J Occup Rehabil (2008) 18:87–101
DOI 10.1007/s10926-007-9117-9

Improving Work Style Behavior in Computer Workers with Neck and Upper Limb Symptoms

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Published online: 4 January 2008

Abstract *Introduction* The goal of this study was to assess the effectiveness of a group-based interactive work style intervention in improving work style behavior. *Methods* Computer workers with neck and upper limb symptoms were randomised into the work style group (WS, $N = 152$), the work style and physical activity group (WSPA, $N = 156$), or the usual care group ($N = 158$). Both intervention groups received the same work style intervention but the WSPA group also received a lifestyle physical activity intervention. Participants from the intervention groups attended six group meetings which focused on behavioral change with regard to body posture and workstation adjustment, breaks, and coping with high work demands in order to reduce work stress. Stage of change, breaks and exercise behavior, and stress outcomes were assessed by questionnaire at baseline (T0) and after 6 (T1) and 12 months (T2). Body posture and workstation adjustment were assessed by observation and by questionnaire at T0, T1, and T2. Multilevel analyses were used to study differences in work style behavior between study groups. *Results* The work style intervention was effective in improving stage of change with regard to body posture, workstation adjustment, and the use of sufficient breaks during computer work. These findings were confirmed by higher self-reported use of breaks and exercise reminder software and less working hours without breaks. However, self-reported changes in body posture and workstation adjustment were less consistent. The work style intervention was ineffective in changing stress outcomes. *Conclusion* A group-based work style intervention seems to be effective in improving some elements of work style behavior. Future studies should investigate the effectiveness of work style interventions on all dimensions of the Feuerstein work style model.

Keywords Work style intervention · Behavioral change · Computer workers · Trans Theoretical Model · Workstation ergonomics

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Introduction

Neck and upper limb symptoms are frequently reported by computer workers. In the year 2002, 28% of the general Dutch working population suffered from pain or stiffness in the neck, shoulder, arms, hands, or wrists in the previous 12 months [1]. A survey conducted in 15 European countries showed a prevalence of 25% for work-related neck/shoulder pain and a prevalence of 15% for work-related arm pain [2]. The total yearly costs of neck and upper limb symptoms in the Netherlands due to decreased productivity, sick leave, chronic disability for work, and medical costs were recently estimated at 2.1 billion euros [3].

Work style has been proposed as a mechanism by which ergonomic and psychosocial risk factors interact to affect the development, exacerbation, and/or maintenance of neck and upper limb symptoms [4]. The concept of work style represents a learned and reinforced strategy that is used to complete, respond to, or cope with increased job demands. If these responses to high work demands are inadequate they might lead to the development and exacerbation of neck and upper limb symptoms. Individual differences in these responses may explain why some workers develop and maintain neck and upper limb symptoms whereas other workers with the same physical tasks, workstation, and job stressors in the same company do not [5]. Key component of inadequate work style is the perceived inability to discuss high work demands with the supervisor. As a result of high work demands, workers will be less inclined to pay attention to their body posture, to adjust their workstation properly, and to use break and exercise reminder software to insure work quality. Work style interventions may reduce neck and upper limb symptoms by improving work style behavior.

To improve work style in the workplace setting, theoretical models of behavior change might be useful [6, 7]. Although theoretical models of behavior change have been used frequently in smoking cessation programs [8, 9], physical activity interventions [10–12], and interventions that intend to improve healthy food intake [12, 13], they have not been applied to work style interventions yet. Therefore it is unknown whether work style interventions based on theoretical models of behavior change are effective in changing actual work style behavior such as using a sufficient number of breaks during computer work. A previous study in the same population showed that a group-based work style intervention was effective in reducing pain symptoms in computer workers with neck and upper limb symptoms [14]. However, this study did not report the effects on work style behavior.

The goal of our study was to investigate the effectiveness of a group-based interactive work style intervention in changing work style behavior (i.e., body posture and workstation adjustment), the use of sufficient breaks, and coping with high work demands in order to reduce work stress.

Methods

Design and Study Population

The RSI@Work study is a randomised controlled trial (RCT) with two intervention groups and a usual care group, an intervention period of six months and measurements at baseline and after six and 12 months of follow-up. The source population for this study consisted of computer workers ($N = \pm 8{,}000$) from the head-offices of seven Dutch companies in various branches (e.g., insurance, science, energy, transportation-policy, and taxes) in different regions of the Netherlands. The researchers used a short questionnaire to select workers who were eligible for participation in the study. This questionnaire was specially developed for this purpose and was focused on the prevalence of neck and upper limb symptoms. The screening questionnaire was not used to measure work style.

The following inclusion criteria were used:

(1) Frequent (i.e., at least once a week) or long term pain, stiffness or tingles in neck, shoulders, arms, wrists, and/or hands in the preceding six months and/or the last two weeks. By using a 6-month period and a 2-week period, we intend to include workers with chronic and recurrent symptoms as well as workers with recent symptoms.
(2) Performing computer work for at least three days a week during at least 3 h a day.
(3) A working contract until the last follow-up measurement.
(4) Not under treatment of a doctor or (physical) therapist for complaints in the neck, shoulders arms, wrists, and/or hands.
(5) No non-work related or clear somatic diseases (e.g., rheumatoid arthritis, cervical hernia, tennis elbow, carpal tunnel syndrome).
(6) Sickness absence of less than 50% of the total working time (i.e., worker is currently working at least 50% of the hours he or she is supposed to work according to his or her working contract).

All workers who gave informed consent and completed the baseline questionnaire were randomised into (1) the work style group (WS group), (2) the work style and physical activity group (WSPA) or (3) the usual care group.

The study was approved by the Medical Ethics Committee of the VU University Medical Center. The baseline measurements and follow-up measurements were conducted in October 2004 (baseline), April 2005 (six month follow-up), and October 2005 (12 month follow-up). A detailed description of the study design and study population has been published elsewhere [15].

Treatment Allocation and Blinding

An independent statistician prepared the randomisation by using a computer-generated randomisation. To prevent unbalanced randomisation, workers were pre-stratified by company and self-reported sports participation assessed with the baseline questionnaire. Furthermore, block randomisation with blocks of three was used. The researchers informed participants about their treatment allocation directly after they completed their baseline measurements. Workers who did not participate in the baseline measurements but sent their completed questionnaire and informed consent by post were randomised at the VU university medical center and were informed about their treatment allocation by phone or by email. Unfortunately it was impossible to blind participants and counsellors for the treatment allocation. However, the researchers who performed the follow-up measurements were not aware of the treatment allocation of participants except for the counsellors who also performed part of the measurements.

Interventions

Participants from the two intervention groups (WS and WSPA) attended interactive group meetings that focused on *behavioral change* with regard to body posture and proper workstation adjustment, the use of sufficient breaks during computer work, and coping with work stress. Group meetings of the WSPA group also focused on behavioral change with regard to physical activity [14], but the effectiveness of this part of the intervention is beyond the scope of this paper.

Like previous lifestyle physical activity intervention studies [10], the RSI@Work interventions were based on theoretical models of behavior change (i.e., the Trans Theoretical Model (TTM) and the Precaution Adoption Process Model (PAPM)). The TTM separates behavior change into five discrete stages that are defined by a person's past behavior and his or her plans for future action [16]. The PAPM resembles the TTM stages but introduces two new stages. These new stages distinguish between people who are unaware of an issue (Stage 1) and those who know something about an issue but never actively thought about it (Stage 2) [17]. Concepts of the PAPM and TTM, such as stage of change, awareness, self-efficacy, and decisional balance were used in the group meetings and applied to both the WS group and the WSPA group.

The interventions for the two intervention groups both consisted of six interactive group meetings in a 6-month period. Time between group meetings was about one month. Both intervention groups attended four large group meetings (with maximally 10 participants) and two small group meetings (with maximally three participants). The duration of the large group meetings was 1.5 h in the WSPA group and 1.0 h in the WS group. The duration of the small group meetings was 45 min in the WSPA group and 30 min in the WS group. All group meetings took place at the workplace, during work time (with permission of the employee), and under the supervision of a specially trained counselor. The counselors used standardized protocols that had been tested and improved during the pilot study. The goal of all group meetings was behavioral change with regard to work style behavior. As noted earlier, the WSPA group was additionally stimulated to improve general physical activity besides work style behavior. However, the content and duration of the work style intervention was similar in both intervention groups.

The goal of the large group meetings was to provide general information and to raise awareness about work style and to discuss and find solutions for general barriers with regard to behavioral change. The goal of the small group meetings was to provide participants with tailored advice based on their stage of change with regard to work style behavior. In addition, solutions for individual barriers with regard to behavioral change were discussed. A detailed description of each group meeting has been published elsewhere [15].

Measurements

All outcome measures were assessed three times: at baseline prior to the start of the intervention (T0), after six month intervention period (T1), and 12 months after the start of the intervention (T2).

Primary Outcome Measures

Body Posture and Workstation Adjustment

The following aspects were observed by trained observers by using a checklist while the participant was working (answering categories between brackets):

1. Monitor height (top of screen far beneath eye height, at eye height, above eye height). Monitor height was dichotomized into 'at eye level' or 'not at eye level.'
2. Monitor distance (shortest distance between the eyes and the computer screen) using a measuring tape. Monitor distance was dichotomized into 'sufficient' or 'not sufficient.' Depending on the size of the monitor, a distance between 50 and 105 cm was defined as sufficient.
3. Keyboard rotation compared to table edge (not rotated $<10°$, rotated $\geq 10°$).
4. Both elbows supported while typing (yes/no)
5. Elbow and forearm supported while working with mouse (yes/no)

6. Rotation of computer worker in relationship to the position of the computer screen (not rotated <10°, rotated ≥10°)
7. Back completely supported (yes/no)
8. Back straight (yes/no)
9. Neck rotation (not rotated <20°, rotated ≥20°)
10. Ulnar deviation while typing with left and/or right hand (yes/no)
11. Ulnar deviation while working with mouse (yes/no)

The following three aspects were self-reported (and illustrated with pictures) instead of observed because these aspects were difficult to observe (Figs. 1 and 3) or because the agreement between self-report and observation was very high (Fig. 2):

1. Desk/keyboard height: What is usually your keyboard height compared to your elbow height (a. keyboard above elbow height, b. keyboard at or below elbow height) (Fig. 1)?
2. Keyboard tilt: Is your keyboard usually tilted (yes/no) (Fig. 2)?
3. Shoulders raised: Do you have the tendency to raise your shoulders while working with the computer? (yes/no) (Fig. 3)

Use of Sufficient Breaks During Computer Work

The following questions were used (answering categories between brackets):

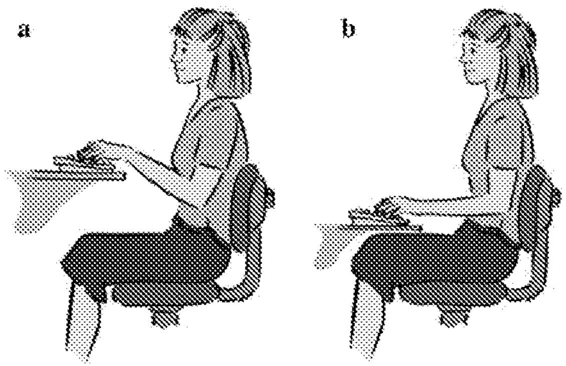

Fig. 1 Keyboard height above elbow height (**a**) and keyboard height at or below elbow height (**b**)

Fig. 2 Keyboard tilted (**a**), keyboard flat on desk (**b**)

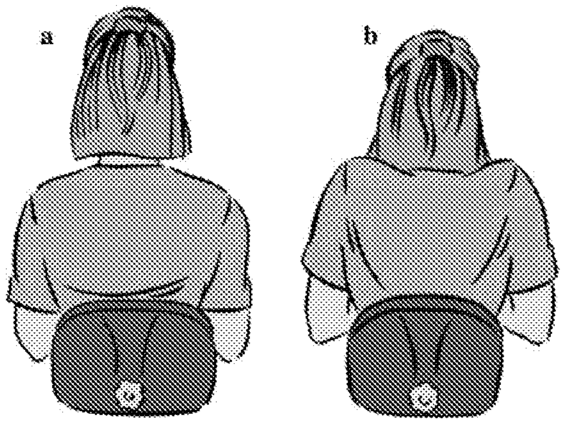

Fig. 3 Shoulders not raised (**a**), shoulders raised (**b**)

1. Use of breaks and exercise reminder software: Do you use breaks and exercise reminder software? (a. yes, b. no).
2. Breaks behavior: What do you usually do with breaks and exercises advised by these software programmes? (a. I have breaks and do exercises, b. I have breaks but no exercises, c. I neglect all advice).
3. How often do you work with the computer continuously for more than 1 h without having a break of at least 5 min? (a. never, b. sometimes, c. regularly, d. always)
4. How often do you sit continuously for more than 1 h without any standing or walking? (a. never, b. sometimes, c. regularly, d. always)
5. How often do you have short breaks (i.e. 5–60 s) during your computer work? (a. never, b. sometimes, c. regularly, d. always)
6. How many 5 min breaks do you have on an average working day (do not count the lunch break)? (number per day)

Answers on question 3–5 were dichotomized into never/sometimes or regularly/always.

Work Stress

A short version of the effort reward imbalance questionnaire [18] was used to assess perceived work stress and overcommitment. According to the effort reward imbalance theory, work stress occurs if the perceived working effort (i.e., time pressure, increasing demands) does not correspond with the reward that is obtained (i.e., job security, promotion prospects, monetary gratification, respect, and support during work). Overcommitment was conceptualized as the need for control (i.e., need for approval, competitiveness, disproportionate irritability, and inability to withdraw from work) [18]. The effort reward imbalance questionnaire has not been used frequently in a study population of computer workers with neck and upper limb symptoms [19]. However, Ostry et al. [20] showed that the effort reward imbalance model independently predicted poor self-reported health status and the presence of chronic diseases.

Phase of Behavioral Change with Regard to Work Style Behavior

Phase of behavioral change with regard to all three work style components was assessed by applying the Trans Theoretical Model and the Precaution Adoption Process model to the concept of work style. Participants were assigned to stages by asking them about their readiness to change behavior with regard to: 1. body posture/workstation adjustment; 2. using sufficient breaks; and 3. coping with work stress. Answering categories were as follows: 1. never thought about it; 2. thought about it but undecided; 3. decided not to change behavior; 4. decided to change behavior but has not started yet; 5. recently initiated the desired behavior; and 6. the desired behavior has maintained through time. Based on these answering categories participants were assigned to the pre contemplation phase (answering categories 1–3), the contemplation phase (answering category 4), the action phase (answering category 5) or the maintenance phase (answering category 6).

Data Analysis

Intention-to-treat analyses were used to estimate the effect of the intervention. This means that all participants who were randomly assigned to one of the two intervention groups were included in the analyses regardless of whether they attended the group meetings. To examine the success of randomization, descriptive statistics were used to compare baseline characteristics.

Primary Analyses

Multilevel analyses (MLwiN version 2.02) were used to study differences in work style behavior between the intervention groups and the usual care group at T1 and T2, using dummy variables for group and time. Multilevel analyses were used in order to adjust for possible dependency between observations of workers from the same company or for possible dependency between repeated measurements within workers. The data of this study were clustered at three levels: company, worker, and time. The interaction between group and time represents the intervention effect over time for each intervention group compared to the usual care group adjusted for baseline values of the outcome measure. In case differences in other baseline characteristics were observed adjusted multilevel analyses were conducted in order to check for confounding. The following baseline characteristics were considered as possible confounders: gender, age, level of education, years of computer work, hours of computer work per day, number of working days, and average pain intensity level in the past four weeks [21].

Proportional odds models were used to study intervention effects on stage of change. Results from these so-called ordered multinomial regression analyses can be interpreted as cumulative odds ratios [22]. In our proportional odds model, cumulative odds ratios below one indicate a shift from the earlier stages (i.e., precontemplation) to the later stages (i.e., action and maintenance). In the analyses with breaks behavior, a cumulative odds ratio above one indicates a shift from "I neglect all advice" to "I have breaks and do exercises."

Power Calculation

The number of participants in each group needed to detect a difference in recovery of neck and upper limb symptoms of 20% between the intervention group and the usual care group was ±80, with $\alpha = 0.05$ (two sided) and $\beta = 0.20$. This number was based on our expectation that recovery would be 80% in the intervention group and 60% in the usual care group. Since we expected a loss-to-follow-up of 40%, ±135 workers were needed in each group at baseline.

Results

Participant Flow and Baseline Characteristics

Approximately 8,000 workers were invited to participate in the RSI@Work study of which 466 were randomized into the trial (Fig. 4). All participants reported neck/shoulder symptoms and/or arm/wrist/hand symptoms that started longer than two weeks ago. Follow-up information was obtained from 84% ($N = 392$) of the participants at six months of follow-up (T1) and from 68% ($N = 318$) at 12 months of follow-up (T2). Figure 4 presents reasons for withdrawal of participants who officially quit to participate during the intervention period ($N = 41$). There were also participants who did not quit officially during the intervention period but who did not complete all follow-up measurements. Dropouts were defined as participants who did not fill out the final follow-up measurements

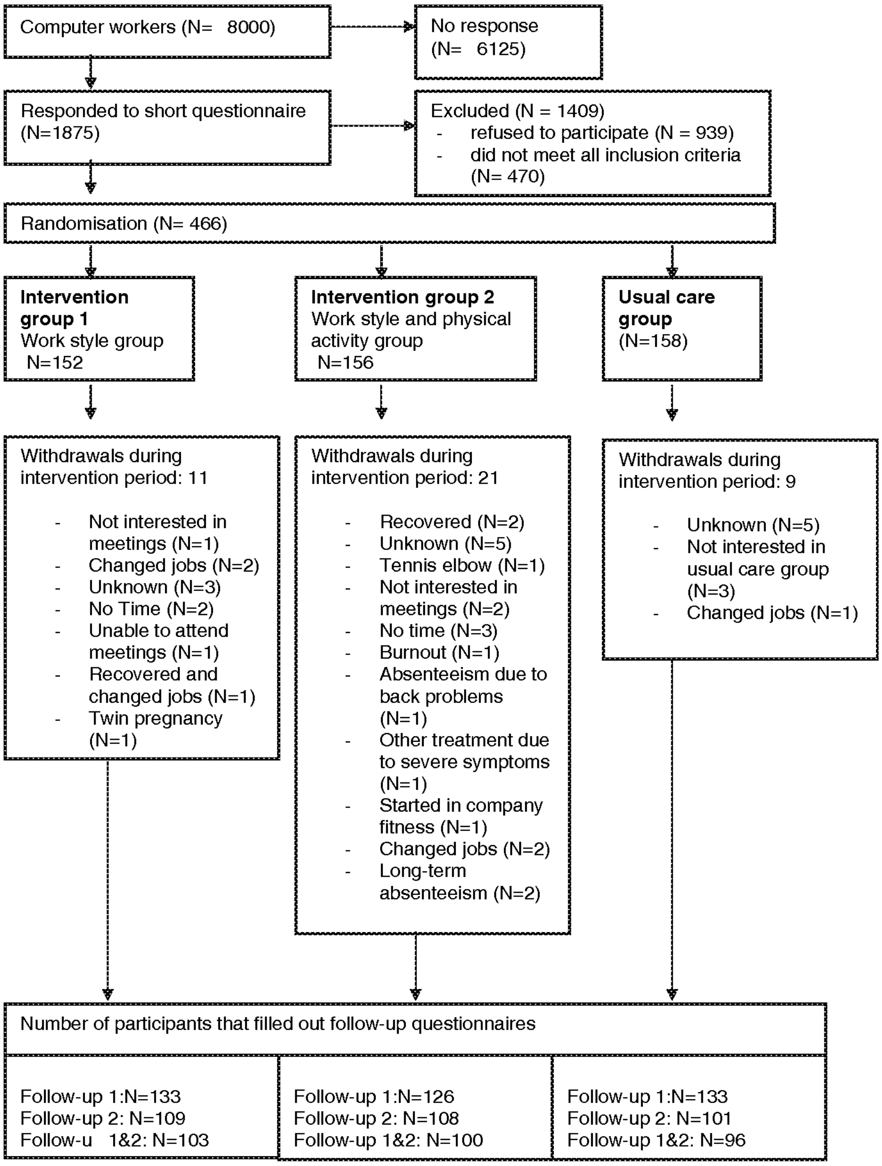

Fig. 4 Flow of participants in the RSI@Work study

($N = 148$). Females dropped out more frequently than men. Dropouts were younger on average, had a shorter history of computer work, and higher pain levels at baseline compared to participants who filled out the final questionnaire. Participants in the (pre)contemplation phase for using breaks and exercise reminder software were more likely to dropout than participants in the action and maintenance phases. This higher dropout among (pre)contemplators was observed in all three study groups. There was no higher dropout among (pre)contemplators for body posture and workstation adjustment, and coping with work stress.

Table 1 shows that baseline characteristics of participants were largely similar in all three study groups. Small differences were observed for level of education and average pain. Adjustment for these variables in multilevel analyses yielded similar results as unadjusted multilevel analyses. Therefore, only results from multilevel analyses adjusted for baseline values of outcome measures are presented. Table 2 presents the number of participants that attended 0, 1, 2, 3, 4, 5, or 6 group meetings. The number of participants that attended at least three group meetings was rather similar in the WS group (82%) and the WSPA group (78%). At baseline, no differences in stage of change outcomes were observed between the groups (Table 6). In the following paragraphs, the observed changes between the intervention groups and the usual care group between baseline and six months of follow-up are referred to as "short-term intervention effects." Observed changes between intervention groups and the usual care group between baseline and 12 months of follow-up are referred to as "long-term intervention effects."

Table 1 Baseline characteristics

	Work style ($N = 152$)	Work style & physical activity ($N = 156$)	Usual care ($N = 158$)
Gender (male)	83/152 (54.6%)	84/156 (53.8%)	92/158 (58.2%)
Age (years) (Mean, SD)	43.8 (8.5)	43.6 (8.7)	44.4 (8.5)
Level of education			
Low	6/149 (4.0%)	5/156 (3.2%)	3/157 (1.9%)
Moderate	75/149 (50.3%)	83/156 (53.2%)	80/157 (51.0%)
High	68/149 (45.6%)	68/156 (43.6)	74/157 (47.1%)
Years of computer work (Mean, SD)	10.9 (5.1)	10.5 (5.4)	10.9 (5.5)
Hours of computer work per day (Mean, SD)	6.1 (1.5)	5.7 (1.6)	5.8 (1.6)
Number of working days per week (Mean, SD)	4.6 (0.7)	4.5 (0.7)	4.5 (0.8)
Average pain intensity in the past 4 weeks (0–10) (mean, SD)	4.1 (2.2)	3.9 (2.0)	3.7 (1.9)
Prevalence of neck shoulder symptoms (average pain intensity $\geq$1)	132/151 (87.4%)	131/152 (86.2%)	140/155 (90.3%)
Prevalence of arm/wrist/hand symptoms (average pain intensity $\geq$1)	112/150 (74.7%)	114/148 (77.0%)	114/154 (74.0%)

Values are numbers (percentages) unless stated otherwise

SD: Standard deviation. None of the differences between groups were statistically significant

Table 2 Number of participants that attended 0, 1, 2, 3, 4, 5 or 6 group meetings in both intervention groups

Number of meetings attended	Work style	Work style & Physical activity
0	3 (2.0)	8 (5.1)
1	6 (3.9)	12 (7.7)
2	19 (12.5)	14 (9.0)
3	14 (9.2)	26 (16.7)
4	30 (19.7)	34 (21.8)
5	61 (40.1)	45 (28.8)
6	19 (12.5)	17 (10.9)

Percentage is presented between brackets

Work Style

Body Posture and Workstation Adjustment

Among the participants from the two intervention groups, there was a general tendency to improve behavior with regard to body posture and workstation adjustment compared to the usual care group. However, few of these improvements were statistically significant (Table 3). Furthermore, the results were not always consistent between the two intervention groups.

The work style intervention was effective in reducing keyboard tilt on the short and long-term in both intervention groups. In addition, it was effective in improving back support on the short-term and the number of participants working with a straight back on the short and the long-term but only in the WS group. Furthermore, the work style intervention was effective in reducing neck rotation in the WS group on the long-term but not in the WSPA group. An unhealthy change in ulnar deviation was observed in the WS group compared to the usual care group but only on the short-term. In the WSPA group only, the work style intervention was effective on the long-term in improving desk and keyboard height and in reducing the number of participants working with raised shoulders. In both intervention groups, the work style intervention was ineffective in improving monitor height, monitor distance, keyboard rotation, elbow (and forearm) support while typing and working with the mouse, rotation of the computer worker, and ulnar deviation while typing.

Use of Breaks and Exercise Reminder Software

In general there was a tendency of a healthy change in the use of breaks and exercises in both intervention groups compared to the usual care group between baseline and follow-up. However, not all of these healthy changes were statistically significant (Table 4). The results were consistent between the two intervention groups although more significant intervention effects were found in the WSPA group than in the WS group.

In both the WS group and the WSPA group, the work style intervention was effective in increasing the number of participants using breaks and exercise reminder software on the short-term and the long-term. However, participants from the intervention groups were not more likely than participants from the usual care group to act upon the breaks and exercise reminders. In other words, participants from the intervention groups were not more likely than participants from the usual care group to shift from the answering category “I neglect all advice” to “I have breaks

Table 3 Self-reported behavior with regard to body posture and workstation adjustment at baseline (T0) and at 6 (T1) and 12 months of follow-up (T2)

	Work style group			Work style and physical activity group			Usual care group			Intervention effect over time	
	T0	T1	T2	T0	T1	T2	T0	T1	T2	WS versus usual care	WSPA versus usual care
N	128	96	58	132	86	60	134	91	59	Odds ratio (95% C.I.)	
Monitor height (% at eye level)[a]	78.1	90.6	84.5	83.3	94.2	78.3	80.6	80.2	71.2	T1: 3.5 (0.9; 13.4) T2: 3.9 (0.9; 15.8)	T1: 4.0 (0.8; 19.7) T2: 1.2 (0.3; 4.6)
N	128	96	59	129	87	60	134	92	59		
Monitor distance (% sufficient)[a]	74.2	80.2	78.0	70.5	75.9	71.7	73.9	71.7	74.6	T1: 1.8 (0.6; 5.2) T2: 1.3 (0.4; 4.8)	T1: 1.5 (0.5; 4.3) T2: 1.0 (0.3; 3.5)
N	128	98	59	132	87	60	134	91	59		
Keyboard rotation (% <10°)[a]	92.2	84.7	96.6	86.4	82.8	91.7	85.8	86.8	93.2	T1: 0.4 (0.1; 1.5) T2: 1.0 (0.1; 6.7)	T1:0.7 (0.2; 2.1) T2: 0.8 (0.2; 3.7)
N	151	132	109	153	126	107	158	133	100		
Keyboard tilt (% no)[b]	46.4	81.1	82.6	42.5	84.9	85.0	46.8	54.9	66.0	T1: 6.6 (2.6; 16.5)* T2: 3.9 (1.4; 11.1)*	T1: 12.4 (4.6; 33.3)* T2: 6.5 (2.2; 19.5)*
N	151	133	109	156	125	108	158	133	101		
Desk/keyboard height (% at or below elbow height)[b]	84.1	95.5	96.3	85.9	96.0	98.1	88.0	94.7	92.1	T1: 1.6 (0.4; 6.0) T2: 3.3 (0.8; 13.7)	T1: 1.6 (0.4; 6.4) T2: 5.7 (1.0; 31.7)*
N	128	98	59	132	86	59	134	91	58		
Both elbows supported while typing (% yes)[a]	24.0	22.4	32.2	34.1	29.9	44.1	32.1	31.9	33.9	T1: 0.9 (0.3; 2.2) T2: 1.5 (0.5; 4.2)	T1:0.8 (0.3; 1.9) T2: 1.5 (0.6; 4.1)
N	129	98	59	132	87	60	134	92	59		
Elbow and forearm supported while working with mouse % yes)[a]	65.9	80.6	71.2	68.9	77.0	63.3	67.2	69.6	71.2	T1: 2.5 (0.9; 6.7) T2: 1.1 (0.4; 3.5)	T1: 1.5 (0.5; 3.9) T2: 0.6 (0.2; 1.9)
N	128	98	59	132	87	60	134	92	57		
Rotation of computer worker (% <10°)[a]	88.3	83.7	89.8	84.1	81.6	96.7	85.8	75.0	94.7	T1: 1.7 (0.5; 6.1) T2: 0.4 (0.0; 3.2)	T1: 2.1 (0.6; 7.2) T2: 2.1 (0.2; 27.8)
N	129	98	59	132	86	60	134	92	59		
Back completely supported (% yes)[a]	48.8	76.5	59.3	43.2	74.4	56.7	48.5	57.6	57.6	T1: 3.4 (1.4; 8.2)* T2: 1.1 (0.4; 3.1)	T1: 3.3 (1.4; 8.1)* T2: 1.2 (0.5; 3.3)
N	129	98	59	132	87	60	134	92	59		
Back straight (% yes)[a]	39.5	74.5	69.5	51.5	73.6	61.7	47.8	62.0	55.9	T1: 3.1 (1.3; 7.2)* T2: 2.9 (1.1; 7.8)*	T1: 1.5 (0.6; 3.5) T2: 1.0 (0.4; 2.6)
N	128	97	59	131	86	60	133	92	59		
Neck rotation (% <20°)[a]	86.7	88.7	96.6	92.4	94.2	85.0	89.5	85.9	86.4	T1: 1.7 (0.5; 5.6) T2: 6.4 (1.1; 38.9)*	T1: 1.9 (0.5; 7.7) T2: 0.6 (0.2; 2.4)
N	151	132	108	153	126	108	155	133	101		
Shoulders raised (% no)[b]	66.9	81.1	79.6	54.9	72.2	80.6	56.8	61.7	65.3	T1: 2.3 (0.9; 5.9) T2: 1.6 (0.6; 4.6)	T1: 2.4 (1.0; 5.8) T2: 3.2 (1.1; 9.0)*
N	128	98	59	132	87	59	134	92	58		
Ulnar deviation while typing with left and/or right hand (% no)[a]	68.8	70.4	79.7	72.0	71.3	79.7	68.7	71.7	72.4	T1: 1.0 (0.4; 2.5) T2: 1.6 (0.5; 4.6)	T1: 0.9 (0.4; 2.1) T2: 1.4 (0.5; 4.0)
N	129	98	59	132	87	60	134	92	59		
Ulnar deviation while working with mouse (% no)[a]	83.7	77.6	71.2	86.4	94.3	70.0	79.1	88.0	71.2	T1: 0.3 (0.1; 0.9)* T2: 0.8 (0.3; 2.4)	T1: 1.2 (0.3; 5.0) T2: 0.6 (0.2; 1.7)

[a] Observed; [b] self-reported; * $p < 0.05$; 95% C.I. = 95% confidence interval

Table 4 Self-reported behavior with regard to the use of breaks and exercise reminder software and the use of sufficient breaks in general at baseline (T0) and at 6 (T1) and 12 months of follow-up (T2)

	Work style group			Work style and physical activity group			Usual care group			Intervention effect over time	
	T0	T1	T2	T0	T1	T2	T0	T1	T2	WS versus usual care	WSPA versus usual care
N	152	132	109	156	126	108	158	133	101	Odds ratio (95% C.I.)	
Use of breaks and exercise reminder software (% yes)	51.3	87.2	76.2	37.9	77.7	75.0	43.0	51.8	59.4	T1: 9.7 (3.5; 27.0)* T2: 2.8 (1.0; 7.7)*	T1: 8.3 (3.2; 21.4)* T2: 4.6 (1.7; 12.7)*
N	152	131	109	156	126	108	157	132	99		
≥1 h computer work without breaks (% always/frequently)	66.4	38.9	36.7	52.6	32.6	25.0	58.6	53.0	48.5	T1: 0.2 (0.1; 0.6)* T2: 0.3 (0.1; 0.7)*	T1: 0.4 (0.2; 1.0)* T2: 0.3 (0.1; 0.8)*
N	152	131	109	156	125	108	157	133	101		
≥1 h computer work without walking or standing (% always/frequently)	48.7	39.7	30.2	46.8	24.0	21.0	51.6	45.9	37.7	T1: 0.8 (0.3; 1.8) T2: 0.7 (0.3; 1.7)	T1: 0.3 (0.1; 0.8)* T2: 0.4 (0.2; 1.1)
N	152	132	109	155	126	107	158	133	100		
Use of short breaks (% always/frequently)	59.9	71.2	68.8	66.5	83.3	83.2	58.9	60.1	62.0	T1: 2.2 (0.9; 4.9) T2: 1.6 (0.6; 3.9)	T1: 3.7 (1.5; 9.3)* T2: 3.0 (1.1; 8.3)*
N	78	115	83	56	98	81	68	69	59	Cumulative odds ratio (95% C.I.)	
Breaks behavior											
• Breaks and exercise (%)	12.8	19.1	18.1	10.7	24.5	19.8	14.7	21.7	22.0	T1: 2.5 (0.8; 8.0)	T1: 2.5 (0.7; 8.7)
• Breaks only (%)	55.1	65.2	68.7	66.1	65.3	65.4	61.8	65.2	61.0	T2: 2.6 (0.7; 9.1)	T2: 1.7 (0.5; 6.2)
• None (%)	32.1	15.7	13.3	23.2	10.2	14.8	23.5	13.0	16.9		
N	152	131	108	154	123	107	156	132	99	Mean difference (95% C.I.)	
Number of 5 min breaks (mean, SD)	3.6 (2.6)	4.2 (3.3)	4.3 (2.8)	4.2 (3.0)	4.8 (2.5)	4.9 (3.0)	3.6 (2.4)	3.7 (2.7)	4.0 (2.5)	T1: 0.6 (−0.1; 1.3) T2: 0.6 (−0.1; 1.3)	T1: 0.4 (−0.3; 1.1) T2: 0.3 (−0.4; 1.1)

* $p < 0.05$; 95% C.I. = 95% confidence interval

and do exercises." Nevertheless, the work style intervention was effective in reducing the number of participants working for one or more hours without taking any breaks in both intervention groups. Differences in effectiveness of the work style intervention were observed between the WS group and the WSPA group with regard to the number of participants working for 1 h or more without walking or standing (effective in WSPA group on the short-term but not in WS group) and the use of short breaks (effective in the WSPA group on the short and long-term but not in the WS group).

Work Stress

The work style intervention was ineffective in changing effort, reward, effort reward imbalance, and overcommitment in both intervention groups (Table 5).

Stage of Change

Table 6 presents the intervention effect over time for phase of behavioral change regarding all three components of work style behavior. In both intervention groups, the work style intervention was effective in moving participants from the earlier stages (i.e., (pre)contemplation) to the later stages (i.e., action and maintenance) with regard to body posture and workstation adjustment but only on the long-term. The work style intervention was also effective in moving participants from the earlier stages to the later stages with regard to the use of breaks and exercise reminder software on both the short and the long-term and in both intervention groups. With regard to coping with work stress, the work style intervention was ineffective in moving participants from earlier to later stages on the short-term in both intervention groups. On the long-term, a shift from the earlier to the later stages for coping with work stress was observed in the WSPA group but not in the WS group.

Table 7 presents a summary of the results on the various elements of work style behavior.

Discussion

The goal of our study was to investigate the effectiveness of a group-based interactive work style intervention on work style behavior (i.e., body posture and workstation adjustment, the use of sufficient breaks and coping with high work demands) in order to reduce work stress. The general idea behind our intervention was that neck and upper limb symptoms in computer workers might be reduced by improving work style behavior. A previous study in the same study population showed that our work style intervention was effective in reducing pain and in improving recovery in the neck/shoulder region [14]. The present study shows that our work style intervention was effective in moving participants from the (pre)contemplation phases to the action and maintenance phases with regard to body posture and workstation adjustment, and the use of sufficient breaks during computer work. These findings were confirmed by a tendency of healthy changes in self-reported use of breaks and exercises. The observed changes with regard to body posture and workstation adjustment, on the other hand, were not always consistent. The work style intervention was not effective in changing coping behavior with regard to work stress.

Changes in Body Posture and Workstation Adjustment

Although there was a general tendency among participants of the two intervention groups to improve body posture and adjust the workstation properly, only few aspects of the workstation and body posture components showed a significant change at the short- and the long-term. A possible explanation for the few significant changes is the relatively good body posture and workstation parameters at baseline which makes it difficult to show improvement. A second explanation is lack of validity and reliability of our questionnaire and observations. Spielholz et al. [23] found self-reports to consistently overestimate exposures for neck and upper limb risk factors compared to video observation and direct measurement. Insufficient validity and reliability of observational and self-report methods make it difficult to show intervention effects due to non-differential misclassification of participants into risk categories. The only aspect of the workstation that showed a significant improvement at the short- and long-term was keyboard tilt. In a pilot study preceding the intervention, we found that keyboard tilt was the only aspect of the workstation with an intraclass correlation coefficient (ICC) of 1.0 between self-report and observation. Most other aspects of the workstation and body posture parameters showed low agreement between self-report and observation (ICC < 0.5). Inter-observer reliability varied largely and was lowest for ulnar deviation while working with the mouse (kappa $= 0.5$) and working with a straight back (kappa $= 0.4$) and highest for elbow support while typing and elbow and forearm support while working with the mouse (kappa $= 0.8$).

Few other studies have assessed the effectiveness of ergonomic interventions on behavioral changes with regard to body posture and workstation adjustment [7, 24–26]. The comparability between studies is difficult since all studies evaluated different interventions. In addition, all

Table 5 Self-reported behavior with regard to coping with high work demands and stress at baseline (T0) and at 6 (T1) and 12 months of follow-up (T2)

	Work style group			Work style and physical activity group			Usual care group			Intervention effect over time	
	T0	T1	T2	T0	T1	T2	T0	T1	T2	WS versus usual care	WSPA versus usual care
N	141	127	108	149	122	104	148	127	94	Mean difference (95% C.I.)	
Effort (mean, SD)	11.7 (3.5)	12.3 (3.8)	12.1 (3.3)	12.2 (3.4)	12.0 (3.4)	11.5 (3.7)	12.6 (3.9)	12.2 (3.8)	12.0 (3.5)	T1: 0.7 (−0.1; 1.5) T2: 0.6 (−0.3; 1.5)	T1: −0.04 (−0.8; 0.8) T2: −0.2 (−1.1; 0.7)
N	114	105	88	125	107	90	119	109	89		
Reward (mean, SD)	48.0 (7.1)	47.7 (6.8)	48.3 (6.3)	48.5 (6.7)	47.6 (6.9)	48.2 (6.9)	49.2 (5.8)	48.9 (6.3)	49.2 (5.4)	T1: −0.2 (−1.7; 1.2) T2: 0.6 (−1.0; 2.1)	T1: 0.1 (−1.3; 1.5) T2: 0.3 (−1.2; 1.8)
N	110	104	87	121	107	88	116	106	86		
Effort reward imbalance (mean, SD)	0.56 (0.2)	0.58 (0.2)	0.55 (0.2)	0.58 (0.2)	0.57 (0.2)	0.54 (0.3)	0.58 (0.2)	0.56 (0.2)	0.54 (0.2)	T1: 0.02 (−0.04; 0.07) T2: 0.01 (−0.05; 0.06)	T1: −0.03 (−0.08; 0.03) T2: −0.02 (−0.07; 0.04)
N	147	130	108	150	124	105	153	132	101		
Overcommitment (mean, SD)	13.0 (3.4)	12.4 (3.5)	11.9 (3.5)	12.6 (3.4)	12.6 (3.6)	11.9 (3.5)	13.1 (3.2)	12.5 (3.2)	12.6 (3.2)	T1: −0.1 (−0.8; 0.5) T2: −0.02 (−0.7; 0.7)	T1: 0.4 (−0.2; 1.1) T2: −0.7 (−1.3; 0.03)

* $p < 0.05$; 95% C.I. = 95% confidence interval; SD = Standard deviation

studies used small study groups (i.e., maximally 150) and only two studies investigated long-term intervention effects [24, 25]. Only one study used observations to assess outcome parameters [25], similar as in our study, whereas other studies used self-report. All studies that used self-report found positive effects on knowledge and behavior [7, 24, 26] although some of these interventions consisted of one training session only [24, 26]. However, self-report may suffer from information bias because participants in the intervention groups are probably more likely than participants in the usual care group to give socially desirable answers, resulting in overestimation of the effectiveness of our work style intervention. The one study that used observations to assess ergonomic changes found no effect of a 1-h ergonomic training. This suggests that it might be more difficult to show observed than self-reported changes in body posture and workstation parameters.

Use of Sufficient Breaks During Computer Work

The observed healthy changes in the use of breaks in both intervention groups were in line with our expectations. It seems plausible to assume that the extra focus on physical activity in the WSPA group contributed to its higher success in reducing the number of participants who reported working with a computer for 1 h or more without walking or standing and in increasing the number of short breaks. In many programs that aim to reduce neck and upper limb symptoms, advice about sufficient breaks and/or exercises is incorporated [7, 24–30]. Yet, few studies have evaluated the effectiveness of these programs on actual changes in the use of breaks and exercises [31]. Monsey et al. [31] compared the compliance to stretch breaks between workers using breaks and exercise reminder software and workers who did not use breaks and exercise reminder software. Although compliance to stretch breaks in the first group was higher than in the second group the difference between the groups was not significant. However, since the study population in this study was small ($N = 26$), the absence of significant findings was probably due to lack of power.

Coping with Work Stress

The two sessions that were spent on coping with work stress were not effective in changing stress outcomes (i.e., effort reward imbalance and overcommitment). This result is in line with the study of Feuerstein et al. [29] that evaluated a cognitive behavioral intervention in workers with neck and upper limb symptoms. Feuerstein et al. [29] compared the effectiveness of a single ergonomic

Table 6 Stage of change at baseline and follow-up measurements and intervention effect over time

Phase of behavioral change	Work style group			Work style and physical activity group			Usual care group			Intervention effect over time	
	T0	T1	T2	T0	T1	T2	T0	T1	T2	WS versus usual care	WSPA versus usual care
Body posture/workstation adjustment	$N = 146$	$N = 129$	$N = 107$	$N = 152$	$N = 124$	$N = 104$	$N = 158$	$N = 127$	$N = 101$	Cumulative odds ratio (95% C.I.)	
Precontemplation (%)	8.0	1.6	0.9	12.3	2.4	0.9	8.8	7.7	7.0	T1: 0.9 (0.4;1.7)	0.6 (0.3; 1.2)
Contemplation (%)	26.8	3.8	4.6	26.6	0.8	1.9	24.1	13.8	20.8		
Action (%)	24.2	48.1	24.1	26.0	52.0	20.8	34.8	25.4	12.9	T2: 0.2 (0.1; 0.5)*	0.1 (0.04; 0.2)*
Maintenance (%)	40.9	46.6	70.4	35.1	44.8	76.4	32.3	53.1	59.4		
Breaks and exercise reminder software	$N = 152$	$N = 129$	$N = 109$	$N = 154$	$N = 124$	$N = 108$	$N = 158$	$N = 133$	$N = 99$		
Precontemplation (%)	36.2	9.9	9.1	32.2	7.2	6.5	36.1	24.1	24.0	T1: 0.4 (0.2; 0.7)*	0.4 (0.2; 0.7)*
Contemplation (%)	28.3	15.3	22.0	27.7	14.4	16.7	28.5	18.8	18.0		
Action (%)	10.5	32.8	11.9	12.9	33.6	14.8	13.3	22.6	12.0	T2: 0.3 (0.2; 0.7)*	0.3 (0.1; 0.6)*
Maintenance (%)	25.0	42.0	56.9	27.1	44.8	62.0	22.2	34.6	46.0		
Coping with high work demands and stress	$N = 150$	$N = 127$	$N = 109$	$N = 146$	$N = 124$	$N = 106$	$N = 158$	$N = 131$	$N = 101$		
Precontemplation (%)	13.9	7.7	11.1	12.6	8.0	2.8	10.8	12.9	11.9	T1: 1.0 (0.5; 1.9)	0.8 (0.4; 1.5)
Contemplation (%)	25.8	10.8	15.6	33.8	15.2	15.0	41.8	23.5	28.7		
Action (%)	11.9	31.5	20.2	13.2	29.6	24.3	13.9	15.9	16.8	T2: 0.8 (0.4; 1.7)	0.4 (0.2; 0.9)*
Maintenance (%)	48.3	50.0	53.2	40.4	47.2	57.9	33.5	47.7	42.6		

* $p < 0.05$; 95% C.I. = 95% confidence interval

Table 7 Summary of the results on the various elements of work style behavior

	WS versus usual care		WSPA versus usual care			WS versus usual care		WSPA versus usual care	
	T1	T2	T1	T2		T1	T2	T1	T2
Body posture and workstation adjustment					*Breaks*				
Monitor height	0	0	0	0	Use of breaks and exercise reminder software	+	+	+	+
Monitor distance	0	0	0	0	≥1 h computer work without breaks	+	+	+	+
Keyboard rotation	0	0	0	0	≥1 h computer work without walking or standing	0	0	+	0
Keyboard tilt	+	+	+	+	Use of short breaks	0	0	+	+
Desk/Keyboard height	0	0	0	+	Breaks behavior	0	0	0	0
Both elbows supported (typing)	0	0	0	0	Number of 5 min breaks	0	0	0	0
Elbow and forearm supported (mouse)	0	0	0	0	Phase of behavioral change	+	+	+	+
Rotation of computer worker	0	0	0	0	*Coping with high work demands and stress*				
Back completely supported	+	0	+	0	Effort	0	0	0	0
Back straight	+	+	0	0	Reward	0	0	0	0
Neck rotation	0	+	0	0	Effort reward Imbalance	0	0	0	0
Shoulders raised	0	0	0	0	Overcommitment	0	0	0	0
Ulnar deviation (typing)	0	0	0	0	Phase of behavioral change	0	0	0	+
Ulnar deviation (mouse)	+	0	0	0					
Phase of behavioral change	0	+	0	+					

+ Significant effect; 0 no effect

T1: difference between baseline and 6 months of follow-up

T2: difference between baseline and 12 months of follow-up

intervention with that of a combined intervention targeting both ergonomics and job stress. The job stress intervention consisted of two workshops about the identification and management of sources of job stress. The combined intervention was not more effective than the ergonomic intervention in reducing job stress and work-related upper extremity symptoms.

Concept of Work Style

Although all elements of work style, as conceptualized in this study, were measured, our concept of work style did not cover all the dimensions that are addressed in the Feuerstein model [4]. Our work style construct included both behavioral (e.g., body posture, workstation adjustment, using breaks) and some cognitive responses (e.g., effort reward imbalance, overcommitment) but no physiological responses. Physiological responses are difficult to measure in the workplace setting. It is unknown to what extent this had any impact on our findings. In addition, the cognitive responses that were assessed in the present study differed from the ones in the original work style model because we were interested in the concept of "effort reward imbalance." This concept, which we included in the present study, is not part of the Feuerstein model but seems to be a significant predictor for the development of neck and upper limb symptoms [32].

Strengths of the Study

This is the first study that investigates the effectiveness of modifying work style on certain elements of work style behavior and on pain and recovery [14]. Results of this study can help to improve work style interventions in order to make them more effective in reducing neck and upper limb symptoms. In contrast to most other workplace intervention studies, we used a stage-based approach to improve all our three work style components. Only two of the studies described in the previous section used models for behavioral change in the development of their interventions [7, 24]. Furthermore, we are one of the first to focus on behavioral change and behavioral maintenance in order to reduce symptoms in the field of work-related neck and upper limb symptoms. Finally the number of participants in our study is relatively large and we evaluated both short-term and long-term intervention effects.

Limitations of the Study

The first limitation is that contamination may have occurred since we randomized our participants on the participant's level and not on company level. In other words, participants from the two intervention groups could have discussed the group meetings with participants from the usual care group. In this way participants in the usual care group may have become aware of their unhealthy work style and changed their behavior. However, participants from the usual care group have not been guided during interactive group meetings which we believe is essential to improve work style on the long-term. The second limitation is the relatively large dropout in all of the three study groups. Part of the dropout might be explained by the fact that participants were not selected based on their work style behavior or physical activity at baseline. We expected that all workers could improve their behavior on at least one of the components of work style or physical activity. Nevertheless workers with a good work style and/or sufficient physical activity at baseline might have been less motivated to improve their behavior even further. The relatively high dropout among the (pre)contemplators for using breaks and exercise reminder software was not unexpected because (pre)contemplators are usually not or less motivated to adopt or maintain the healthy behavior. However, since all study groups, including the usual care group, showed the same selective dropout among (pre)contemplators it probably had little effect on our results. Finally, misclassifications are often observed when participants classify themselves into stage of change with regard to physical activity and dietary behavior [33–35]. Since stage of change was self reported, misclassification may have occurred for work style stage of change parameters as well. However, it seems that misclassification played only a minor role in our study since non differential misclassification will result in bias towards the null (i.e., weaker effects) while we found a strong shift from (pre)contemplation to action and maintenance for the use of breaks and exercise reminder software and body posture and workstation adjustment.

Conclusions and Future Directions

This study shows that intervening on work style in computer workers with neck and upper limb symptom seems to be effective in changing some elements of work style behavior. Together with the positive results on pain reduction that were previously reported [14], we conclude that work style interventions are promising with regard to the reduction of neck and upper limb symptoms. The work style intervention was least effective in changing stress outcomes. Possibly changes on the organizational level are needed in order to achieve such changes. By improving this part of the intervention we might be able to show stronger and more consistent improvements in work style behavior and neck and upper limb symptoms of computer workers. Future studies should use uniform instruments to assess work style (i.e., work style measure [5]) in order to improve the comparability between studies, preferably combined with observations of work style behavior. Furthermore, future studies should address all dimensions of the Feuerstein work style model.

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