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Participation during Major Technological Change and Low Back Pain

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Abstract: The development of IT involves major changes in many work settings. Theories of organizational change predict negative consequences of change-related work load on back pain to be less when employees participate in the planning and implementation of change. In a longitudinal field study the effects of participation in the introduction of a new internet service were tested. 29 employees (16 f, 13 m) of a municipal office were studied before, at the end of, and 6 months after implementation of an electronic service. Their participation in the planning and implementation of the project, psychosocial working conditions and back pain were assessed using standardized validated questions. 15 employees said that they had no influence on the project or were only informed of it, while 14 employees said that they could make suggestions, or even take part in decision-making. The two groups did not differ in experience of back pain six months before the project was started, but the group with low participation possibilities had significantly more back pain after the implementation of the project (p=0.021). There was no change in back pain in those employees who had sufficient possibilities of participation. Prevention of work related back pain during phases of technological change should involve employees in planning and implementation.

Key words: Occupational low back pain, Participatory ergonomics, Technological change, Computer work, Prevention

Introduction

The majority of work-related musculoskeletal disorders have a complex and multi-faceted aetiology[1)]. Among other factors, biomechanical load, psychosocial stress, health behaviour and pain-related cognitions are assumed to play an important role in the development of persistent Low Back Pain (LBP)[2)]. This field study tests whether technological change that increases computer work is an antecedent of increase in back pain and whether participation in the planning and implementation of technological change buffers its influence on LBP.

Reaction to work stressors leads to a catabolic state in which energy is provided in order to cope with the stressors. The stress response is characterized by activation of the sympathetic-adrenal medullary system (SAM), including catecholamine secretion, leading to increased heart rate and blood pressure. Moreover, activation of the SAM system leads to secretion of norepinephrine which heightens muscle activity because of an increased sensitivity of the synapses and by recruiting more muscle fibres when performing an activity[3)]. Studies by Lundberg and coworkers show that both mental stress and physical effort elevate electromyographic (EMG) activity. Thus, mental stressors can elevate the SAM system and EMG activity even in the absence of heavy physical work or bad posture[4–6)].

Implementation of a new technique that involves changes in performing most tasks is a major stressor[7, 8)]. New technologies do increase the intensity of computer office work that is associated with LBP[9)]. New technologies, and increase in computer office work, are work demands consistently described as risk factors for LBP in the literature[10)]. Furthermore, following the introduction of new technology, the main predictor of job satisfaction is low job control[8, 11)]. Job control includes having authority over making decisions and involves participat-

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ing in decision-making on what has to be done and how it should be done. Concerning the planning and implementation process of new technology, the most important aspect of job control is participation in planning and making decisions[12]. Participation may buffer the effects of major technological change on LBP because it allows active coping with technological change, namely adapting new tasks to an individual's style of working (e.g. by scheduling breaks between tasks) as well as anticipating and preventing work and organizational problems[10]. The more intensely employees take an active part in the change process, the less they feel they are helpless victims of change, losing control on how they do their work[10]. We therefore expect greater participation, such as playing an active role in planning and implementation, to be more preventive than less intense participation, such as only being informed of change while being expected to undergo an increase in mental strain during and after technological implementation[10]. We think that both the effects of mental work load during technological change and participation in the planning and implementation of technological change should be considered, which is in accordance with current models of occupational musculoskeletal pain, such as the 'Brussels model'[13], the Neuromotor Noise Theory[14], and the 'Cinderella model'[15]. Altogether, evidence is increasing that intense mental strain during computer work and lack of breaks contributes to the development of persistent LBP[9]. Nevertheless, there is still a lack of longitudinal field studies that assess major change in work characteristics, LBP, and job influence[16].

Since the implementation of new technology is associated with more stress, we expect higher LBP in all participants at the end of the implementation period (Hypothesis 1). Furthermore, we expect an interaction between the effects of the implementation of the new technology at work over time and participation in the planning and implementation of technological change. Those employees who could participate more actively in the planning and implementation of technological change should show less increase in LBP (Hypothesis 2).

Methods

Participants

The sample consisted of 47 employees of a municipal service organization in Switzerland. All staff was involved in a longitudinal three-wave study that lasted 16 months. 36 out of 47 employees completed the first questionnaire. 29 of those 36 completed a second questionnaire. The longitudinal sample from all three measurements was reduced to 20, since 7 employees left the organization during the period of study, and two participants did not take part in the final measurement. Informed consent was obtained from all participants. Table 1 shows the sample characteristics. The study was performed in consensus with all requirement defined by the Swiss Society of Psychology, including participants, e.g., information about their rights and guarantee of anonymity. Since the measurements were restricted to standardized validated questionnaires that were used in many studies before, no ethical approval for this study was necessary in Switzerland. The organizational change that included the introduction of the new technique was part of the SWISS government plans to introduce e-government in administration, i.e. democratically legitimized.

Material and procedure; introduction of a new internet service

The technological change process consisted of the development of an organizational internet portal, which included the offer of organizational services via the internet. The change process involved extra effort from all employees, who had to maintain their usual business while taking part in the project. The project started with a presentation to the employees and was introduced and organized in 6 modules of implementation including various feedback loops. Employees were invited to make comments on preliminary web sites and to participate in group meetings. Participation included planning of the input, processing, and output during Internet-based task completion. For instance, participation of employees was important with respect to the kind of personal information of employees that was published on the website. However, although all employees were invited to participate at the level of the organization, the process of participation had to be organized by supervisors on lower levels, which could induce differences in the actual participation offered to the employees. Additional information on the implementation process is available from the authors.

Questionnaires; participation

Regarding participation in the technological change process, participants in the study were asked to comment on how much they felt they were involved in decision-making during the change at the end of the implementation process in the second measurement. The participants made a graded response ranging from 'concerning decisions made about the internet project ...I had no influence' [1], 'I only was informed' [2], to 'I could make suggestions' [3], 'I took part in decision-making' [4] and 'I had considerable influence on decision-making' [5]. The item on participation was from the Instrument for Stress Oriented Task Analysis[17].

Table 1. Sample characteristics

		Baseline First FU		Baseline First FU Second FU	
		F	%	F	%
Age	1 <20	3	10.3	1	5.0
	2 20–30	6	20.7	5	25.0
	3 30–40	5	17.2	4	20.0
	4 40–50	7	24.1	4	20.0
	5 50–60	8	27.6	6	30.0
	Total	29	100.0	20	100.0
Sex	1 f	16	55.2	10	50.0
	2 m	13	44.8	10	50.0
	Total	29	100.0	100.0	
Tenure (yr)	1 <2	1	3.4	1	5.0
	2 2–3	4	13.8	3	15.0
	3 3–5	7	24.1	5	25.0
	4 5–10	5	17.2	2	10.0
	5 10–20	3	10.3	2	10.0
	6 >20	9	31.0	7	35.0
	Total	29	100.0	20	100.0
Participation	1 no influence	6	20.7	2	10.0
	2 only get informed	9	31.0	6	30.0
	3 can make suggestions	6	20.7	5	25.0
	4 participate on decisions	3	10.3	3	15.0
	5 have considerable influence	5	17.2	4	20.0
	Total	29	100.0	20	100.0
Participation (low/high)	1 low	15	51.7	8	40.0
	2 high	14	48.3	12	60.0
	Total	29	100.0	20	100.0
LBP t1	1 never	18	62.1	13	65.0
	2 less than monthly	5	17.2	3	15.0
	3 less than weekly	5	17.2	3	15.0
	4 less than daily	1	3.4	1	5.0
	5 daily	0	0.0	0	0.0
	Total	29	100.0	20	100.0
LBP t2	1 never	17	58.6	12	60.0
	2 less than monthly	2	6.9	1	5.0
	3 less than weekly	5	17.2	3	15.0
	4 less than daily	4	13.8	4	20.0
	5 daily	1	3.4	0	0
	Total	29	100.0	20	100.0
LBP t3	1 never			11	55.0
	2 less than monthly			5	25.0
	3 less than weekly			1	5.0
	4 less than daily			1	5.0
	5 daily			1	5.0
	Missing			1	5.0
	Total			20	100.0
Evaluation website: Information	1 bad	1	3.4	1	5.0
	2 moderate	12	41.5	12	60.0
	3 good	15	51.7	7	35.0
	Missing	1	3.4	0	0
	Total	29	100.0	20	100.0
Evaluation website: Design	1 bad	3	10.3	3	15.0
	2 moderate	11	38.0	9	45.0
	3 good	15	51.7	8	40.0
	Total	29	100.0	20	100.0
Evaluation website: Ease of navigation	1 bad	4	13.8	2	10.0
	2 moderate	12	41.4	9	45.0
	3 good	13	44.8	9	45.0
	Total	29	100.0	20	100.0

Low back pain

LBP was assessed as pain in the lower back felt in the last twelve months and was graded as 'never' [1], 'less than monthly' [2], 'less than weekly' [3], 'less than daily' [4] and 'daily' [5]). The item is part of a scale measuring psychosomatic complaints developed by Mohr[18], based on Fahrenberg[19]. Its validity in research on LBP has been shown in previous work[20, 21].

Evaluation of the website

At first follow-up all employees evaluated the Internet website. The website was evaluated by employees with respect to "Information", "Design", and "Ease of navigation", on a three-point scale graded as 'good' [1], 'moderate' [2], 'bad' [3].

Study design

The study had a longitudinal design. The baseline assessment was approximately two months before the technological change process started. After 10 months the second questionnaire was sent. This was at the time when the technological change process was finished. The third questionnaire was filled out 6 months after the 6 modules were finished and the participants had had 6 months of experience with the new technology.

Data analysis

LBP data were analyzed in a two-factorial ANOVA, including the repeated measurement of pain as a within-subjects factor and the participation in the technological change process as a between factor. For use as a between factor in ANOVA, the response option 'I have no influence', and the response option 'I only was informed', were recoded into 'no influence' [0] (15 participants) while the other response options were recoded into 'had influence' [1] (14 participants, Table 1). *p*-values were two-tailed with α set to 5%.

Results

Prevalence of LBP

Participants' reports on one-year prevalence of LBP at baseline showed that the majority of respondents experienced no LBP. A majority of 62.1% reported 'never' having experienced low back pain (Table 1). 17.2% of the participants reported low back pain 'less than monthly', Only a few participants reported more frequent pain ('less than weekly': 17.2%; 'less than daily' 3.4%; and 'daily': none). However, 10 months later, at the end of the technological implementation process, more frequent pain was reported ('less than weekly': 17.2; 'less than daily': 13.8%; and 'daily': 3.4%). After 6 months of working with the new technology, LBP was less frequent

Table 2. Correlations between study variables

Variables	Age	Sex	Tenure	Participation	Participation (low/high)	LBP t1	LBP t2	LBP t3	Information	Design	Ease of navigation
Age											
Sex	0.312 (p=0.100)										
Tenure	0.587 (p=0.001)	0.207 (p=0.282)									
Participation	0.188 (p=0.328)	0.539 (p=0.003)	0.095 (p=0.626)								
Participation (low/high)	0.035 (p=0.856)	0.517 (p=0.004)	–0.152 (p=0.430)	0.854 (p=0.000)							
LBP t1	0.466 (p=0.011)	–0.005 (p=0.978)	0.053 (p=0.784)	–0.115 (p=0.552)	–0.054 (p=0.782)						
LBP t2	0.530 (p=0.003)	–0.085 (p=0.663)	0.227 (p=0.235)	–0.423 (p=0.022)	–0.353 (p=0.060)	0.630 (p=0.000)					
LBP t3	0.069 (p=0.780)	0.154 (p=0.529)	0.114 (p=0.642)	–0.199 (p=0.413)	–0.082 (p=0.738)	0.399 (p=0.090)	0.248 (p=0.306)				
Information	–0.184 (p=0.348)	0.063 (p=0.750)	–0.178 (p=0.364)	0.251 (p=0.197)	0.252 (p=0.196)	–0.034 (p=0.865)	–0.147 (p=0.454)	–0.487 (p=0.034)			
Design	–0.282 (p=0.139)	–0.064 (p=0.139)	–0.375 (p=0.045)	0.246 (p=0.198)	0.340 (p=0.072)	–0.098 (p=0.612)	–0.243 (p=0.204)	–0.375 (p=0.113)	0.390 (p=0.040)		
Ease of navigation	–0.490 (p=0.007)	–0.003 (p=0.986)	–0.313 (p=0.098)	0.126 (p=0.515)	0.262 (p=0.170)	–0.174 (p=0.368)	–0.182 (p=0.346)	–0.507 (p=0.027)	0.756 (p=0.001)	0.504 (p=0.005)	

Table 3. Mean values of study variables in high and low participation groups

Variable	Low Participation (N=15)		High Participation (N=14)			
	Mean	SD	Mean	SD	t	p (two tailed)
Age (yr)	33.333	15.887	34.286	11.579	–0.183	0.856
Sex	12 f, 3 m		4 f, 10 m		χ^2=7.744	0.005
Tenure	4.333	1.676	3.857	1.512	0.801	0.430
LBP t1	1.600	1.056	1.571	0.852	0.080	0.937
LBP t2	2.400	1.454	1.500	0.941	1.992	0.058[a]
LBP t3	1.857	1.215	1.666	1.155	0.340	0.738
Information	2.357	0.497	2.643	0.633	–1.328	0.196
Design	2.067	0.704	2.500	0.519	–1.876	0.072
Ease of navigation	2.133	0.640	2.500	0.760	–1.409	0.170

[a]corrected for unequal variances.

again, almost reaching baseline values (Table 1). Correlations between study variables are shown in Table 2. Participation in the technological change process had a significantly negative relation to LBP during the implementation process (R=–0.423, p=0.022).

Table 3 shows descriptive results for the low and high participation subgroups. The evaluation of the design of the website tended to be more positive in the high participation group (p=0.072). At baseline mean LBP did not differ between groups. There were significantly more women in the low compared to the high participation group. Hence, in analysis of variance sex was introduced as a control variable (Table 4). In line with expectations (Hypothesis 1), LBP was found to have a tendency to increase during the implementation process (F(1,26)=4.717, p=0.039), but the increase was restricted to those who reported having had no participation in the change process (Fig. 1). LBP in those who reported to have participation in the change process remained rather unchanged. This significant interaction confirms the second hypothesis (F(1,26)=6.000, p=0.021). The same ANCOVA with inclusions of all three measurement points revealed no significant main effect of the implementation process (F(2,32)=1.238, p=0.304) or interaction effect of implementation process and participation (F(2,32)=1.902, p=0.166), which is in part due to the smaller sample of 20 participants in the three-wave longitudinal sample. It does show, however, that LBP tends to decrease again

Table 4. Two factorial ANCOVA

Innersubject Effects	Sum of Squares	df	Mean Square	F	*p*	Partial Eta-Square
Technological Change	2.086	1	2.086	4.717	0.039	0.154
Technological Change × Participation	2.654	1	2.654	6.000	0.021	0.188
Within subjects Error	11.500	26	0.442			
Between subjects Effects						
Constant	182.914	1	182.914	88.123	0.000	0.772
Participation	3.523	1	3.523	1.697	0.204	0.061
Between subjects Error	53.967	26	2.076			

All effects were controlled for sex.

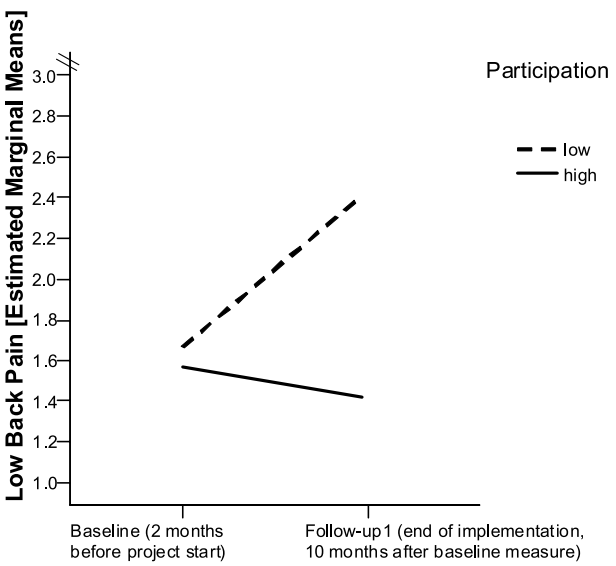

Fig. 1. Low back pain before and at the end of technological change implementation (N=29).

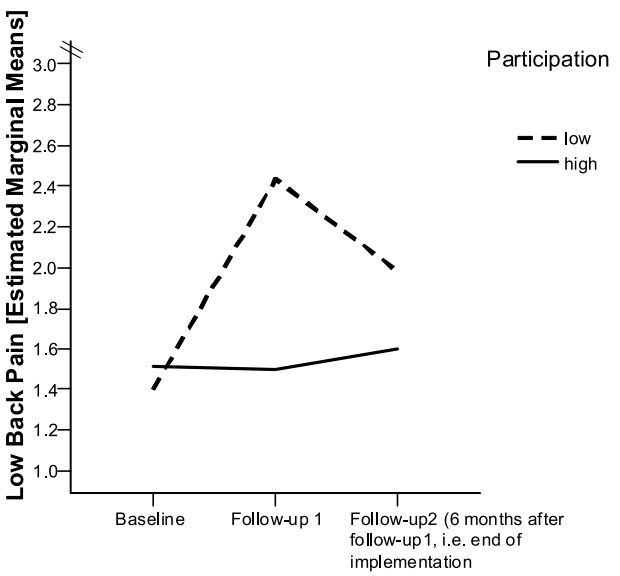

Fig. 2. Low back pain before, at the end and 6 months after the end of technological change implementation (N=20).

after 6 months of experience with the new technology (Fig. 2).

Discussion

During recent decades computer use by employees has increased dramatically. Despite the relatively low level of physical activity, computer work is closely associated with musculoskeletal pain[9]. Technologies are changing rapidly and employees have to adapt. New technologies do generate extra strain on employees. The question in this study is whether or not the consequences of this extra strain could be buffered by participation of employees in the change process[10]. The results confirm our expectation that participation may help prevent employees becoming ill during technological change. Employees should participate in the planning and implementation of new technologies, not only to maintain performance levels and work satisfaction[22] but also to prevent ill-health.

The small sample size and the fact that the participants were healthy with relatively comfortable jobs limited the possibility of generalizing the study's results, and there is need, therefore, for replication. Furthermore, although we asked for *opportunity* to participate, the measure may to some extent reflect employees' participatory behavior. There were significantly more women in the low participation group than men. We think that this pattern is not specific for our sample but common when technological change takes place in organizations. The repeated measurement approach in this study rules out gender bias which may weaken the conclusions that can be drawn from crossectional studies. The loss of participants from staff turnover during the study period was 7. We can not rule out bias here. All departing participants were asked whether their decision to leave was related to the technological change process. This was denied by all of them (reasons were end of contract/vocational training, etc.). From these reports bias is less likely.

Conclusion

This study makes a link between lack of participation in the planning and implementation of new technologies and development of musculoskeletal disorders. Against the background of increasing pressure for many employees[23], this study promotes the idea of participation in technology change —also known as participatory ergonomics[24]— as a way of preventing occupational LBP.

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