Applied Ergonomics 39 (2008) 743–753

APPLIED ERGONOMICS

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Prognostic factors for the effects of two interventions for work-related neck–shoulder complaints: Myofeedback training and ergonomic counselling

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Received 2 October 2006; accepted 17 November 2007

Abstract

Aim: To explore prognostic factors for the effects of two interventions (myofeedback training in combination with ergonomic counselling (Mfb/EC) and ergonomic counselling alone (EC)) on discomfort and disability in work-related neck–shoulder complaints.
Methods: Thirty-six females completed the interventions. Discomfort and disability were assessed at baseline, immediately after the intervention, and at 3-month follow-up. Potential sociodemographic and psychological prognostic factors were assessed using questionnaires. Data were analysed using multiple regression and general linear modelling.
Results: Changes in discomfort were best predicted by baseline discomfort levels. Changes in disability were predicted by baseline disability levels, patient profile, and coping strategy 'ignoring sensations'. A significant difference between the Mfb/EC and EC group was found for coping strategy 'ignoring sensations', which appeared to be a predictor for changes in disability at 3-month follow-up in the Mfb/EC group only.
Conclusions: Subjects with high levels of initial discomfort and disability and specific psychological patient profiles benefit most from interventions. Myofeedback training contributes a specific quality to those who ignore pain sensations.

Keywords: Work-related; Myofeedback; Prognostic factors

1. Introduction

Neck–shoulder pain is common and often long lasting. Lifetime prevalence of neck pain in females has been reported to be 43% (Borghouts et al., 1998). Neck pain is especially common among the working population: For instance, 15% of the working population in the Netherlands report complaints in that region (Blatter et al., 2005). As it has large consequences for individuals, health care, and society, there is an urgent need for adequate intervention programs for work-related complaints.

Work-related neck–shoulder complaints are multifactorial in nature (e.g. Andersen et al., 2003) and as a result different intervention approaches have emerged. Interventions often focus on adjustment of the work environment and education of ergonomic principles (e.g. Linton and van Tulder, 2001; Horgen et al., 2005). There is some evidence confirming the effectiveness of these interventions (Westgaard and Winkel, 1997; Verhagen et al., 2006) and well-designed work stations are considered a condition for healthy working. However, the prevalence of complaints among workers remains high (Westgaard and

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doi:10.1016/j.apergo.2007.11.007

Winkel, 1997), so there is a need for developing new interventions.

A relatively new intervention approach is the myofeedback training based on the Cinderella hypothesis of Hägg (1991). During this intervention (Hermens and Hutten, 2002), subjects wear a garment enabling continuous recording of upper trapezius muscle activation patterns. In contrast to classical feedback during which subjects receive feedback when muscle activation is too high, Cinderella-based myofeedback provides feedback when relaxation is insufficient. The feedback can make subjects aware of this insufficient relaxation and contribute to improve time spent in relaxation, which might result in a reduction of complaints. As interventions focusing on multiple factors have shown to be related to a decreased incidence of complaints (Lincoln et al., 2000), 4 weeks of Cinderella-based myofeedback training was combined with ergonomic counselling and showed clinically relevant improvements in about 50% of the subjects (Hermens and Hutten, 2002; Voerman et al., 2007). This suggests the presence of subgroups in which the intervention is beneficial, a common finding when evaluating the effectiveness of pain programs.

Identification of prognostic factors, factors that have predictive value regarding outcome of specific therapies, facilitates clinical decisions concerning the choice of interventions and the referral of subjects to appropriate intervention programs. The search for prognostic factors has mainly focused on low back pain programs. The factors appear to cover the whole spectrum of the biopsychosocial model of pain and disability of Waddell (1998) (e.g. Elkayam et al., 1996; Hasenbring et al., 1994; Bot et al., 2005). van der Hulst et al. (2005) classified the factors into either sociodemographic, physical, or psychological and concluded that the prognostic value of the physical factors is superimposed by the sociodemographic and psychological factors when considering the effect of multidisciplinary treatment in chronic low back pain (van der Hulst et al., 2005). In only a few studies prognostic factors for neck and/or shoulder pain have been investigated, showing that discomfort, duration and history of symptoms, disability, age, and well-being are related to outcome, (Croft et al., 1996; Hoving et al., 2004). The relation between these factors and outcome, however, appeared to be inconsistent (Borghouts et al., 1998) and the studies predominantly focused on prognostic factors for the clinical course of neck pain rather than for interventions. This information would however be useful for optimizing clinical decisions regarding the allocation of interventions.

The present study is an attempt to explore prognostic factors for the effect of interventions for work-related neck–shoulder complaints. Two interventions are considered in this perspective, i.e. Cinderella-based ambulant myofeedback training combined with ergonomic counselling (Mfb/EC) and ergonomic counselling only (EC). Outcome is defined in terms of discomfort and disability immediately after the interventions and at 3-month follow-up and prognostic factors for outcome were compared between the two interventions. As literature has shown that the physical factors have less predictive value, only sociodemographic and psychological factors were evaluated.

2. Methods

2.1. Design and subjects

This study was undertaken within the framework of a randomized clinical trial to evaluate the effectiveness of two interventions for persistent work-related neck–shoulder complaints, i.e. Mfb/EC and EC, on discomfort and disability. Subjects were randomly assigned to the Mfb/EC or the EC group. Measurements were performed prior to the intervention but before randomization (baseline, B), immediately after 4 weeks of intervention ($T0$), and after 3-month follow-up ($T3$). It was ensured that measurements were performed at the same time of the day (i.e. morning or afternoon) and at the same day of the week.

Participants were recruited regionally in the Netherlands, using the NEW-study questionnaire (Sandsjö et al., 2006), measuring sociodemographic characteristics, potential-risk factors for the development of work-related complaints, general health, and the extent and severity of complaints. Subjects eligible for participation were elderly female computer workers, typically over 45 years, working for at least 16 h a week and reporting *persistent* complaints in the neck and/or shoulder region for at least 30 days during the last year. These complaints had to be subjectively assigned to computer work, and as such were labeled work-related musculoskeletal complaints. Exclusion was based on reporting pain in more than three body regions for more than 30 days during the past 12 months, severe arthrosis, joint disorders, diagnosis cancer/tumour(s) diagnosis, or the use of muscle relaxants. Subjects were also excluded when reporting other complaints in the upper extremity not related to work.

The study was approved by the local medical ethics committee and subjects gave their written informed consent prior to participation.

2.2. Interventions

2.2.1. Ergonomic counselling

All subjects received 4 weeks of intervention during which they kept a diary of activities and discomfort scores. In this diary, they reported discomfort scores at three different times of the day: When getting up, at lunch time, and at the end of the day. These scores were just used to get insight into possible structural changes in pain over the day. During this 4-week period they were visited weekly by a therapist. The first visit comprised an ergonomic workplace investigation by means of the risk inventory of

Huppes et al. (1997). This checklist contains questions to evaluate work tasks, working hours, workload, workplace, and working methods, without referring to the relevance of muscle relaxation. For each of the five domains, a 'traffic light' indicates whether there is no risk (green), some risk (orange), or a threatening condition (red). Based on this 'score' it was attempted to improve the situation and herewith reduce the risks by discussing this with the subject. The remaining visits were used to further discuss ergonomics, the consequences of possible ergonomic adjustments, etc. according to a manual to guarantee a uniform intervention in terms of aspects to be discussed. This manual had specifically been developed for this study and contained standard instructions for beginning and ending of the visits, and structured questions regarding the ergonomic changes that were performed during or after previous visits, the consequences of these changes in terms of discomfort, and individual goals and appointments for the following week.

2.2.2. Myofeedback training

In addition to the ergonomic counselling, subjects assigned to the Mfb/EC group used a two-channel ambulant feedback system for training of muscular relaxation during work. This system includes a garment incorporating dry sEMG electrodes to enable a stable recording of upper trapezius muscle activity (Hermens and Hutten, 2002). The harness was connected to a sEMG processing and storage system (see Fig. 1).

Embedded software of the myofeedback system provided detection of muscle rest, expressed in sEMG parameter relative rest time (RRT), which was defined as the percentage of time in which root mean square (RMS) was below threshold (10 μV for at least 0.125 s). Feedback by means of vibration and a soft sound was provided after each 10 s interval (Voerman et al., 2004) when RRT was below 20%. This 20% threshold was based on the results of Hägg and Åström (1997).

Fig. 1. Myofeedback system.

After B, the myofeedback system was handed over to the subjects and they were informed about the principles of feedback. They got instructions about how to use the system and some basic information about relaxation skills. In order to fulfil the Mfb/EC intervention, subjects had to wear the system for 4 weeks, for at least 2 days a week, 2 h a day, and 8 h a week during their regular occupational activities. During the weekly visits of the therapist, the data were downloaded and discussed and it was carefully monitored that subjects complied with the requirements of this minimal wearing time. It was furthermore monitored that subjects wore the device during several activities that were well representative for their normal daily work activities. This procedure was facilitated by means of the diary. For more details concerning the myofeedback training, see Hermens and Hutten (2002) and Voerman et al. (2007).

2.3. Outcome measures

Discomfort in the neck at time of the measurement (at *B*, *T*0, and *T*3) was assessed by means of visual analogue scales (VAS) (Gift, 1989). Subjects were asked to rate their subjectively experienced level of discomfort at that particular moment. The VAS consists of a 10 cm horizontal line with 'no discomfort at all' at the left and 'as much discomfort as possible' at the right extremity of the line. Psychometric properties of the VAS have proven to be sufficient (Todd, 1996).

The level of experienced disability was assessed with the pain disability index (PDI), a self-rating scale that measures the impact of pain on the abilities to participate in life activities (Pollard, 1984). The PDI contains seven items, one for each domain, i.e. (1) family and home responsibilities, (2) recreation, (3) social activity, (4) occupation, (5) sexual behaviour, (6) self-care, and (7) life-support activity. Answers are provided on a categorical 11-point scale with 'not disabled' and 'fully disabled' at the extremes. Psychometric properties of the PDI are sufficient (Tait et al., 1990), and Cronbach's alpha was .89 in the current population.

2.4. Assessment of potential prognostic factors

At B subjects were asked to complete several questionnaires assessing sociodemographic and psychological factors that were assumed to be potential prognostic factors for the effect of intervention on pain and disability. The selection of these factors was mainly based on the reviews of Borghouts et al. (1998) and van der Hulst et al. (2005).

2.4.1. Sociodemographic factors

1. Age, job satisfaction, and pain duration in the neck and shoulder region in the last year were assessed using the NEW-questionnaire (Sandsjö et al., 2006).
2. Discomfort and disability were assessed using VAS and the PDI, as described above.
3. Health-related quality of life was assessed by means of the VAS dimension of the EuroQol 5D (EQ5D-VAS) (Euroqol-group, 1990). The EQ5D-VAS, also called the Health Thermometer, is a global health status measure. On a 20 cm vertical line with endpoints of 0 (worst imaginable health state) at the bottom and 100 (best imaginable health state) at the top, subjects had to draw a line on the thermometer that best corresponded to their current health-related quality of life, and these scores were used to evaluate changes in health status over time.

2.4.2. Psychological factors

1. Fear-avoidance beliefs are important factors in several cognitive–behavioural models explaining the perpetuation of pain (Vlaeyen et al., 1995; Hasenbring et al., 2001) and were thus considered potential prognostic factors. Fear-avoidance beliefs were assessed using the Dutch language version of the Fear-Avoidance Beliefs Questionnaire (FABQ; Vendrig et al., 1998), a 16-item 7-point measure that aims at identifying beliefs concerning the influence of work and physical activity on pain and on whether activities should be avoided. High scores represent high fear-avoidance beliefs. The FABQ has two subscales: one describing fear-avoidance beliefs about work (FABQ-W, range 0–42) and one describing fear-avoidance beliefs about physical activity (FABQ-PA, range 0–24). The FABQ has proven to be psychometrically sound (Swinkels-Meewisse et al., 2003) and internal consistency was satisfactory in the current population (Cronbach's alpha .83 for FABQ_PA and .82 for FABQ_W).
2. Aspects related to pain experience were assessed with a Dutch language version of the Multidimensional Pain Inventory (Lousberg et al., 1999), a self-report instrument concerning pain experience. The MPI consists of 61 questions in three domains, and based on the outcome of this questionnaire subjects were classified into profiles for their pain behaviour and burden of illness: 'average', 'adaptive coper', 'interpersonally distressed', 'dysfunctional', and 'anomalous', including subjects not classifiable. The MPI has adequate psychometric properties (Lousberg et al., 1999).
3. Coping strategies with regard to pain were assessed using the Dutch version of the Coping Strategies Questionnaire (CSQ) (Spinhoven et al., 1994), which has seven subscales regarding cognitive reactions: 'Catastrophizing', 'observed pain control', 'ignoring sensations', 'coping self-statements', 'reinterpreting pain sensations', 'praying or hoping', and 'diverting attention', and one subscale describing behavioural actions: 'Increasing behavioural activities'. Forty-four questions are answered by means of a mark at a 11-point VAS scale with 'never' and 'always' as extremes. The CSQ is known to have good psychometric properties (Spinhoven et al., 1994), and Cronbach's alpha calculated with the current data for the subscales varied between .74 and .95.
4. Expectations regarding the effect of the intervention were assessed by two questions defined by the authors. These questions were: (1) I expect participation in the intervention activities to be beneficial for my musculoskeletal symptoms (Expectation_1), and (2) I do not expect participation in the intervention activities to improve my situation (Expectation_2).

2.5. Data analysis

Changes in discomfort and disability were calculated: VAS and PDI scores obtained at *T*0 (immediately after the intervention) and *T*3 (at 3-month follow-up) were subtracted from *B* values and expressed in ΔVAS_{B-T0}, ΔPDI_{B-T0}, ΔVAS_{B-T3}, and ΔPDI_{B-T3}.

(Sub)Scores of the questionnaires assessing sociodemographic and psychological factors were calculated. Results of the MPI provided classification in patient profiles. Because of the sample size, the small number of 'dysfunctional' and 'interpersonally distressed' subjects, and the characteristics of the profiles, the profiles were clustered in the following way: 'dysfunctional' and 'interpersonally distressed' (MPI_1), and 'average' and 'adaptive coper' (MPI_2). Subjects with a dysfunctional or interpersonally distressed profile usually report higher discomfort, higher levels of affective distress, lower activity levels, and less pain-related interference in their lives compared to the average and adaptive copers (Lousberg et al., 1999).

In Table 1 an overview is provided of the potential sociodemographic and psychological prognostic factors selected for this study.

2.6. Statistical analysis

The actual effectiveness of the interventions in terms of discomfort and disability, analysed using linear mixed modelling techniques, is described in detail elsewhere (Voerman et al., 2007) and is only briefly reported in the current study to provide necessary insight into the effects of the intervention.

Bivariate Pearson's correlation coefficients were then calculated to examine the relationship between the dependent outcome measures (ΔVAS_{B-T0}, ΔPDI_{B-T0}, ΔVAS_{B-T3}, and ΔPDI_{B-T3}) and the independent potential prognostic factors measured at baseline, including VAS

Table 1
(Subscales of) Questionnaires used for assessment of potential prognostic factors

Potential sociodemographic prognostic factors		Potential psychological prognostic factors	
Questionnaire	Factor	Questionnaire	Factor
QB	Age	FABQ	Fear avoidance beliefs about work (FABQ_W)
	Job satisfaction		Fear avoidance beliefs about physical activity (FABQ_PA)
	Duration complaints neck	MPI	Dysfunctional and Interpersonally distressed profiles (MPI_1)
	Duration complaints shoulder(s)		Average and adaptive coper profiles (MPI_2)
VAS	Pain intensity (VAS)	CSQ	Catastrophizing
PDI	Disability (PDI)		Observed pain control
EQ5D	Health-related quality of life (EQ5D-VAS)		Ignoring sensations
			Coping self-statements
			Reinterpreting pain sensations
			Praying or hoping
			Diverting attention
			Increasing behavioural activities
		Expectations	Expectation_1
			Expectation_2

Abbreviations: VAS, Visual Analogue Scale; PDI, Pain Disability Index; EQ5D, EuroQol 5 Dimensions; FABQ, Fear Avoidance Beliefs Questionnaire; MPI, Multidimensional Pain Inventory; CSQ, Coping Strategies Questionnaire.

and PDI. In literature, the inclusion of baseline scores in analysis of prognostic factors is subject to discussion. However, as the level of change is dependent on the initial score and alternative methods are not sufficient, inclusion of baseline values should be preferred over exclusion, similar to comparative studies of e.g. Bekkering et al. (2005) and Bot et al. (2005). Inherently, baseline inclusion also results in correction for within-group variability at baseline. Associated variables ($p \leqslant 0.2$) were subsequently included in the multivariate linear regression model. Dummy variables were created for the MPI profiles using profile 2 ('average' and 'adaptive coper') as reference category. Separate models were built for ΔVAS_{B-T0}, ΔPDI_{B-T0} (immediately after the intervention) and ΔVAS_{B-T3}, and ΔPDI_{B-T3} (3-month follow-up) using manual backward elimination. Only factors with a $p < 0.1$ were retained in the model. When no more factors could be removed, this was considered the final predictive model. To prevent from over-fitting and thus less stable and less generalizable models, the maximum number of variables included in the models were calculated by dividing the number of subjects in each outcome measure by 10 (Peduzzi et al., 1995), i.e. 3 in the present study. Adjusted R^2 values, unstandardized *B*'s, standard errors, *p*-values, and corresponding 95% confidence intervals (CI) were presented.

Post hoc analysis was then performed to explore whether this set of regression coefficients were different between the Mfb/EC and EC groups using general linear models. This analysis included the selected variables and their interaction with the variable 'intervention type' (i.e. Mfb/EC or EC). The *F*-test and the resulting *p*-value emerging from this analysis is the overall test of whether the set of regression parameters differs between the two groups. Statistical package for social sciences (SPSS) was used for statistical analysis and alpha was set at .05 for statistical significance.

3. Results

3.1. Subjects

Baseline measurements were performed with 38 subjects (18 in the Mfb/EC group and 20 in the EC group), with a mean (sd) age of 49.6 (5.3) and 48.9 (4.2), respectively. Mean height was 1.67 m (6.4) in the Mfb/EC group and 1.67 (6.8) in the EC group, with a mean weight of 72.0 (12.0) and 70.5 (12.2), respectively.

Immediately after B, two subjects in the EC group dropped out because of motivational reasons, so *T*0 measurements were performed with 36 subjects (18 in the Mfb/EC group and 18 in the EC group). B and *T*0 were separated by 34 (± 8) and 32 (± 6) days for both groups, respectively.

At *T*3, three subjects dropped out in the Mfb/EC group, each due to long-lasting illness, so *T*3 measurements were available from 15 subjects in the Mfb/EC group and 18 subjects in the EC group. Mean number of days between *T*0 and *T*3 was 83 (± 12) for the Mfb/EC and 84 (± 18) for the EC group.

Prior to the intervention 7% of the subjects reported neck–shoulder complaints for shorter than 1 year, and 51% of the subjects reported complaints for between 2 and 5 years. Fourteen percent of the population reported to have complaints between 6 and 15 years, and the remainder (i.e. 28%) suffered from neck–shoulder pain for more than 15 years.

3.2. Prognostic factors for the effect of intervention

Immediately after the intervention ($T0$) and at 3-month follow-up ($T3$), both groups reported a significant decrease in discomfort and disability compared to B ($F = 11.58$, $p < .001$; $F = 9.99$, $p < .001$). No difference was found between the Mfb/EC and EC groups regarding changes in discomfort ($F = .69$, $p = .50$) (see also Fig. 2), but subjects in the Mfb/EC groups showed a tendency towards larger changes in disability compared to subjects in the EC group ($F = 3.27$; $p = .05$) (see also Fig. 3).

Initial values of the potential prognostic factors are presented in Table 2 for both the Mfb/EC and EC groups. There were no significant differences in initial values between the two groups ($p > .05$).

3.3. Effects immediately after the intervention

Potential prognostic factors that were associated ($p < .2$) with the dependent factors ΔVAS_{B-T0} and ΔPDI_{B-T0} are presented in Table 3. In addition, this table provides the R^2_{adj} value of the multivariate regression model comprising all these factors. The strongest relation was found between ΔVAS_{B-T0} and VAS, and between ΔPDI_{B-T0} and PDI. Three CSQ subscales were related to ΔPDI_{B-T0}, but no such relations were found for ΔVAS_{B-T0}.

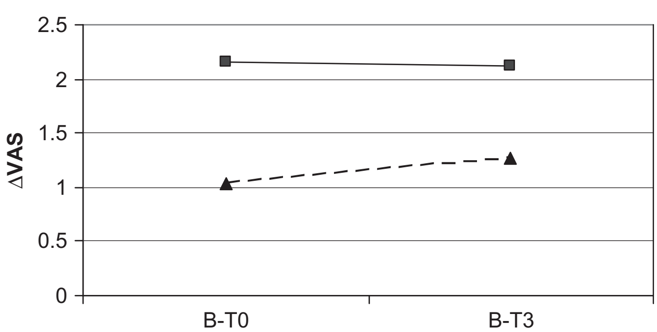

Fig. 2. Mean ΔVAS for the Mfb/EC and the EC group. -■-, Mfb/EC; -▲-, EC.

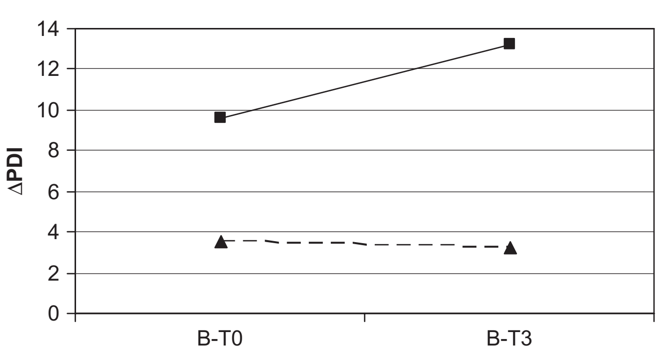

Fig. 3. Mean ΔPDI for the Mfb/EC and the EC group. -■-, Mfb/EC; -▲-, EC.

Table 2
Baseline values for potential prognostic socio-demographic and psychological factors for Mfb/EC and EC

	Mfb/EC $n = 18$	EC $n = 20$
Socio-demographic factors		
Age	49.6 (sd 5.3)	48.9 (sd 4.2)
Job satisfaction		
Highly unsatisfied	12%	0%
Unsatisfied	0%	5%
Satisfied	70%	80%
Very satisfied	18%	15%
Pain		
VAS_B	4.1 (sd 2.6)	3.0 (sd 2.2)
Duration complaints in neck last 12 months		
No complaints	11.1%	0%
1–7 days	5.6%	0%
8–30 days	16.7%	10%
More than 30 days	38.9%	60%
Every day	27.7%	30%
Duration complaints in shoulder(s) last 12 months		
No complaints	5.6%	0%
1–7 days	5.6%	0%
8–30 days	5.6%	10.0%
More than 30 days	55.5%	50.0%
Every day	27.7%	40.0%
Disability		
PDI_B	21.4 (sd 16.0)	13.4 (sd 10.5)
Health-related quality of life		
EQ5D-VAS	72.8 (sd 16.6)	80.6 (sd 14.2)
Psychological factors		
Fear-avoidance beliefs (FABQ)		
Work (FABQ_W)	10.6 (sd 6.3)	9.6 (sd 5.8)
Physical activity (FABQ_PA)	15.7 (sd 9.2)	14.4 (sd 7.8)
Patient profile (MPI)		
Dysfunctional and interpersonally distressed	22%	5%
Average and adaptive coper	50%	75%
Anomalous and not classified	28%	20%
Coping with pain (CSQ)		
Catastrophizing	2.3 (1–7)[a]	1.8 (1–4)[a]
Observed pain control	5.0 (1–9)[a]	5.8 (1–10)[a]
Ignoring sensations	5.2 (1–10)[a]	5.3 (1–10)[a]
Coping self-statements	4.6 (1–10)[a]	4.1 (1–9)[a]
Reinterpreting pain sensations	3.4 (1–8)[a]	3.3 (1–10)[a]
Praying or hoping	3.2 (1–8)[a]	2.6 (1–10)[a]
Diverting attention	2.8 (1–6)[a]	4.1 (1–10)[a]
Increasing behavioural activities	2.9 (1–8)[a]	3.9 (1–10)[a]
Expectations		
Expectation_1	4.5 (2–6)[b,c]	4.5 (2–6)[b,c]
Expectation_2	3 (1–6)[b,c]	2 (1–6)[b,c]

[a] Mean and range.
[b] Median and range.
[c] 1 = completely disagree; 6 = completely agree.

The final model for prognostic factors affecting changes in discomfort immediately after the intervention is shown in Table 4. ΔVAS_{B-T0} is best predicted by discomfort in the neck region at baseline only: Subjects reporting high levels of discomfort were most likely to benefit from the interventions.

ΔPDI_{B-T0} was best predicted by the level of disability prior to intervention, the score at the CSQ subscale 'ignoring sensations', and MPI-patient profile 'dysfunctional' and 'interpersonally distressed' relative to subjects with 'average' and 'adaptive coper' profiles. Subjects characterized by a 'dysfunctional' or 'interpersonally distressed' profile benefit more from the interventions than the 'average' and 'adaptive coper'. Furthermore, subjects with high initial levels of disability and those who ignore pain sensations are most likely to benefit from the interventions (see Table 4).

R^2_{adj} is somewhat lower for the prognostic model for changes in disability than changes in discomfort, but both are high (.64 and .60, respectively).

3.3.1. Effects at 3-month follow-up

The results of bivariate correlation analysis for identifying potential prognostic factors for the effect of intervention after 3 months, and the R^2_{adj} value of the multivariate regression model comprising all factors, are presented in Table 5.

Baseline discomfort appeared to be the only relevant predictor for ΔVAS_{B-T3} ($F = 30.8$, $p < .001$) (Table 6).

ΔPDI_{B-T0} was best predicted by the level of disability at baseline, age, and scores at the CSQ subscale 'ignoring sensation' ($F = 17.60$, $p < .001$). Subjects with a higher baseline disability score, a higher age, and lower scores on the subscale 'ignoring sensations' appeared most likely to benefit from the interventions at 3-month follow-up (see Table 6).

R^2_{adj} when predicting changes at 3-month follow-up was slightly higher for disability compared to discomfort (.63 and .50, respectively).

3.4. Comparison of regression coefficients between Mfb/EC and EC

Post hoc analysis using general linear modelling indicated that the influence of prognostic factors was comparable between the two interventions in this study with regard to ΔVAS_{B-T0}, ΔPDI_{B-T0} and ΔVAS_{B-T3} ($p > .05$). The regression coefficients for ΔPDI_{B-T3}, however, were different between the two groups for CSQ subscale 'ignoring sensations' ($p = .03$). Prognostic models for the Mfb/EC and EC groups were therefore calculated separately (see Table 7). The effect of CSQ subscale 'ignoring sensations' is significantly larger in the EC group ($R^2_{adj} = .70$) compared to the Mfb/EC group ($R^2_{adj} = .67$).

Table 3
Bivariate correlation coefficients (r) and p-values for factors related ($p < .20$) to effects immediately after the intervention

ΔVAS_{B-T0}			ΔPDI_{B-T0}		
Variable	r	p	Variable	r	p
VAS	.75	.00	PDI_B	.73	.00
EQ5D-VAS	−.40	.03	MPI_1	.53	.00
MPI_1	.37	.03	CSQ 'catastrophizing'	.42	.01
PDI_B	.30	.08	VAS_B	.40	.02
Expectation_1	.25	.15	CSQ 'ignoring sensations'	−.33	.05
			Job satisfaction	−.28	.12
			CSQ 'praying or hoping'	.26	.13
			Expectation_1	.26	.12
			EQ5D-VAS	−.27	.14
$R^2_{adj} = .60$			$R^2_{adj} = .55$		

Table 5
Bivariate correlation coefficients (r) and p-values for factors related ($p < .20$) to effects at 3-month follow-up

ΔVAS_{B-T3}			ΔPDI_{B-T3}		
Variable	r	p	Variable	r	p
VAS_B	.72	.00	PDI_B	.65	.00
EQ5D-VAS	−.44	.02	Age	.42	.02
Expectation_1	.31	.09	CSQ 'ignoring sensation'	−.37	.05
Age	−.29	.12	CSQ 'diverting attention'	−.36	.05
MPI_1	.27	.14	CSQ 'increasing behavioural activities'	−.32	.08
$R^2_{adj} = .48$			$R^2_{adj} = .64$		

Table 4
Final prognostic models for ΔVAS_{B-T0} and ΔPDI_{B-T0}

	Beta (SE)	95% CI	p	R^2_{adj} when removed
ΔVAS_{B-T0} $R^2_{adj} = 0.54$				
Constant	−1.14 (.51)	−2.17 (−.11)	.03	
VAS	.79 (.12)	.54 (1.04)	.00	–
ΔPDI_{B-T0} $R^2_{adj} = 0.60$				
Constant	1.58 (3.06)	−4.65 to 7.82	.61	
PDI	.42 (.09)	.23–.61	.00	.36
MPI_1	8.77 (3.56)	1.51–16.03	.02	.53
CSQ 'ignoring sensations'	−.70 (.40)	−1.50 to .11	.09	.57

Table 6
Final prognostic models for ΔVAS_{B-T3} and ΔPDI_{B-T3}

	Beta (SE)	95% IC	p	R^2_{adj} when removed
ΔVAS_{B-T3} $R^2_{adj}=0.50$				
Constant	−.90 (.56)	−2.04 to .25		
VAS_B	.72 (.13)	.46–.99	0.00	–
ΔPDI_{B-T3} $R^2_{adj}=0.63$				
Constant	−48.08 (13.99)	−76.84 to 19.31	.002	
PDI_B	.59 (.11)	.36–.82	.000	.27
Age	1.05 (.27)	.49–1.62	.001	.45
CSQ 'ignoring sensations'	−1.34 (.58)	−2.54 to −.15	.029	.56

Table 7
Final prognostic models for ΔPDI_{B-T3} in Mfb/EC and EC

	B (SE)	95% IC	R^2_{adj} when removed
Mfb/EC $R^2_{adj}=.67$			
Constant	−20.18 (17.3)	−58.79 to 18.4	
PDI_B	.58 (.12)	.32–.84	.03
Age	.42 (.33)	−.32 to 1.15	.65
CSQ 'ignoring sensations'	−.20 (.78)	−1.95 to 1.54	.69
EC $R^2_{adj}=.70$			
Constant	−72.65 (17.56)	−110.90 to −34.39	
PDI_B	.52 (.20)	.08–.96	.56
Age	1.62 (.35)	.87–2.37	.21
CSQ 'ignoring sensations'	−2.20 (.68)	−3.69 to −.72	.47

This means that when assigned to the EC group, lower levels of ignoring sensations are related to improved outcome, while in the Mfb/EC group the level of ignoring sensation is not that relevant.

4. Discussion

This study explored prognostic factors for the effect of interventions for work-related neck–shoulder complaints in terms of discomfort and disability immediately after the intervention and at 3-month follow-up. In addition, a comparison was made between prognostic factors for two interventions; Mfb/EC and EC.

The results show that:

(1) The baseline level of discomfort is the only relevant prognostic factor for changes in discomfort immediately after the intervention and at 3-month follow-up, explaining 50% and 54% of the change in discomfort, respectively.
(2) The initial level of disability and coping strategy 'ignoring sensations' are relevant predictors for changes in disability immediately after the intervention and at 3-month follow-up. Psychological patient profile 'dysfunctional' and 'interpersonally distressed' is additionally important immediately after the intervention, while age is additionally relevant at 3-month follow-up. The percentages explained variance are relatively high.
(3) Prognostic factors for outcome are largely comparable between the Mfb/EC and EC groups, except for disability at 3-month follow-up: In the EC group subjects ignoring pain sensations showed the smallest improvements, while for the Mfb/EC group outcome is not dependent on ignoring pain sensations.

Changes in discomfort both immediately after the intervention as well as at 3-month follow-up were best predicted by the level of discomfort prior to the interventions. Subjects reporting higher levels of discomfort appeared to be most likely to benefit. The relation between initial discomfort and outcome has been addressed more often in literature (e.g. Borghouts et al., 1998; Hoving et al., 2004; Bekkering et al., 2005; Bot et al., 2005). Although some studies show that high initial discomfort levels are predictors for poor prognosis (Borghouts et al., 1998; Hoving et al., 2004; van der Hulst et al., 2005), others report better outcome in subjects with high discomfort as they may have more to gain from interventions compared to those with low discomfort (Bot et al., 2005). One explanation for this inconsistency in literature may be related to the definition of effective outcome. For instance, although those with high initial discomfort levels are more likely to show a reduction in discomfort, and thus benefit more from an intervention compared to subjects with low initial discomfort levels, it is equally likely that they still have relatively high levels of discomfort after the intervention and thus can be considered as not recovered (i.e. a poorer prognosis). It should be noted however that the observation of larger improvements in subjects reporting high baseline discomfort may also have been affected by the 'regression to the mean' phenomenon.

The same reasoning counts for the finding of larger beneficial effects in terms of disability in subjects with high baseline disability levels, a finding that has more often been reported in literature (e.g. Skargren and Oberg, 1998; van der Hulst et al., 2005). But in contrast to discomfort, changes in disability were predicted by other factors than baseline values only.

A consistent factor for predicting disability was that subjects ignoring pain sensations, a coping strategy, were less likely to benefit from interventions. The relevance of coping strategies in pain and disability perpetuation is commonly accepted. Burton et al. (1995) concluded that coping strategies were seven times more important than the clinical or historical variables for predicting outcome in disability scores in back pain patients. Subjects with low scores at 'ignoring pain sensations', which are subjects who do not deny their pain, were most likely to benefit from the interventions. One could hypothesize that subjects who do not deny or ignore their pain sensations may more easily perceive changes in their complaints and thus benefit more from intervention compared to subjects who do ignore pain sensations. The initial level of ignoring pain sensations is especially important when considering disability 3 months after ending the intervention: While in the EC group there is a negative, significant association between disability and ignoring sensations at baseline, this association is not significant in the Mfb/EC group. Thus, in the Mfb/EC group, outcome after the intervention is not affected by whether or not subjects ignore their pain sensations. Subjects showing high levels probably have poorer outcome in the EC group but not in the Mfb/EC group. An explanation for this finding is that the myofeedback continuously confronts subjects with their sensations which makes that they more easily detect changes and benefit more compared to the subjects in the EC group. Therefore in the EC group acknowledgment of complaints and pain sensations before the start of the intervention is desirable for optimal benefit from the intervention while this is not required in the Mfb/EC group.

There is rather strong evidence for subjects with 'interpersonally distressed' and 'dysfunctional' profiles to benefit more from interventions in terms of disability reduction compared to 'average' and 'adaptive copers' (e.g. Talo et al., 1992; van der Hulst et al., 2005) and the present findings support this. Subjects with a 'dysfunctional profile' usually report higher discomfort, higher affective distress, lower activity levels, and more interference of pain in daily living. In addition, 'interpersonally distressed' subjects report that significant others are not supportive. van der Hulst et al. (2005) hypothesized that treatment in 'interpersonally distressed' and 'dysfunctional' subjects reduces distress and improves adequate coping skills, which is not an obstruction in average or adaptive copers. Therefore, this subgroup may benefit more from interventions. In agreement, interventions based on self-management principles appeared to be beneficial in these chronic pain patients (McCracken and Turk, 2002). At 3-month follow-up however, patient profile at baseline is not a significant predictor for outcome anymore, while age is. The role of age in predicting outcome is often discussed in literature. Hoving et al. (2004) reported a poorer prognosis in women over 40 years of age and Anonymous (1966) (see review of Borghouts et al., 1998) showed that worse outcome was found in females over the age of 50 compared to male and younger subjects. Other studies showed no relation (e.g. Deyo and Diehl, 1988; Skargren and Oberg, 1998). A possible explanation for older subjects showing the largest improvements, as found in the present study, might be that complaints are better accepted with age, as inherent to ageing. As a result, intervention-induced improvements may have more impact on perceived disability.

In line with literature, different predictors were found for the outcome measures discomfort and disability (Deyo and Diehl, 1988). This finding is not unexpected as assessment of disability reflects a broad spectrum of phenomena, and concerns an interaction between social and personal factors (Kjellman et al., 2002). This study also supported the finding that different predictors are relevant at follow-up compared to at immediately after intervention (Cherkin et al., 1996; McCracken and Turk, 2002; Hoving et al., 2004). The percentages of explained variance were substantial; 50–70% of the change in outcome after intervention could be explained by the included variables in this study, which is mainly the result of including baseline values in the analysis. Bot et al. (2005) found rather comparable levels of explained variances for pain and disability; 43–54% but other studies reported lower values (e.g. Hoving et al., 2004). The sample size of the present study was small. Among others, this resulted in large variability in outcome measures. Furthermore it had methodological implications as the number of subjects was not large enough to divide it into a sample from which the prognostic factors were derived and a test sample for independent validation of the models. This is important because the discriminating power of prognostic models is always higher in data from which the model has been derived compared to new data. It was also not possible to study all possible interaction effects as this would have induced unbalanced statistical models. Furthermore, it should be noted that a number of factors that might have a predictive value on complaints were not measured in the current study. First of all, job demands and supervisor support (Johnston et al., 2007) and activities during leisure time (van den Heuvel et al., 2005) for instance have shown to be associated with neck disability but were not considered for the present sample.

Secondly, factors related to changes in behaviour and perpetuation of this behaviour after the intervention may have interfered. The number, relevance, or quality of the ergonomic changes performed during the intervention period might be such factors. Additional research needs to provide more insight into the relative contribution of different ergonomic adjustments to improvement after the intervention. In line with this, it might be interesting to explore whether besides cognitive–behavioural and ergonomic factors also physiological factors like muscle relaxation at rest are predictive for outcome after the intervention in terms of pain and disability.

Finally, the lack of a pure control group in this study may be considered a methodological shortcoming which makes it hard to control for non-specific effects like regression to the mean. However, as this study included subjects with primarily long lasting complaints (up to over 15 years) for which subjects often received various treatments in the past, non-specific effects are not very likely to occur. Besides this, the fact that control groups in occupational research are hard to accomplish should challenge occupational epidemiologists to develop study designs in which this shortcoming can be overcome.

From this preliminary study it may be concluded that subjects with work-related neck–shoulder complaints with high initial levels of discomfort and disability will benefit from these interventions. This benefit seems to be more evident for patients with an 'interpersonally distressed' and 'dysfunctional profile' and those who do not ignore their pain sensations.

No difference was found between the prognostic factors for the Mfb/EC and EC intervention, except for changes in disability at 3-month follow-up where subjects who ignore pain sensations seemed to be more responding to myofeedback in combination with ergonomic counselling compared to subjects taking part in ergonomic counselling alone. This lasting improvement indicates that myofeedback contributes a specific quality to those subjects who ignore their pain sensations.

Acknowledgements

This work was undertaken within the project 'Neuromuscular Assessment of the Elderly Worker (NEW)', with partial financial support from the EC within the RTD action QRLT 2000 00139, and AFA Insurance, Sweden. The authors would like to thank Linda Oostendorp en Karin Groothuis for their valuable contribution to this study.

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