International Journal of Occupational Safety and Ergonomics (*JOSE*) 2014, Vol. 20, No. 4, 617–626

A Quasi-Experimental Study of the Effects of the Erggi Action Model of Musculoskeletal Symptoms and VDU Working Conditions Among University Staff

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Purpose. *The aim of this study was to investigate musculoskeletal symptoms and working conditions of university workers with and without contact with an Erggi action model.* ***Methods.*** *A quasi-experimental and longitudinal field study design examined effects of the Erggi action model with 3 types of questionnaires filled by 1000 university workers. The statistical analyses used logistic regression.* ***Results.*** *Subjects who had contact with the Erggi action model had a higher probability of weekly musculoskeletal symptoms impairing their work, perceived more possibilities to influence their musculoskeletal symptoms and had lower risk for sick leave compared to those without contact with the Erggi action model.* ***Conclusions.*** *The Erggi action model increases the probability of influencing workers' musculoskeletal symptoms, decreases the number of sick leave and increases awareness of musculoskeletal symptoms and working conditions.*

musculoskeletal symptoms office ergonomics

1. INTRODUCTION

Office workers using a video display unit (VDU) have a high prevalence and incidence rate of work-related musculoskeletal symptoms of the neck, shoulder and upper extremities [1, 2, 3]. The symptoms frequently become chronic and lead to long-term consequences such as sick leave. Musculoskeletal symptoms, disorders or diseases are among the main causes of sick leave and represent a financial burden for employers, workers and society [4, 5].

Some risk factors for musculoskeletal symptoms are related to physical work load, although work has become relatively static, i.e., most work is done in a sitting posture indoors with repetitive type of manual work with small active muscle masses [6]. Sitting for long periods can cause fatigue and feeling of discomfort because of difficulties in maintaining a proper sitting posture.

The authors want to thank The Finnish Labor Protection Fund of State for financing this research, and Marja-Leena Hannila, University of Eastern Finland, for statistical help.

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Monotonous and repetitive movements of upper extremities can also expose workers to musculoskeletal symptoms [7]. Furthermore, VDU work with long working hours, high mental demands and hectic work pace without a sufficient work–rest regimen elevates muscle tension, which is a risk factor for musculoskeletal symptoms [1, 8]. Both peak and cumulative musculoskeletal discomfort predict future musculoskeletal pain in healthy workers [9].

Preventing musculoskeletal symptoms can be enhanced with early interventions [10]. Different preventive health promotion programmes are common in the workplace where they extend care provided by occupational health services. However, most preventive programmes have been initiated in the workplace where the rate of musculoskeletal symptoms was already high [10, 11, 12, 13]. Prevention programmes usually help to treat symptoms, whereas they should prevent the exposure of healthy subjects to risk factors, which result in symptoms [14, 15].

Types of ergonomics interventions may vary from an exercise to an adjustment of workstation, furniture, equipment, lighting or work–rest regimen [11, 15, 16, 17]. It is difficult to find convincing evidence that ergonomics measures decrease work-related musculoskeletal symptoms and enhance health [18, 19]. Workplace interventions have poor planning, implementation or reporting and process outcomes have frequently been inadequately documented [19]. Moreover, nature of a phenomenon is very complex and it is impossible to control all variables. However, a review of participatory ergonomics interventions showed relatively positive impacts on musculoskeletal symptoms and injuries, and a reduction in compensation claims and sick leave days [20].

Physical ergonomics interventions in VDU work focus on care or secondary prevention of musculoskeletal symptoms. An active ergonomics training programme increased the knowledge of ergonomics through enhancement of perceived control over a physical working environment and it decreased the risk of musculoskeletal symptoms in 216 office workers [21]. In studies with office workers, hands-on ergonomics education and consultation [22], and workstation improvements with ergonomics counselling [23] were effective in improving daily postural comfort and decreasing musculoskeletal symptoms. Moreover, ergonomics training programmes generate behavioural changes, improvements of work postures and practices, and achieve reductions in risk and pain [23, 24]. There are also indications that musculoskeletal symptoms in VDU work can be reduced by either implementing an intensive ergonomics approach or simply by providing educational ergonomics. The co-operative planning with and active involvement of both workers and practitioners were the most effective way to improve physical ergonomics of VDU workplace [17]. However, all of these interventions focused on small groups of subjects and typically musculoskeletal symptoms were already prevalent.

The aim of this study was to investigate the differences in self-reported musculoskeletal symptoms and VDU working conditions in subjects who had contact with Erggis, i.e., individuals being educated with the Erggi action model, compared to subjects who had no contact with Erggis while being educated with the Erggi action model and at one-year follow-up.

2. METHODS

A quasi-experimental and longitudinal field study design consisted of pre-intervention, post-intervention and follow-up questionnaires.

2.1. Intervention: Erggi Action Model

The intervention in this study (the Erggi action model) consisted in the workplace health promotion based on educating volunteers called Erggi, who were working at various departments at the university. Erggis participated in the Erggi action model with a permission of the supervisor of their department. An Erggi was an expert in basic ergonomics of VDU work in an office after participating in the Erggi action model education. An Erggi can guide and help co-workers by tutoring during and after the Erggi action model education. Tutoring can include counselling workers in microergonomics such as adjustments or acquisitions of office furniture and in maintenance of a good working posture. An Erggi as a colleague was close to co-workers and easy to ask for help. Contact with an Erggi can be initiated by a worker, a head of a department, a representative of occupational health care or through activities of an Erggi (such as a tour round a department to check ergonomics details or group discussions at department meetings). Hence, an Erggi was an active developer of ergonomics in departments as a part of the workplace health promotion programme. An Erggi can identify relevant sources of information or contacts such as the occupational health services for difficult problems related to ergonomics or workplace health promotion.

The educational programme of the Erggi action model consisted in basic and advanced participatory learning and training in groups for 18 months. The programme included lectures on physical strain in VDU work, practical training in the workplace, completing a personal ergonomics developmental task, presentation of a task, a practical session and a closing session (Figure 1). Implementation of actions performed by Erggis in their workplace was the main practical element of the Erggi action model. Discussions about ergonomics and tutoring workers were frequent actions. Before activities, Erggis informed their departments of a new role with e-mails and meetings. The Erggi action model included ergonomics actions in departments during and after Erggis' education.

2.2. Subjects

One thousand workers from 37 university departments (one or two workers from each department) took part in this study. The mean number of workers in each department with Erggis was 39 (range: 2–270 workers per department) and in departments without Erggis the mean number of workers was 69.

2.3. Questionnaires

The effects of the Erggi action model and its practical implementations were studied with three prospective questionnaires. The questionnaires were mailed to the subjects at the beginning (pre) and end (post) of the Erggi action model education, and one year later (follow-up). Although the questionnaire (the same one was used in the three phases) was developed for this study, most questions were based on questionnaires such as the Nordic questionnaire [25]. Of the 1000 workers who received the pre- and post-questionnaires, 568 subjects returned the first questionnaire and 338 returned the second one. In the follow-up phase, 336 subjects returned the questionnaire. About 40% of the subjects (n = 181) returned both pre- and post-questionnaires and ~20% of the subjects (n = 90) returned all three questionnaires. The subjects who responded to at least two questionnaires were included in this study.

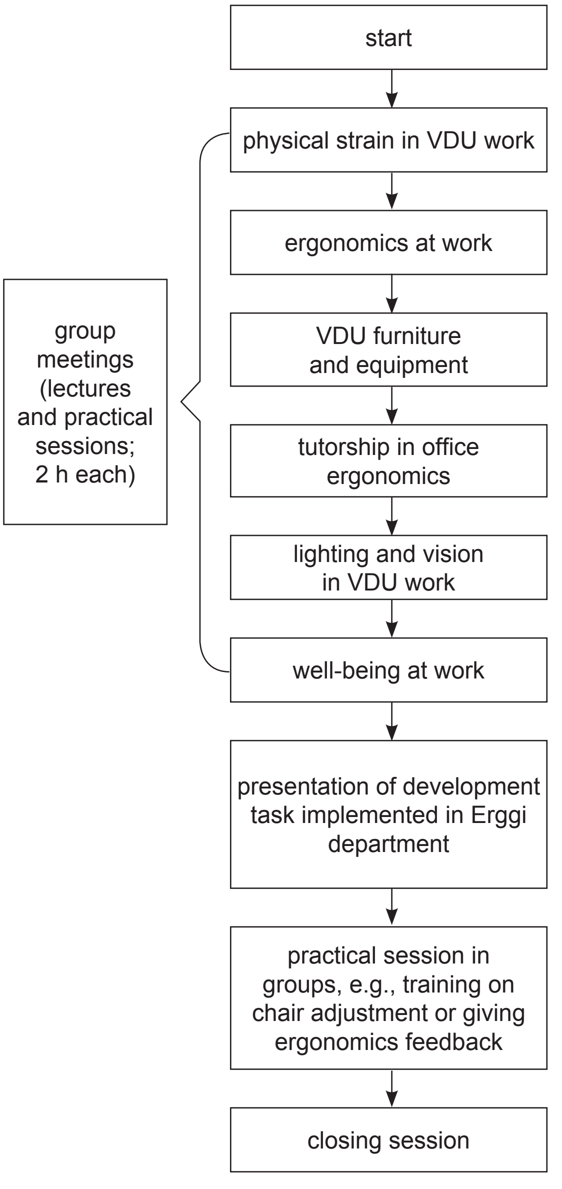

Figure 1. Erggi action model. *Notes.* VDU = video display unit.

Background factors were gathered for this study with questions on gender, age, position at a university (trichotomized into professors/teachers/researchers, office staff, laboratory staff and others), type of employment (permanent/nonpermanent position), working time (h/day),

Data on potential symptoms, absences and ergonomics-related issues were also gathered with questions on musculoskeletal symptoms impairing work during the past week (*no*/*yes* with area or symptoms), sick leave because of musculoskeletal discomfort during the past 12 months (measured on a 4-point scale: *none*, *1–9 days*, *10–29 days*, *30 days or over*, but dichotomized into two classes: *sick leave* and *no sick leave*), and self-rated possibility to influence musculoskeletal symptoms (measured on a 4-point scale: *no*, *somewhat*, *much* or *very much*, but dichotomized into: *no possibilities* and *yes*). There were also questions on the age of furniture and computer for VDU work (measured on a 4-point scale: *0–2 years*, *3–5 years*, *6–10 years*, *11 years or over*) and the number of hours of VDU work. The questionnaires included dichotomized items (*yes*/*no*) of ergonomics attitude of co-workers and managers, and characteristics of VDU workstation such as adjustability and material of the chair, space for feet and support for forearms.

During the Erggi action model, an occupational physiotherapist checked the workplace as an ordinary measure of the occupational health services. The actions promoting occupational health were not controlled in this study. The potential effect of the occupational health services on this study was considered with a selection of predictive variables. The question "Did you have an ergonomics contact with an Erggi during the past 12 months?" limited actions of interest to the Erggi action model. The potential confounding effect of actions of the occupational health services was minimized and was similar among all subjects in the study.

The Ethical Committee of the University of Kuopio and the Kuopio University Hospital approved the study.

2.4. Statistical Analyses

SPSS version 14 was used for data analysis. Data obtained from the questionnaires were cross-tabulated by ergonomics aspects of the workplace and work techniques. Statistical significance of differences between the subjects with and without contact with the Erggi action model was calculated with a contingency table analysis with the χ^2 test.

The statistical analyses based on the comparison between two groups which were formed according to the dichotomized variable "ergonomic contact with an Erggi" in the post-questionnaire (*yes*/*no*). The self-reported musculoskeletal symptoms during the past week in the follow-up questionnaire were the outcome of the study and were dichotomized into *no musculoskeletal symptoms* and *symptoms impairing work during the previous week* (*yes*/*no*). Variables included in the analyses from the pre-questionnaire (one time point only) were age, gender, position at a university and permanent/nonpermanent position. Data on perception of ergonomics at a VDU workplace, age of a VDU workplace, number of self-reported musculoskeletal symptoms, sick leave because of musculoskeletal reasons, and possibility to influence musculoskeletal symptoms described in three questionnaires were included. These variables showed significant differences in the χ^2 test ($p < .05$).

Firstly, crude logistic regressions were performed for each factor from the χ^2 test to obtain odds ratio (*OR*) and 95% confidence interval (CI). All analyses were adjusted to age. Secondly, significant variables from the crude logistic regressions were analysed with a backward multiple logistic regression. The contribution of each variable added step-wise to current multiple regression models was checked with *p*. The variable with the lowest *p* in each step was removed. The steps continued until all variables in the model contributed at $\leq .05$.

3. RESULTS

The mean age of the subjects was 39 years (range: 19–64). Fifty percent of the subjects were university teachers and researchers (50%), and women (68%). The average daily working hours of a VDU worker was 5.5 h (range: 0.3–15.0). For 86% of the subjects, the workstation (furniture and computer) were under 5 years old (Table 1).

TABLE 1. Characteristics of Subjects

Characteristic, *M* (*SD*)	Pre-Questionnaire	Post-Questionnaire	Follow-up Questionnaire
Age (years)	39.3 (10.1)	40.7 (10.5)	40.6 (10.8)
Work experience at university (years)	8.0 (7.7)	9.0 (8.0)	9.1 (8.0)
Work at VDU (h/day)	5.4 (2.0)	5.4 (2.0)	5.6 (2.0)

Characteristic, *n* (%)	Pre-Questionnaire	Post-Questionnaire	Follow-up Questionnaire
Women	353 (68)	218 (73)	203 (67)
Position at university			
professor	30 (6)	13 (4)	15 (5)
teacher or researcher	252 (50)	129 (43)	139 (47)
laboratory staff	41 (8)	28 (9)	21 (7)
office staff	171 (34)	121 (41)	110 (37)
other	8 (2)	6 (2)	13 (4)
Permanent position	206 (40)	138 (47)	137 (46)
Age of VDU workstations (years)			
0–2	241 (48)	129 (45)	126 (42)
3–5	195 (39)	111 (39)	129 (43)
6–10	56 (11)	37 (13)	37 (12)
>10	14 (3)	11 (4)	6 (2)
Weekly musculoskeletal symptoms interfering work (versus *no*)	269 (52)	167 (56)	114 (38)
Sick leave days in past 12 months caused by musculoskeletal reasons (versus *no)*	87 (17)	49 (16)	44 (15)
Reason for musculoskeletal sick leave			
neck-shoulder	13 (19)	13 (31)	17 (44)
upper limb	15 (22)	5 (12)	5 (13)
upper back	2 (3)	3 (7)	2 (5)
low back	38 (56)	16 (38)	15 (39)
VDU ergonomics (versus *less than good*)	308 (61)	195 (68)	228 (78)
Possibility to influence musculoskeletal symptoms (versus *less than good*)	396 (78)	218 (75)	235 (79)

Notes. VDU = video display unit.

Before the Erggi action model, 52% of the subjects were suffering from musculoskeletal symptoms on a weekly basis, whereas 38% at one-year follow-up (Table 1). Most of the musculoskeletal sick leave were caused by low back problems in the pre- (56%), post- (38%) and follow-up questionnaires (39%). Before the Erggi action model, 61% of the subjects considered the ergonomics of their VDU workstation to be at least good. Most subjects (78%) believed that they could influence musculoskeletal symptoms. There were no significant changes in ergonomics of VDU workstation and in perceived possibilities to influence musculoskeletal symptoms during the Erggi action model education according to the post- and follow-up questionnaires.

The male subjects who had contact with an Erggi and had a permanent position before the Erggi action model had a higher risk for musculoskeletal symptoms in the follow-up questionnaire (Table 2). Moreover, in the pre- and post-questionnaires, musculoskeletal symptoms were significant predictors. Perceived possibilities to influence musculoskeletal symptoms and good VDU ergonomics were associated with less risk. Sick leave was significantly associated with musculoskeletal symptoms in the follow-up questionnaire. The male subjects who did not have contact with the Erggi showed significant association with less risk for musculoskeletal symptoms in the follow-up questionnaire. Moreover, having a less than 2-year-old VDU workstation was a protective factor before the intervention, but associated with a higher risk in the follow-up

TABLE 2. Logistic Regressions Data Predicting Self-Reported Musculoskeletal Symptoms in Follow-Up Questionnaire

	Pre-Questionnaire			
	No Contact With Erggi		Contact With Erggi	
Characteristic	*OR*	95% CI	*OR*	95% CI
Male	**0.31**	**[0.19, 0.54]**	**1.65**	**[1.03, 2.67]**
Permanent position	**0.49**	**[0.30, 0.80]**	**2.60**	**[1.53, 4.42]**
Position at university				
professor, teacher or researcher	1.00	ref	1.00	ref
office staff	**3.67**	**[2.20, 6.12]**	0.79	[0.49, 1.27]
laboratory or other staff	0.86	[0.43, 1.73]	0.82	[0.40, 1.67]
Age of VDU work stations (less than 2 years)	**0.42**	**[0.20, 0.78]**	0.71	[0.39, 1.31]
Good VDU ergonomics	**6.06**	**[3.64, 10.09]**	0.48	[0.51, 1.36]
Musculoskeletal symptoms weekly interfering with work	**5.19**	**[3.13, 8.62]**	**3.56**	**[2.25, 5.62]**
Sick leave	**5.90**	**[2.74, 12.70]**	1.11	[0.63, 1.95]
Influence on musculoskeletal symptoms	**0.16**	**[0.07, 0.34]**	**0.28**	**[0.15, 0.52]**
	Post-Questionnaire			
	No Contact With Erggi		**Contact With Erggi**	
Characteristic	***OR***	**95% CI**	***OR***	**95% CI**
Male				
Permanent position				
Position at university				
professor, teacher or researcher				
office staff				
laboratory or other staff				
Age of VDU work stations (less than 2 years)	1.65	[0.86, 3.16]	1.59	[0.98, 2.56]
Good VDU ergonomics	**7.53**	**[4.44, 12.78]**	**0.54**	**[0.32, 0.93]**
Musculoskeletal symptoms weekly interfering with work	**1.84**	**[1.16, 2.91]**	**7.36**	**[4.34, 12.47]**
Sick leave	**2.71**	**[1.46, 5.03]**	1.59	[0.95, 2.67]
Influence on musculoskeletal symptoms	**0.29**	**[0.17, 0.49]**	**0.59**	**[0.35, 1.00]**
	Follow-up Questionnaire			
	No Contact With Erggi		**Contact With Erggi**	
Characteristic	***OR***	**95% CI**	***OR***	**95% CI**
Male				
Permanent position				
Position at university				
professor, teacher or researcher				
office staff				
laboratory or other staff				
Age of VDU work stations (less than 2 years)	**2.66**	**[1.45, 4.88]**	1.59	[0.94, 2.67]
Good VDU ergonomics	1.22	[0.71, 2.11]	**0.51**	**[0.29, 0.89]**
Musculoskeletal symptoms weekly interfering with work	—	—	—	—
Sick leave	**4.68**	**[2.53, 8.64]**	**2.16**	**[1.35, 3.46]**
Influence on musculoskeletal symptoms	**0.21**	**[0.11, 0.37]**	**0.17**	**[0.09, 0.30]**

Notes. OR = odds ratio, CI = confidence interval, VDU = video display unit. Boldface indicates statistically significant *OR* with 95% CI.

questionnaire. Moreover, good VDU ergonomics, musculoskeletal symptoms, sick leave increased the risk for musculoskeletal symptoms, whereas the possibility to influence musculoskeletal symptoms decreased risk for musculoskeletal symptoms in the follow-up questionnaire. The comparison between the subjects with and without contact with an Erggi showed that good VDU ergonomics protected those who had a contact with an Erggi. A sick leave was a risk factor for the subjects without contact with an Erggi in the pre-questionnaire, but that difference disappeared after being educated with the Erggi action model in the post-questionnaire.

Multiple regressions showed that for the subjects with contact with an Erggi, musculoskeletal symptoms and sick leave were significant predictors before the Erggi action model when accounting for all the significant factors (Table 3). Sick leave remained significant at all measurement points and had an influence on musculoskeletal symptoms in the follow-up questionnaire. For the subjects without contact with the Erggi, musculoskeletal symptoms at the pre-questionnaire only remained significant. The comparison between the subjects with and without contact with the Erggi showed no significant differences when accounting for multiple factors at the same time.

4. DISCUSSION

This study investigated the differences in self-reported musculoskeletal symptoms and VDU working conditions during the Erggi action model

TABLE 3. Multiple Logistic Regression for Self-Reported Musculoskeletal Symptoms in Follow-Up Questionnaire for Factors, Which Were Significant in Crude Logistic Regressions (Table 2)

	Pre-Questionnaire			
	No Contact With Erggi		Contact With Erggi	
Characteristic	*OR*	95% CI	*OR*	95% CI
Male				
Good VDU ergonomics (versus *less than good*)	0.54	[0.20, 1.08]	1.70	[0.59, 4.99]
Musculoskeletal symptoms weekly interfering with work (versus *no*)	**8.13**	**[1.96, 33.76]**	**5.80**	**[1.97, 17.11]**
Sick leave (versus *no*)	7.53	[0.49, 116.63]	**3.93**	**[1.02, 15.25]**
Influence on musculoskeletal symptoms (versus *no*)				

	Post-Questionnaire			
	No Contact With Erggi		Contact With Erggi	
Characteristic	*OR*	95% CI	*OR*	95% CI
Male				
Good VDU ergonomics (versus *less than good*)	0.34	[0.06, 1.90]	0.69	[0.17, 2.79]
Musculoskeletal symptoms weekly interfering with work (versus *no*)	3.05	[0.57, 16.24]	1.49	[0.41, 5.45]
Sick leave (versus *no*)	na	na	**5.57**	**[1.61, 19.36]**
Influence on musculoskeletal symptoms (versus *no*)			2.54	[0.59, 10.99]

	Follow-Up Questionnaire			
	No Contact With Erggi		Contact With Erggi	
Characteristic	*OR*	95% CI	*OR*	95% CI
Male	**4.00**	**[1.40, 11.40]**	**3.16**	**[1.19, 8.39]**
Good VDU ergonomics (versus *less than good*)				
Musculoskeletal symptoms weekly interfering with work (versus *no*)	—	—	—	—
Sick leave (versus *no*)	**4.31**	**[1.21, 15.28]**	**3.58**	**[1.35, 9.47]**
Influence on musculoskeletal symptoms (versus *no*)	1.35	[0.50, 3.65]	**3.40**	**[1.31, 8.85]**

Notes. *OR* = odds ratio, CI = confidence interval, VDU = video display unit, na = not possible to evaluate because of limited number of subjects. Boldface indicates statistically significant *OR* with 95% CI.

and at the one-year follow-up. The study sample included middle-aged subjects, mainly university teachers or researchers, who used VDU in their work. Almost 50% of the subjects reported musculoskeletal symptoms in each phase of the study. In general, VDU workstations and the possibilities to influence musculoskeletal symptoms were considered as good and no major changes were detected during this study. The subjects who had contact with an Erggi were more likely to experience weekly musculoskeletal symptoms interfering with their work during the Erggi action model, but the subjects without contact were more likely to require sick leave. The findings of this study confirm the results of studies with more limited groups of workers including those with musculoskeletal complaints [17, 22, 24]. The Erggi action model was designed in accordance with the previous studies which showed that co-worker level activation is efficient in improving ergonomics and implementing safer working methods [26, 27, 28]. The Erggi action model aimed at practical actions in a cost-effective manner. Ergonomics counselling combined with group discussions was a very cost-effective way to improve workplace design and work techniques [26].

In this study, all workers reported increased ability to reduce their musculoskeletal symptoms. This perceived control had a significant role in previous ergonomics interventions [21, 24]. The intervention in the present study, the Erggi action model, did not have any specific influence on reducing musculoskeletal symptoms. However, as *OR* changed for several factors (i.e., musculoskeletal symptoms, sick leave and VDU ergonomics), increasing the awareness and knowledge, and control of the physical working environment at workstation might be necessary. In the present study, more male than female workers had contact with an Erggi. For unknown reasons, women exploit Erggi skills better than men. This gender difference might be related to the fact that musculoskeletal symptoms are more common among women than men [2, 29]. The results suggest that further studies are necessary. Ergonomics tutors such as Erggis can be effective in promoting workplace health and ergonomics at least among women.

A limitation of this study is the fact that all workers were aware of an Erggi or heard about it from co-workers. However, since this study used the quasi-experimental study design, where the subjects were compared to their own results before and after the Erggi action model, this limitation did not affect the results. Moreover, the result that good VDU ergonomics conferred a protective effect on the subjects with contact with an Erggi compared to a higher risk estimates for the subjects without contact throughout the study shows that limitation has not been a severe problem in this study. These results also agree with the previous studies [17, 28, 30, 31, 32]. The low response rate to the second and third questionnaire (20%) was another source of concern. The response rate in this study (20%–57%) is similar to the response rate in previous studies on office ergonomics [33, 34]. A study evaluating participation in longitudinal randomized clinical trials showed that the number of missed visits, dropouts and timing of dropout were nonrandom events and depended on certain characteristics, i.e., healthy subjects with fewer chronic symptoms were more likely to remain in the study [33]. This suggests that this study results may have been underestimated since the healthy subjects remained in the study.

The Erggi action model influenced workers who had contact with an Erggi. Those workers had a higher probability to influence their musculoskeletal symptoms and to decrease need for sick leave. This suggests that the Erggi action model can increase the awareness of musculoskeletal symptoms and knowledge of good ergonomics in VDU working conditions among university workers.

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