of psychosocial risk factors on musculoskeletal complaints—part 1: assembly workers. *Int J Ind Ergon*. 2007; 37:367–74.
 19. Sobeih TM, Salem O, Daraiseh N, Genaidy A, Shell R. Psychosocial factors and musculoskeletal disorders in the construction industry: a systematic review. *TIES*. 2006;7(3):329–44.
 20. Linton SJ, Kamwendo K. Risk factors in the psychosocial work environment for neck and shoulder pain in secretaries. *J Occup Med*. 1989;31:609–13.
 21. National Institute for Occupational Safety and Health (NIOSH). Health hazard evaluation report (Report No. HETA 89-299-2230). Washington, DC, USA: U.S. Department of Health and Human Services; 1992.
 22. Faucett J, Rempel D. VDT-related musculoskeletal symptoms: interactions between work posture and psychosocial work factors. *Am J Ind Med*. 1994;26:597–612.
 23. Lim SY, Carayon P. An integrated approach to cumulative trauma disorders in computerized office: the role of psychosocial work factors, psychological stress and ergonomic risk factors. In: Smith MJ, Salvendy G, editors. *Human–computer interaction: applications and cases*. Amsterdam, The Netherlands: Elsevier; 1993. p. 880–5.
 24. Carayon P, Haims MC, Lim S-Y. Longitudinal study of ergonomic and psychosocial work stressors and musculoskeletal discomfort among computer users. In: Brown O, Hendrick HW, editors. *Human factors in organizational design and management—V*. Amsterdam, The Netherlands: Elsevier Science; 1996. p. 273–8.
 25. Bernard BP, editor. *Musculoskeletal disorders and workplace factors* (NIOSH Publication No. 97-141). Cincinnati, OH, USA: National Institute for Occupational Safety and Health (NIOSH); 1997. Retrieved June 19, 2009, from: <http://www.cdc.gov/niosh/docs/97-141/>
 26. Conway FT. Psychological mood state, psychosocial aspect of work, and musculoskeletal discomfort in intensive video display terminal (VDT) work. *Int J Hum Comput Interact*. 1999;11(2):95–107.
 27. Swanson NG, Sauter SL. A multivariate evaluation of an office ergonomic intervention using longitudinal data. *TIES*. 2005;7(1):3–17.
 28. Warren N. Psychosocial and work organization risk factors for WRMSD. In: Karwowski W, editor. *International encyclopedia of ergonomics and human factors*. New York, NY, USA: Taylor & Francis; 2001. p. 1299–302.
 29. Straaton KV, Fine PR, White MB, Maisiak RS. Disability caused by work-related musculoskeletal disorders. *Curr Opin Rheumatol*. 1998;10:141–5.
 30. National Research Council (NRC). *Musculoskeletal disorders and the workplace: low back and upper extremities*. Washington, DC, USA: National Academy Press; 2001.
 31. Bongers PM, de Winter CR, Kompier MA, Hildebrandt VH. Psychosocial factors at work and musculoskeletal disease. *Scand J Work Environ Health*. 1993;19:297–312.
 32. Sauter SL, Swanson NG. An ecological model of musculoskeletal disorders in office work. In: Moon SD, Sauter SL, editors. *Beyond biomechanics: psychosocial aspects of musculoskeletal disorders in office work*. London, UK: Taylor & Francis; 1996. p. 3–21.

33. Teuchmann K, Totterdell P, Parker SK. Rushed, unhappy and drained: an experience sampling study of relations between time pressure, perceived control, mood and emotion exhaustion in a group of accountants. *J Occup Health Psychol.* 1999; 4(1):37–54.
34. Rieman J. The diary study: a workplace oriented research tool to guide laboratory efforts. In: *Proceedings of the ACM INTERCHI 1993 Conference on Human Factors in Computing Systems.* New York, NY, USA: ACM Press; 1993. p. 321–6.
35. Sellen A, Harper R. Paper as an analytic resource for the design of new technologies. In: *Proceedings of the ACM INTERCHI 1997 Conference on Human Factors in Computing Systems.* New York, NY, USA: ACM Press; 1997. p. 319–26.
36. Adler A, Gujar A, Harrison BL, O'Hara K, Sellen A. A diary study of work-related reading: design implications for digital reading devices. In: *Proceedings of the ACM CHI 98 Conference on Human Factors in Computing Systems.* New York, NY, USA: ACM Press; 1998. p. 241–8.
37. Brown B, Sellen A, O'Hara K. A diary study of information capture in working life. *Proceedings of the ACM CHI 2000 Conference on Human Factors in Computing Systems.* New York, NY, USA: ACM Press; 2000. p. 438–45.
38. Lundberg U, Melin B, Ekström M, Dohns IE, Sandsjö L, Palmerud G, et al. Psychophysiological stress responses, muscle tension, and neck and shoulder pain among supermarket cashiers. *J Occup Health Psychol.* 1999;4(3):245–55.
39. DeLongis A, Folkman S, Lazarus R. The impact of daily stress on health and mood: psychological and social resources as mediators. *J Pers Soc Psychol.* 1998; 54:486–95.
40. Carayon P, Hajnal C. A daily study of computer user and worker stress: preliminary results. In: Smith MJ, Salvendy G, editors. *Human–computer interaction: applications and case studies.* Amsterdam, The Netherlands: Elsevier; 1993.
41. McNair D, Lorr M, Droppleman L. *Profile of mood states.* San Diego, CA, USA: Educational and Industrial Testing Service; 1971.
42. Carayon-Sainfort P. The use of computers in offices: impact on task characteristics and workers stress. *Int J Hum Comput Interact.* 1992;4(3):245–61.
43. Carayon P. Chronic effect of job control, supervisor social support, and work pressure on office worker stress. In: Sauter SL, Murphy L, editors. *Organization risk factors for job stress.* Washington, DC, USA: APA Press; 1995. p. 357–70.
44. Kuorinka I, Jonsson B, Kilbom Å, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon.* 1987;18(3):233–7.
45. Nunnally JC. *Psychometric theory.* New York, NY, USA: McGraw-Hill; 1978.
46. Wanous JP, Reichers AE, Hudy MJ. Overall job satisfaction: How good are single-item measures? *J Appl Psychol.* 1997;82:247–52.
47. Lindström K, Leino T, Seitsamo J, Torstila I. A longitudinal study of work characteristics and health complaints among insurance employees in VDT work. *Int J Hum Comput Interact.* 1997;9(4):343–68.
48. Yang C-L, Carayon P. Effect of computer system performance and job support on stress among office workers. In: Smith MJ, Salvendy G, editors. *Human–computer interaction: applications and case.* Amsterdam, The Netherlands: Elsevier; 1993. p. 931–6.
49. Smith MJ, Cohen BF, Stammerjohn L. An investigation of health complaints and job stress in video display operations. *Hum Factors.* 1981;23(4):387–400.
50. Carayon P. Longitudinal studies of job design and VDT use: overview and synthesis. In: Luczak H, Çakir AE, Çakir G, editors. *Work With Display Units 92.* Amsterdam, The Netherlands: Elsevier Science; 1993.
51. Faucett J. Integrating “psychosocial” factors into a theoretical model for work-related musculoskeletal disorders. *TIES.* 2005;6(6):531–50.
52. Smith MJ. Psychosocial aspect of working with video display terminals (VDTs) and

- employee physical and mental health. In: Seppälä P, Luopajarvi T, Nygård CH, Mattila M, editors. Proceedings of the 13th Triennial Congress of the International Ergonomics Association, Tampere, Finland, 1997. Helsinki, Finland: Finnish Institute of Occupational Health; 1997. p. 23–5.
53. Maslach C. The client role in staff burn-out. *J Soc Issues*. 1978;34(4):111–24.
54. Haufler A, Feuerstein M, Huang GD. Job stress, upper extremity pain and functional limitations in symptomatic computer users. *Am J Ind Med*. 2000;38:507–15.
55. Putz-Anderson V, editor. Cumulative trauma disorders. A manual for musculoskeletal diseases of the upper limbs. London, UK: Taylor & Francis; 1988.
56. Silverstein BA, Fine L, Armstrong T. Occupational factors and the carpal tunnel syndrome. *Am J Ind Med*. 1987;11:343–58.
57. Armstrong TJ, Buckle P, Fine LJ, Hagberg M, Jonsson B, Kilbom Å. A conceptual model for work-related neck and upper-limb musculoskeletal disorders. *Scand J Work Environ Health*. 1993;19:73–84.