The impact of work on musculoskeletal complaints and work disability

Freek J.B. Lötters

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Contents **Page**

1.

INTRODUCTION

Musculoskeletal disorders in the Netherlands

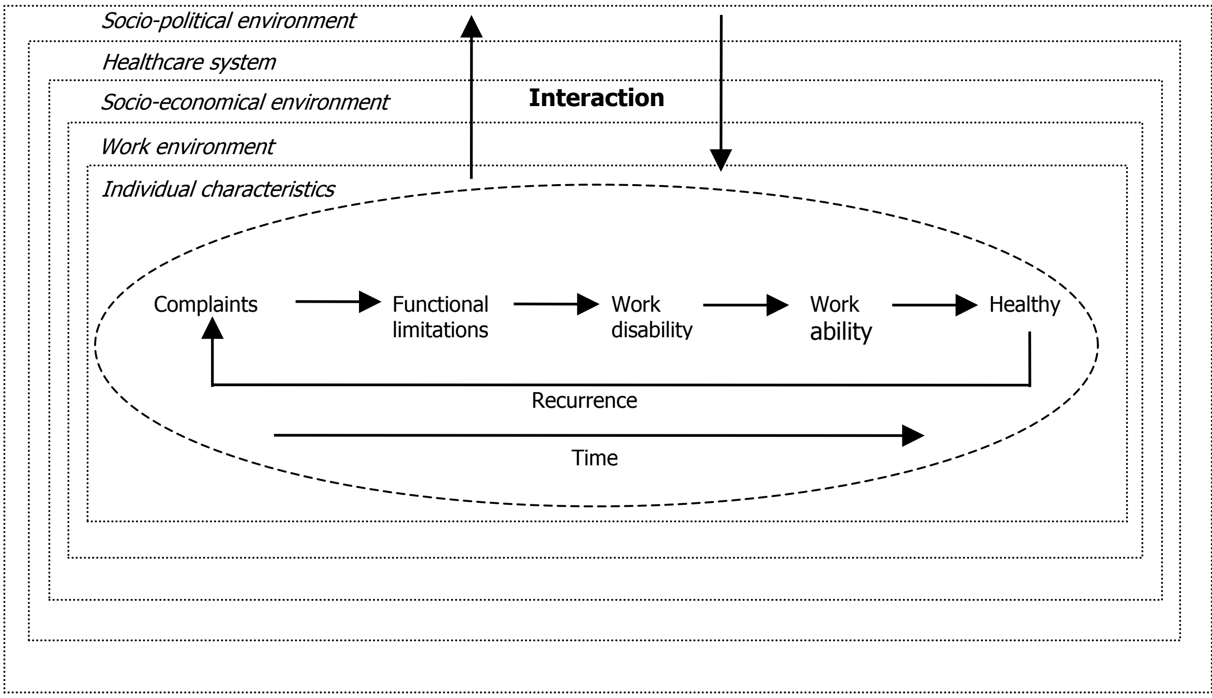
Musculoskeletal disorders (MSD) are well recognised as a major public health problem[1, 2]. Almost three quarters of the general Dutch population aged 25 years and over reported any musculoskeletal pain during the past 12 months of which 44% mentioned low back pain (LBP), 45% neck shoulder pain, 23% elbow/wrist/hand pain, 28% hip/knee pain, and 15% ankle/foot pain[3]. These high prevalences lead to substantial direct costs, such as hospital care costs, general practice costs, and paramedical costs. These direct costs were calculated as 7.3% of the allocated health care costs in the Netherlands, thereby being one of the most expensive health care areas[4].

In 2002, the overall sick leave in the Dutch working population was 5.4% (excluding sick leave due to pregnancy or absence shortly after giving birth)[5] of which roughly one quarter was due to MSD[3]. MSD account for approximately 30 % of all sickness absences, both in frequent and prolonged sickness absenteeism[6]. In 2002, in the Netherlands 1.6% of all workers received a worker's compensation benefit after 12 months of sickness absence, of which about 27% was due to musculoskeletal disorders with low back pain accounting for 50% of the latter cases[5]. Hence, sickness absence and work disability due to MSD are responsible for large indirect costs, which may supersede the direct costs. Regarding LBP, the indirect costs constituted 93% of the total costs of back pain[7], whereas of the total cost for neck pain 77% was attributed to indirect costs[8].

Conceptual model for the work disability process

Time is an important aspect to take into account when studying work disability. Krause et al. have stressed that the impact of risk factors may vary across different phases of the disablement process and concomitant return to work[2]. A conceptual model is presented in which the work disability is described as a time related process[9]. This work disability process illustrates the sequential 'happenings' from exposure to certain risk factors and subsequent onset of musculoskeletal complaints to functional limitations, work disability, recovery, and possible recurrence (as indicated in figure 1). In the literature some discrepancy exists between the terminology of work disability and functional limitations (often measured with a functional *disability* scale, like the Roland Morris *Disability* Questionnaire[10] or the Quebec Back Pain *Disability* Questionnaire[11]). Functional disability (as a consequence of musculoskeletal complaints) is considered to be synonymous with *functional limitations*, whereas work disability (as a consequence of functional limitations) refers to the disability that hampers the worker to play his social role as expected, resulting in sickness absence. The work disability process as described above is embedded in a context of different overlapping layers, which can be regarded as domains influencing the work disability process, i.e. individual characteristics, work environment, socio-economic aspects, the health care system, and socio-political aspects[1, 2, 12, 13]. Within this thesis the conceptual model for the work disability process is applied to musculoskeletal complaints.

Figure 1. The Work Disability Process within its transdisciplinary context.



The first step in the work disability process is the onset of complaints due to certain risk factors. Many established work-related risk factors have been identified for the occurrence of musculoskeletal disorders and low back pain in particular[1, 2, 14-16]. Despite this knowledge of established work-related risk factors for the occurrence of MSD, no sound criteria can be found in existing diagnostic guidelines as well in guidelines for reporting MSD as an occupational disease when the MSD of a particular worker can be considered as being primarily caused by specific working conditions (i.e. is work-related). At individual level the magnitude of work-relatedness of complaints is highly subjective, i.e. by the worker himself or by expert judgement of the attending physician[1]. Hence, the question arises whether the knowledge on risk factors can be used to evaluate the decision that the particular MSD of a worker most likely has been caused by his work more evidence based, for example in a structured decision model[17]?

Given the uncertainty in the work-relatedness of MSD, it remains to be seen whether primary prevention interventions aimed at reducing the risk on musculoskeletal disorders by reducing the physical load at the workplace will indeed reduce the risk on musculoskeletal complaints[18, 19]. Hence, it is important to identify through which pathway an intervention will be effective and, for example, how much reduction in mechanical exposure is needed to have a noticeable impact on musculoskeletal health.

The presence of musculoskeletal complaints often leads to functional limitations in daily life[3]. However, not every worker with functional limitations is too disabled to work[20, 21]. In this respect it was questioned whether the established risk factors for the occurrence of musculoskeletal disorders also determine the occurrence of sickness absence and whether the determinants of functional limitations at work are equal to the prognostic factors for duration of sickness absence due to musculoskeletal disorders[22, 23]. Identifying those workers on sick leave who are at risk for prolonged sickness absence is essential, because the 20% of workers who are on sick leave at least 4 months due to LBP will account for 60% of the health care costs[24]. In addition, the importance of a prognostic factor might change during the sickness absence[2, 25, 26]. However, few studies have investigated interaction of prognostic factors with time in their analyses[25-27]. Moreover, these few studies have limited themselves to low back pain. In this regard, disorder-specific risk profiles are largely unknown for sickness absence due to MSD.

Although improvements in pain perception and functional disability appear to be associated with time of return to work (RTW)[26, 28-30], many workers who returned to work were not fully recovered from their initial complaints[31-33]. Little is known about the required improvement enabling RTW, the additional health improvement after RTW, and whether the health status at the time of RTW is associated with the probability of a recurrence of sick leave. A few studies have reported a probability of recurrence of 25 to 44% within 6 months to 3 years after RTW[34-36]. The suggested divergence between full recovery from complaints and return to work and its possible influence on the recurrence of new sick leave periods, brings about questions regarding the timing of initiating return to work[37] and the way RTW is initiated, i.e. by modified work or directly returning at full duty in the regular job[38].

Objectives of this thesis

In order to facilitate intervention strategies in an efficient way, the impact of risk factors and prognostic factors in the work disability process needs to be established[2, 18]. In this thesis the focus is on the specific role of work-related and individual characteristics in MSD and sickness absence. Hence, this thesis will address the following research questions:

1. What is the probability that for an individual worker his LBP is caused by exposure to hazardous work?
2. What are the effects of primary preventive interventions on both mechanical exposure and musculoskeletal complaints?
3. What are prognostic factors for return to work after sickness absence due to musculoskeletal complaints?
4. What is the influence of modified work on return to work among workers on sick leave due to musculoskeletal complaints?
5. What is the contribution of perceived health status in the decision to return to work and the risk of a recurrent sick leave after a sick leave episode due to musculoskeletal complaints?.

Outline of this thesis

The answers on research question 1 and 2 will be given by systematic reviews on peer-reviewed epidemiological studies. The results are described in, respectively, *chapter 2* and *chapter 3*.

Research questions 3 and 5 will be answered using a cohort study with 253 Dutch workers on sick leave for 2 to 6 weeks due to musculoskeletal disorders. These workers were send a questionnaire shortly after inclusion, after return to work, and at 12 months after inclusion.

In *chapter 4* the prognostic factors for return to work after sickness absence are presented, in *chapter 7* the relationship between improvement in perceived health status, time of return to work and recurrent sick leave is described, and *chapter 8* is about productivity loss shortly after return to work.

The prognostic value of psychological factors on total compensation benefit over 12 months was determined using a Canadian cohort with 187 workers receiving total compensation benefits due to musculoskeletal disorders with inclusion at 4 to 5 weeks post-injury. These results are described in *chapter 5.*

A second Dutch cohort study with 12 months follow-up period among 164 workers on sick leave for 2 to 6 weeks due to musculoskeletal disorders was used to answer research question 4. The results of this study are described in *Chapter 6* .

Chapter 9 provides a general discussion on the findings.

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2.

MODEL FOR THE WORK-RELATEDNESS OF LOW BACK PAIN

Adapted from:
Lötters F, Burdorf A, Kuiper J, Miedema H. Model for the work-relatedness of low-back pain.
Scand J Work Environ Health 2003;29(6):431-40.

Abstract

Study design. A meta-analysis and clinical decision modelling

Objectives. To present a model for the level of work-relatedness of low back pain (LBP) in a worker with LBP given both the personal exposure profile to well-established risk factors for LBP and the probability of LBP when not exposed to these factors.

Methods. After a systematic review of the literature a meta-analysis was conducted using a random effect model to calculate a pooled prevalence for LBP in the unexposed population and a pooled odds ratio (OR) for each risk factor. An unbiased risk estimate for each risk factor was obtained by correcting the pooled OR for confounding by other risk factors. The probability of having LBP was calculated with a logistic regression model. The input in the model was (1) age-dependent prevalence when not exposed, (2) unbiased risk estimates per risk factor for both low and high exposure. To determine the level of work-relatedness, the attributable fraction was calculated.

Results. The pooled prevalence for LBP among unexposed subjects was 22% for the age category <35years, 30% for 35-45 years, and 34% for >45 years. The pooled odds for manual material handling was 1.51 (1.31-1.74), frequent bending/twisting 1.68 (1.41-2.01), whole body vibration 1.39 (1.24-1.55), and job dissatisfaction 1.30 (1.17-1.45). For high exposure to manual material handling, frequent bending and/or twisting and whole body vibration pooled odds ratios were found of 1.92, 1.93 and 1.63, respectively.

Conclusion. The presented model is the first model that estimates the probability of work-relatedness of LBP for a given worker presenting with LBP to a general practitioner or to an occupational health physician.

Introduction

In the process of unraveling the multi-factorial etiology of back disorders and the specific contribution of work-related risk factors, epidemiological surveys have identified various individual, psychosocial, and physical risk factors. Manual material handling (MMH), frequently bending and twisting of the trunk (FBTT), whole body vibration (WBV), and high physical workload (HPW) are well-established physical risk factors for low back pain (LBP)[1-3]. Although psychosocial factors are far less clear in the etiology of LBP, job dissatisfaction (JobDis) and Monotonous work (MoWo) seem to be important factors contributing to the occurrence of LBP[1, 3-5]. These risk factors have been addressed in several recommendations in national and international occupational health guidelines with the aim to avoid or diminish the occurrence of work-related LBP[6-9]. However, occupational health guidelines are compiled for a general working population and cannot directly determine the work-relatedness of LBP when considering an individual worker who presents himself with LBP.

Clinical decision theory provides a methodology to translate these general recommendations to an individual level by using a decision rule model[10-12]. The application of decision rule models has long been advocated in clinical practice, e.g. in cardiac surgery[13]. Thus, the use of clinical decision theory allows to estimate the likelihood that a worker's LBP is due to work-related risk factors, considering the probability of LBP when not exposed to these risk factors. Until now, no model exists within general and occupational medicine that takes into account crucial work-related risk factors and may assist in determining the level of work-relatedness of LBP in an individual worker. A more accurate determination of the work-relatedness of LBP might enable occupational health practitioners to intervene in a more appropriate way in the relationship between the worker and the work environment.

The purpose of this study is to present a model to estimate the level of work-relatedness of LBP for an individual worker, taking into account the personal exposure profile to established risk factors for LBP.

Methods & Assumptions of the model

Data from the literature

Extensive searches of available literature concerning work-related risk factors for LBP have recently been published[1, 3]. For the present study an additional selection on these data was made using the following additional inclusion criteria:

- articles describing the occurrence of non-specific low back pain in terms of period prevalence of one year or less or an one-year incidence;
- articles presenting associations between non-specific LBP and exposure to work-related physical and/or work-related psychosocial risk factors;

To update the available information a literature search was made from January 2000 to September 2002 in the MEDLINE and EMBASE databases using the strategy: low back pain AND risk factors (AND (lifting OR posture OR vibration OR workload OR job satisfaction OR monotonous work)).

Studies were excluded if the exposed population experienced an exposure below pre-determined cut-off points. To act in accordance with internationally accepted guidelines[6, 9] the following cut-off points were used: MMH requires frequent lifting of 5 kg, or more than 1x a day lifting more than 25 kg (including patient handling), FBTT more than 2 hours a day more than 20^o bending and/or twisting, WBV more than 0.5 m/s^2 during a working day, whereas HPW, JobDis and monotonous work were dichotomous variables, i.e. yes/no. Any disagreement regarding study inclusion and exposure assessment were resolved by consensus among the authors.

Data extraction

The analysis focused on associations between the occurrence of LBP and age, MMH, FBTT, WBV, HPW, JobDis and MoWo. Risk estimates were expressed by odds ratios (OR) or relative risks. Whenever possible, the risk estimate of these risk factors was retrieved from the original article, as well as the variables that were adjusted for in the statistical analysis. In several publications this information was not presented, but for all studies that provided sufficient raw data for 2 x 2 tables, risk estimates were calculated with 95% confidence intervals.

Prevalence of LBP when not exposed

The prevalence of LBP among unexposed subjects was extracted from unexposed populations in the included studies. To calculate the probability of having LBP, a pooled prevalence among non-exposed subjects was determined, weighted by study size. The weighted pooled prevalence from the meta-analysis is assumed to represent the prevalence of LBP among the age category 35-44 years, which can be considered as the mean age category in the general working population. Several studies have indicated an age effect in the prevalence of LBP[1, 14, 15]. To take this age effect into account, we selected studies that described the effect of age in multivariate models adjusted for other risk factors for LBP. We then conducted a meta-analysis to obtain unbiased risk estimates for the described age categories, using the aged <35 years as a reference category. The weighted pooled prevalence and the unbiased risk estimates for the age categories 35-44 years and >45 years were used to assess the probability of LBP in three age categories for the unexposed workers.

Meta-analysis

A meta-analysis was conducted on the risk factors MMH, FBTT, WBV, HPW, JobDis, and MoWo[1-3]. Preliminary analysis revealed that the homogeneity statistic was significant for all risk factors, meaning that the risk estimates were heterogeneous between studies, compared with the variance within the studies involved. Therefore, we used a random effects model to calculate a pooled risk estimate for each risk factor[16, 17].

In order to get an unbiased risk estimate for each risk factor we divided the study results in adjusted and unadjusted risk estimates, by defining adjusted risk estimates as those estimates that were adjusted for one of the other risk estimates used in the meta-analysis. When no significant differences were detected between unadjusted and adjusted risk estimates, they were pooled. In case of a significant difference, the unadjusted risk factor was corrected for other risk factors by a correction factor before pooling[12, 18]. This correction factor was calculated from studies describing both unadjusted and adjusted risk estimates for the same risk factor by subtracting the unadjusted ln(OR) from the adjusted ln(OR) for that risk factor. The correction factor was added to the ln(OR) of the studies, using unadjusted estimates for that particular risk factor[12, 18]. Finally, the unbiased risk estimates were pooled.

Magnitude, frequency and duration of exposure

In studies describing more than one risk estimate for a risk factor taking into account the magnitude, frequency and/or duration of exposure, the lowest value above the defined cut-off point was selected as initial input in our meta-analysis. Subsequently, a more detailed analysis was conducted on those studies that included estimates for both low and high exposure to the distinguished risk factors. For these studies pooled risk estimates for low and high exposure were calculated as well as the risk ratio of high versus low exposure, using the same strategy as described before. Multiplying this risk ratio with the pooled risk estimate from the general meta-analysis resulted in the risk estimate for high exposure per risk factor to be used in the model.

Model development

The basis of the model is the probability of LBP for subjects not exposed to the risk factors under study. The probability equals the prevalence among unexposed subjects calculated in the meta-analysis. The probability of LBP can be increased when exposure to one or more risk factors is present. The adjusted estimates per risk factor from the meta-analysis were used as input into the model. Hence, the probability for LBP can be calculated with the following formula:

$$p_x = \frac{1}{1 + (\exp - (\varepsilon + \ln(\vartheta_{het_1}) + \ln(\vartheta_{het_2}) + ... + \ln(\vartheta_{het_i}))}$$

with $\varepsilon = \ln\left(\frac{p_a}{1 - p_a}\right)$

p_a = age-dependent prevalence of LBP when not exposed, and

$\hat{\vartheta}_{het}$ = effect size of a risk factor

The final calculated probability presents the likelihood for the occurrence of LBP given the combination of risk factors present. The model is presented as a score chart, with rounded values of $10*\ln(OR_{adjusted})$ per risk factor as scores[13]. For example, a pooled $\ln(OR_{adjusted})$ of 0.42 will result in a score of +4 in the prediction chart. The total sum score of the risk factors present corresponds with the probability of developing LBP in that specific case. In order to determine the level of work-relatedness, i.e. the probability that the LBP was caused by work-related risk factors, we used the attributable fraction for that individual worker exposed to these risk factors within the model.

Table 1. Characteristics of the included studies (N=40). When odds ratios/relative risks are presented underlined and in italics they are adjusted for each other, odds ratios/relative risks presented only in italics are adjusted for one of the other risk factors, but no value for those risk factor(s) is given.

Authors	Design	Study population	MMH	FBTT	WBV	HPW	JobDis
Alcouffe et al.[19]	CS	7010 workers (M&F)	<u>*1.4 (1.2 -1.6)*</u>	<u>*2.0 (1.7-2.3)*</u>	<u>*1.3 (1.7-2.2)*</u>		
Arad et al. [20]	CS	831 nurses (F)	2.7 (1.8-4.1)[1]				
Bigos et al.[21]	PC	1631 workers in a Boeing company factory (M&F)					1.7 (1.3-2.2)
Boshuizen et al.[22]	CS	450 tractor drivers & 110 agriculture workers (M)			1.5 (1.0-2.1)		
Boshuizen et al.[23]	CS	242 drivers & 210 operators (M)			*1.3 (0.6-2.6)*		
					1.7 (1.1-2.8)		
Bovenzi et al.[24]	CS	234 bus drivers & 125 maintenance workers (M)		<u>*2.3 (1.2-4.3)*</u>	<u>*3.6 (1.6-8.2)*</u>		
Bovenzi et al.[25]	CS	1155 tractor drivers & 220 office workers (M)		<u>*2.0 (1.2-3.5)*</u>	<u>*1.6 (1.0-2.4)*</u>		
Burdorf et al.[26]	CS	114 concrete workers & 52 maintenance workers (M)		2.8 (1.3-6.0)	3.1 (1.3-7.5)		
Burdorf et al.[27]	CS	161 tank terminal workers		*1.1 (1.0-1.2)*			
Estryn-Behar et al.[28]	CS	1505 nurses (F)	*2.0 (NA)*	*2.1 (NA)*			
			2.6 (1.8-3.7)	2.8 (1.9-4.1)			
Gilad et al.[29]	CS	250 mine workers (M)	3.1 (1.1-8.7)				
Hartvigsen et al.[49]	PC	1397 Danish workers (M&F)				1.7 (1.2-2.3)	
Heliövaara et al. [30]	CS-p	2946 Finnish women & 2727 Finnish men				2.5 (1.4-4.7)[1]	
Holmström et al. [31]	CS	1772 construction workers	1.1 (1.0-1.3)				1.4 (1.1-1.7)
Hoogendoorn et al. [56]	PC	861 Dutch workers	<u>*1.6 (1.0-2.7)*</u>	<u>*1.3 (0.8-2.2)*</u>			<u>*1.8 (1.0-3.2)*</u>
Hoogendoorn et al.[50]							
Houtman et al.[32]	CS-p	5865 Dutch workers (M&F)				1.6 (1.4-1.9)	
Kerr et al. [51]	CC	316 workers (M&F) in automobile industry		*1.7 (1.0-2.9)*		3.0 (1.8-5.4)	1.7 (1.2-2.5)
Kumar et al.[52]	CS	50 tractor driving farmers & 50 non-tractor driving			2.6 (1.1-6.2)		
Latza et al.[54]	CS-p	770 German workers (M&W)				1.8 (1.1-2.9)	
Latza et al. [53]	CS	571 construction workers (M)	2.3 (1.1-6.5)				
Lau et al.[33]	CS-p	752 population study HongKong households (M&F)	2.3 (1.9-2.7)				
Leigh et al. [34]	CS-p	1414 American workers (M&F)				1.7 (1.1-2.9)	
Liira et al.[35]	CS-p	8020 Canadian blue-collar workers (M&F)	1.5 (1.1 - 1.9)	2.3 (1.7-3.2)	1.8 (1.4-2.7)		

Table 1. Continued

Authors	Design	Study population	MMH	FBTT	WBV	HPW	JobDis
Linton et al.[36]	CS	22180 Swedish workers (M&F)	1.8 (1.5-2.1)	2.2 (1.8-2.6)	1.8 (1.5-2.2)		
Magnusson et al. [37]	CS	228 drivers & 137 sedentary workers (M)	1.9 (1.2-2.8)		1.8 (1.2-2.8)		
Ory et al.[38]	CS	418 tannery workers (M)	3.5 (1.4-8.8)				
Papageorgiou et al.[57]	CS-p	767 working population					1.4 (1.2-1.8)
Picavet et al. [55]	CS-p	22415 Dutch population (M&F)	<u>*1.2 (1.1-1.3)*</u>[3]	<u>*1.6 (1.5-1.8)*</u>			
			1.5 (1.4-1.5)	1.9 (1.8-2.1)			
Pietri et al. [39]	CS	1709 commercial travellers (M&F)	<u>*1.3 (1.0-1.7)*</u>		<u>*2.0 (1.3-3.1)*</u>		
Van Poppel et al.[58]	PC	238 worker in cargo department KLM					1.2 (1.1-1.4)
Saraste et al. [40]	CS-p	2872 Swedish population (M&F)	1.9 (1.6-2.3)	2.6 (2.1-3.3)	2.1 (1.3-3.5)		
Smedley et al. [41]	CS	1616 nurses (F)	1.7 (1.1-2.3)[1]				
Smedley et al. [42]	PC	961 nurses (F)	1.7 (1.1-2.5)[1]				
Suadicani et al.[43]	CS	469 steel plant workers (M&F)	2.4 (1.5-3.6)	2.4 (1.6-3.7)			
Svensson et al. [44]	CS	940 Swedish men	1.7 (1.1-2.6)			1.5 (1.0-2.4)	2.0 (1.2-3.2)
Svensson et al. [45]	CS	1410 Swedish women		1.4 (1.1-1.8)			1.4 (1.1-1.8)
Waters et al. [46]	CS	284 industrial workers (M)	2.1 (1.1-4.0)				
Wells et al. [47]	CS	196 letter carriers, 76 meter readers, 127 clerks (M)	2.2 (1.3-3.7)				
Xu et al.[48]	CS-p	5940 workers (M&F)		<u>*1.7 (1.5-1.9)*</u>	<u>*1.3 (1.0-1.6)*</u>	<u>*1.3 (1.1-1.5)*</u>	
			1.6 (NA)	2.0 (1.7 -2.4)	1.8 (1.2-2.7)	2.2 (1.6-3.9)	

[1] = other value than in the original published review due to choice other endpoint.
[2] =When both adjusted and unadjusted OR are given the adjusted are used in the meta-analysis;
[3] =only used to calculate correction factor; CS=Cross-Sectional; CS-p=Cross-Sectional population study; PC=Prospective Cohort; CC=Case-Control; M=male; F=female;
NA = not applicable

Results

Data from the literature

The two reviews focusing on risk factors and the occurrence of LBP included 44 studies[1, 3]. Of these studies, 30 fulfilled the criteria for our analysis[19-48]. Fourteen studies were rejected from further analysis for the following reasons: a health endpoint other than a period prevalence of ≤ 12 months and/or the incidence of LBP (n=9), lack of a clear exposure definition (n=2), or specific low back pain such as disk prolapse and sciatica (n=3). Besides these 30 studies, 10 more studies were included after an additional literature search using the same criteria[49-58]. Table 1 lists the features of the 40 studies included in the analysis.

Data extraction

Table 1 summarizes the risk estimates for the factors under study. Of the 40 studies included, 35 had a cross-sectional design (including 10 population-based studies). Five studies had a longitudinal design. The ratio of unadjusted and adjusted studies was for MMH 15:3, FBTT 7:8, WBV 8:5, HPW 7:1, JobDis 8:1, and MoWo 4:1.

Prevalence of LBP when not exposed

The weighted pooled prevalence for the occurrence of LBP among unexposed subjects was 30%, resulting in a probability for LBP when not exposed of p=0.30. This prevalence represents the probability of LBP among the age category 35-44 years as indicated by the meta-analysis. The risk estimates for age categories 35-44 years and >45 years are presented in table 2. From the weighted pooled prevalence of 30% and these risk estimates we calculated a probability of LBP among non-exposed subjects of 35 years and younger of 22% and for non-exposed subjects over 45 years of 34%.

Meta analysis

Table 2 gives the pooled unadjusted and adjusted risk estimates per risk factor. For all risk factors the pooled risk estimate from studies with adjustment for one of the other risk factors differed from the pooled estimate based on studies without this adjustment. The confounders corrected for were based on the available epidemiological information in studies reported both the adjusted and the unadjusted risk estimates per risk factor. This resulted in a correction factor for MMH corrected for FBTT of -0.2[28, 55], FBTT corrected for MMH of -0.2[48, 55], WBV corrected for MMH and FBTT of -0.3[23, 25, 48], HPW corrected for MMH and FBTT of -0.5[48], MoWo corrected for JobDis and HPW of -0.6[32] and JobDis corrected for HPW of -0.1[50]. Subsequently, the corrected risk estimates and the adjusted risk estimates were pooled to get a final unbiased risk estimate for that risk factor (Table 2). The final risk estimates of HPW and MoWo were not significant, and where thus left out of the model.

Table 2. Results of the meta-analysis on six occupational risk factors for LBP and the effect of age on LBP.

Risk factor	Number of studies		Pooled Risk estimate (CI)	Pooled Risk estimate (CI) After correction	Overall pooled Risk estimate (CI)
AGE 35-45	Adjusted	n=9	1.47 (1.19 - 1.82)	1.47 (1.19 - 1.82)	1.47 (1.19 - 1.82)
AGE >45	Adjusted	n=10	1.78 (1.42 - 2.22)	1.78 (1.42 - 2.22)	1.78 (1.42 - 2.22)
MMH	Unadjusted	n=15	1.95 (1.63 - 2.30)	1.54 (1.30 - 1.83)	1.51 (1.31 - 1.74)
	Adjusted	n=3	1.38 (1.13 - 1.68)	1.38 (1.13 - 1.68)	
FBTT	Unadjusted	n=7	2.20 (1.82 - 2.66)	1.80 (1.49 - 2.18)	1.68 (1.41 - 2.01)
	Adjusted	n=8	1.52 (1.20 - 1.93)	1.52 (1.20 - 1.93)	
WBV	Unadjusted	n=8	1.83 (1.63 - 2.06)	1.38 (1.15 - 1.66)	1.39 (1.24 – 1.55)
	Adjusted	n=5	1.43 (1.19 - 1.71)	1.43 (1.19 - 1.71)	
HPW	Unadjusted	n=7	1.69 (1.52 - 1.89)	1.03 (0.92 - 1.15)	1.13 (0.96 - 1.33)[1]
	Adjusted	n=1	1.28 (1.08 - 1.52)	1.28 (1.08 - 1.52)	
JobDis	Unadjusted	n=8	1.39 (1.16 - 1.68)	1.29 (1.16 - 1.45)	1.30 (1.17 - 1.45)
	Adjusted	n=1	1.75 (0.96 - 3.19)	1.75 (0.96 - 3.19)	
MoWo	Unadjusted	n=4	1.68 (1.22 - 2.30)	0.92 (0.67 - 1.26)	1.00 (0.80 - 1.26)[1]
	Adjusted	n=1	1.35 (1.10 - 1.64)	1.35 (1.10 - 1.64)	

Abbreviations: MMH =Manual Material Handling; FBTT =Frequent Bending and Twisting of the Trunk; WBV =Whole Body; Vibration; HPW =High Physical Workload; JobDis =Job Dissatisfaction; MoWo=Monotonous Work; CI =confidence interval; [1]= not significant.

Magnitude, frequency, and duration of exposure

Table 3 shows the result from the analysis on low and high exposure for the physical risk factors included into the model, i.e. MMH, FBTT and WBV. Five studies mentioned both low and high exposure values for MMH[19, 37, 38, 50, 53], three studies for FBTT[31, 48, 50] and three studies for WBV[22, 24, 25]. The cut offs for high exposure that were used, were approximately for MMH >15 kg 10% of the working time, for FBTT 30^{o} bending/twisting>10% of the working time, and for WBV a five year exposure to 1 m/s^2 or an equivalent vibration dose[22]. The analysis resulted in a risk estimate for high exposure of 1.92 for MMH, 1.93 for FBTT, and 1.63 for WBV.

Table 3. Analysis on studies presenting risk estimates for both low exposure and high exposure.

Risk factor	Number of studies (unadj./adj.)	Overall Pooled Risk estimate		Ratio High / Low risk estimate	Risk estimate High exposure in the model
		Low exposure	High exposure		
MMH	5 (3 / 2)	1.27 (1.00-1.62)	1.61 (1.26-2.05)	1.27	1.92
FBTT	3 (2 / 1)	1.14 (0.85-1.52)	1.31 (0.92-1.87)	1.15	1.93
WBV	3 (2 / 1)	2.25 (2.01-2.52)	2.63 (1.69-4.10)	1.17	1.63

Abbreviations: see table 2.

Model development

The model was built upon the age-dependent prevalence of LBP when not exposed. Additional presence of one or more of the risk factors under study will raise the probability. The transformation of the model into a flow chart yielded a score for MMH, FBTT, WBV, and JobDis of +4, +5, +4, and +3, respectively. Considering the risk estimates for high exposure of MMH, FBTT and WBV, the high exposure scores in the flow chart resulted in +7, +7, and +5, respectively.

When no exposure to one of the risk factors under study is present, the chart score will be 0 and result in the age-dependent prevalence when not exposed. From all possible scores a concomitant probability for having LBP could be derived which finally was transposed into an attributable fraction indicating the level of work-relatedness for LBP. Figure 1 shows the flow chart and the corresponding attributable fractions per score.

Figure 1. Flow chart to assess the level of work-relatedness of low back pain

RISK FACTORS	Score If risk factor present		SCORE
	Exposed	High Exposed[1]	
• Lifting/Manual material handling	+ 4	+ 7	....
• Frequent bending/twisting trunk	+ 5	+ 7	....
• Whole body vibration	+ 3	+ 5	....
• Low job satisfaction	+ 3	----	....
		Total score (0-22)	....

Total score	AGE (years)		
	< 35	**35 – 45**	**> 45**
	ATTRIBUTABLE FRACTION		
0 (no exposure)	0	0	0
1	7	7	6
2	14	13	12
3	20	18	17
4	26	23	22
5	31	28	26
6	35	32	30
7	39	35	33
8	43	39	36
9	46	42	39
10	49	44	42
11	52	47	44
12	55	49	46
13	57	51	48
14	59	53	50
15	61	54	51
16	62	56	53
17	64	57	54
18	65	58	55
19	66	60	56
20	68	61	57
21	69	61	58
22	69	62	59

1= cut off MMH: >15kg 10% working time, FBTT: >10% working time with 30^{o} bended/twisted back and WBV: 5 years exposure to 1m/s^2 or equivalent vibration dose;
Horizontal lines indicate the 50% level of work-relatedness of LBP

Discussion

In order to indicate the level of work-relatedness of LBP, we presented a model based on the available epidemiological information from the literature. Techniques from clinical decision modeling enabled us to present a model that may help the general practitioner and the occupational health physician in determining the level of work-relatedness of LBP for an individual worker given the personal exposure profile to well-established risk factors.

Heterogeneity

To minimalize heterogeneity between studies we used strict selection criteria for the studies to be included. Regarding case definitions we used only studies on non-specific low back pain in terms of period prevalences. Regarding exposure we selected studies that had exposure to the risk factors of interest above a predetermined cut-off point. Furthermore, we used a random effect model in our meta-analysis to overcome heterogeneity in study population. Most studies which were found had a cross-sectional design. However, regarding the longitudinal studies included the variable scores did not differ that much (see table 1).

Age dependent prevalences

The basis of the model is the age-dependent prevalence of LBP when not exposed. The model is aimed at the situation in which a worker with LBP presents himself to the general practitioner or the occupational health physician. This might imply that using point prevalence should give a better estimate for the age-dependent prevalence in that particular situation. However, most epidemiological studies use period prevalences as outcome. To verify the effect of using a point prevalence instead of a period prevalence, we calculated both measures of prevalence from two available data sets[59, 60]. These data showed that among the workers, who had LBP in the previous 12 months, about 60% reported to have had LBP in the previous 7 days. Thus, from these data it appeared that the point prevalence roughly equals 0.6 times the period prevalence. However, using point prevalence in the model appeared to have a minor effect on the results of the model in terms of the attributable fraction. For the consistency of the model, we chose to uphold the use of the period prevalence, because the risk estimates of the included risk factors are primarily based on 12-month prevalences.

Correcting unadjusted risk estimates

It is known that not taking into account confounding factors might overestimate a certain risk factor[18]. Using a multiplicative model, we determined an unbiased risk estimate for the risk factors by means of correction for other confounding risk factors. For this purpose we used a technique often used in clinical decision modelling, i.e. calculating a correction factor for the unadjusted risk estimates[12, 18]. In order to do so, we needed studies that reported both unadjusted and adjusted risk estimates for the same risk factor. However, few studies presented this information. The two studies determining the correction factor for

MMH and FBTT revealed almost the same value; the same applies to the correction factor for WBV. However, the correction factor for HPW, JobDis, and MoWo could only be calculated from one study. The correction factor for HPW was rather high, resulting in a strong correction of the risk estimate (see Figure 1). Although this might indicate an underestimation of the true risk estimate for HPW, the fact that exposure to MMH and FBTT will strongly influence the self-reported HPW[1], justifies the calculated correction factor.
To gain better insight into the effects of adjustment on the risk factors for LBP, we suggest that future studies present data on risk estimates in both unadjusted and adjusted analyses.

Magnitude, frequency, and duration of exposure

Several studies have indicated that the level of exposure to the physical risk factors determines the occurrence of LBP[22, 50, 61]. Unfortunately, there was little information available to split up exposure into magnitude, frequently and duration. We therefore chose to select studies that described both low exposure and high exposure, using approximately the same cut off for high exposure. Because of the low numbers in this analysis, the pooled risk estimates differed from those in the general meta-analysis. However, this difference was controlled for, by using the same studies for calculating pooled risk estimates for both low exposure and high exposure. For MMH we could derive low and high exposure values from five studies, using approximately the same cut off for high exposure, i.e. >15 kg >10% of the working time[19, 37, 38, 50, 53]. Because of variation in exposure definition, it is difficult to give an exact cut off for high exposure to MMH. However, the cut off that could be gathered from the studies included corresponded in reason with recommendations considering MMH[62].

For FBTT and WBV we found three studies for the analysis with a cut off for high exposure of approximately >30^{o} bending/twisting >10% of the working time for FBTT[31, 48, 50], and 5 years exposure to 1 m/s^2 or an equivalent vibration dose for WBV[22, 24, 25]. The cut off for FBTT corresponded well with data presented by Punnett et al[61]. In their study the OR for FBTT increased significantly when the exposure duration was >10% of the cycle time. This study was not included in the meta-analysis because injury claims and physical examination were used as endpoint definition for LBP. High exposure for WBV could be quantified rather accurately, because exposure to WBV was determined by direct measurements.

Regarding foregoing, we have to consider that epidemiological studies do not have sufficient power to measure all relevant dimensions. Incorporating information of a more biomechanical and physiological nature into the model might supplement the epidemiological data, and thus provide a more elaborate model, including magnitude, frequency and duration of the distinguished risk factors[62].

Practical implications of the model

The level of work-relatedness of LBP is indicated by the attributable fraction (Figure 1). To determine the likelihood of work-relatedness of the presented LBP dichotomously, we propose to use a cut-off point of 50%, meaning that if the calculated probability that the LBP is due to occupational exposure is 50% or more, the presented LBP can be regarded as work-related (see Figure 1). An attributable fraction of 50% is often used in decision making, for example on compensating lung cancer patients occupationally exposed to hazardous agents such as asbestos[63].

In the model both low exposure and high exposure could be distinguished (Figure 1). To put this distinction into practice we suggest to use the cut off definitions as described in this article.

It must be clear that the model is not an etiological model for low back pain, but an attributable model for the effect of work on having low back pain. The model gives an estimate of the work-relatedness for the individual worker and can be used as a possible tool to direct intervention strategies. Furthermore, it must be emphasized that the presented model does not consider the nature and severity of LBP, such as LBP with sickness absence. The model only assesses the level of work-relatedness for an individual worker. Future longitudinal studies must determine the factors that predispose e.g. disability, chronicity, and sick leave and the interaction between these factors and the factors in our model.

Conclusions

The presented model enables the general practitioner and the occupational health physician to estimate the level of work-relatedness of LBP for an individual worker. This may provide useful guidance as to interventions to be proposed.

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3.

ARE CHANGES IN MECHANICAL EXPOSURE AND MUSCULOSKELETAL HEALTH GOOD PERFORMANCE INDICATORS FOR PRIMARY PREVENTIVE INTERVENTIONS?

Adapted from:

Lötters F, Burdorf A. Are changes in mechanical exposure and musculoskeletal health good performance indicators for primary interventions? *Int Arch Occup Environ Health* 2002;75(8):549-61.

Abstract

Objectives. The purpose of this review is to present more insight into the effects of primary prevention interventions on both mechanical exposure and musculoskeletal health and to determine whether these outcomes are good performance indicators of such interventions.

Methods. The literature was scrutinised for relevant references. Primary preventive was defined as any activity aimed at preventing the occurrence of musculoskeletal disorders in occupational populations. Primary outcome measures were mechanical exposure, musculoskeletal health, and sick leave due to musculoskeletal disorders. The impact of interventions was assessed by calculating the reduction in mechanical exposure and the Preventive Fraction (PF) of the musculoskeletal complaints. After selection 40 studies were included for further analysis.

Results. In general, of the 40 included studies 29 (73%) found a reduction in musculoskeletal symptoms (PF range 0,10 - 0,95). Eighteen out of 29 studies (62%) reported a statistically significant reduction in musculoskeletal disorders. In 12 of the 40 studies (30%) changes in both mechanical exposure and musculoskeletal health were used as performance indicators for the intervention. Of these studies 8 (67%) showed a reduction in both mechanical exposure (range 14-87 % reduction) and musculoskeletal disorders or sick leave due to musculoskeletal disorders (preventive fraction range 0,15 - 0,92). From these 9 it was seen that a reduction of at least 14% in mechanical exposure resulted in a concomitant improvement in musculoskeletal health.

Conclusion. More quantitative information is needed to describe the relationship between mechanical exposure and musculoskeletal health as presented in the model. In this case is recommended to measure not only changes in health outcomes but also changes in mechanical exposure along the pathway of the intervention in primary preventive intervention studies. This way a better insight will be gained about the dose-response relationships between exposure to physical load risk factors and WRMSD. More insight in these relationships will eventually lead to more efficient implementations of primary preventive intervention strategies.

Introduction

Musculoskeletal health is a considerable problem in working populations[1]. Several risk factors concerning physical load have been described for the occurrence of musculoskeletal disorders[2-4].

In primary preventive interventions one has to consider the level of exposure to these risk factors in the working situation to determine whether musculoskeletal disorders truly can be qualified as work-related musculoskeletal disorders (WRMSD). A widely recognised problem is that there is little convincing evidence on dose-response relationships, i.e. how much exposure reduction is needed to have a significant effect on reducing WRMSD[5, 6]. A distinction has to be made between relative and absolute differences in mechanical exposure after a primary preventive intervention and its effect on musculoskeletal health. For example, an absolute reduction in mechanical exposure of 25% can lead to different outcomes on musculoskeletal health relative to the initial magnitude of the exposure to certain risk factors. In their review, Westgaard and Winkel[5] suggested that a reduction in mechanical exposure might be beneficial for musculoskeletal health in work situations where mechanical exposure initially is high.

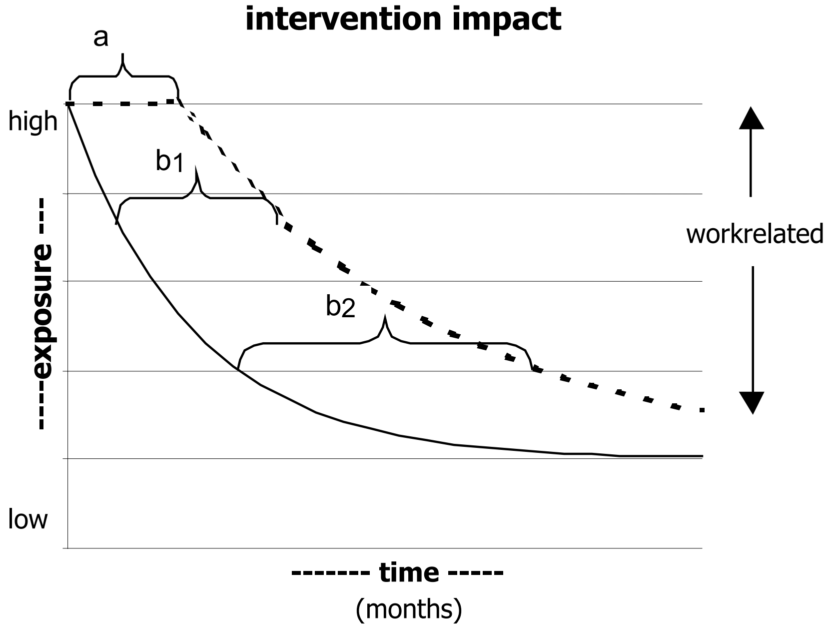
An other aspect to take into account when studying the effects of a primary preventive intervention is the time window in which effects can occur. Whilst the mechanical exposure may reduce rapidly in magnitude, there will almost certainly be a time lag before any reduction in the magnitude of the effect on musculoskeletal health takes place[7]. Some WRMSD may have a latency period of several years[8].

Figure 1 illustrates the hypothetical model for intervention impact based on the aspects described above. To contribute to the discussion raised by several authors about this model[5-7], it might be essential to determine whether changes in mechanical exposure and/or musculoskeletal health are good performance indicators of primary preventive interventions[8].

Several studies reviewed effects of interventions strategies on physical load risk factors[1, 5, 9, 10]. However, few studies have demonstrated the effect of an intervention on these risk factors regarding both mechanical and musculoskeletal health as performance indicators[5, 6, 11]. It still remains unclear whether primary preventive interventions aimed at reducing the risk of musculoskeletal disorders by reducing the physical load, will lead concomitant to an improvement in musculoskeletal health[12]. So, it is important to identify through which pathway an intervention will be effective and, for example, how much reduction in mechanical exposure is needed to have a noticeable impact on musculoskeletal health. In this regard it seems essential to determine whether quantification of mechanical exposure and its effect on musculoskeletal health are good performance indicators on the pathway of effectiveness for interventions on reducing physical load risk factors[8].

The purpose of this review is to present more insight into the effects of primary preventive interventions on both mechanical exposure and musculoskeletal health and to determine whether these outcomes are good performance indicators of such interventions.

Figure 1. Intervention impact as function of exposure and time.



Footnote:

a = the time lag between reduction in mechanical exposure and improvement of musculoskeletal health[7].

b1 / b2 =level of exposure and the time it takes before changes in musculoskeletal health take place. The model shows that high exposure will lead sooner to a change in musculoskeletal health[5]

The straight line indicates the change of mechanical exposure due to an intervention strategy and the dotted line indicates the change in prevalence in musculoskeletal disorders

Methods

Identification and selection of the studies

For the literature search we used MEDLINE 1966-February 2001, EMBASE 1988-February 2001, NIOSHTIC-2 and relevant references from peer-reviewed articles. The following search strategy was conducted: "musculoskeletal disease" OR "occupational disease" AND "ergonomic intervention". As optional keywords for musculoskeletal disease we used "work-related musculoskeletal disorders", "repetitive strain injuries", "low back". As optional keywords for ergonomic intervention we used "prevention", "ergonomics", "sick-leave", "return to work", "mechanical exposure", "occupational health".

The articles were screened by reading title and abstract, using the following inclusion criteria:

- articles published in English;
- articles published in peer-reviewed scientific journals;
- articles on work-related musculoskeletal disorders;
- articles from 1980 until 2001;
- no review papers.

In a second selection we excluded articles according to the following exclusion criteria:

- methodological shortcomings;
- articles not concerning primary preventive intervention strategies directed at reducing mechanical exposure;
- no information on the occurrence of musculoskeletal disorders or musculoskeletal sick leave;
- laboratory studies;
- studies concerning pre-employment screening.

Disagreement regarding study inclusion was resolved by consensus among the authors.

Data abstraction and measures of evaluation

Primary preventive intervention was defined as any activity aimed at preventing the occurrence of WRMSD in occupational populations. The included studies were categorised into four groups of intervention strategies[9]:

1. administrative intervention (interventions that primarily consist of organisational strategies targeting work practices and policies);
2. engineering intervention (interventions targeting the physical work environment);
3. personal intervention (interventions addressing worker behaviour, education and training);
4. multiple intervention (combination of the above mentioned interventions).

In this review participatory ergonomics is regarded as an approach of implementing an intervention rather than a specific intervention category itself.

The effect of an intervention on mechanical exposure is quantified by calculating the percentage reduction in mechanical exposure between intervention and control group or between pre- post measures. Endpoints of health outcome are physical discomfort (discomfort measured immediately after the intervention), musculoskeletal symptoms assuming a musculoskeletal disorder (by incidence, period prevalence or diagnosed by a physician), and sick leave. These outcome measures were compared between experimental and control groups or between pre- and post measurements when no control group was included. The statistical significance was derived from the original paper. The intervention impact on musculoskeletal health, characterised by the Preventive Fraction (PF), was calculated as a relative difference between the outcome of the reference group and the intervention group, divided by the outcome of the reference group:

$$\text{Preventive Fraction } (PF_e) = O_u - O_e / O_u$$

With:

O_u = occurrence (prevalence or incidence) unexposed (pre-test or control)

O_e = occurrence (prevalence or incidence) exposed (post-test or intervention)

In other words, the PF is that proportion of the occurrence of the health outcome among the reference group that could have been prevented if the intervention had also been imposed on them. When musculoskeletal health was expressed for several body regions and no differences between body regions were observed, the preventive fraction was calculated from the average value of these body regions.

Intervention impact

To study the intervention impact we used the model of Westgaard & Winkel[5]. This model shows a common path for ergonomic interventions to influence musculoskeletal health through changing mechanical exposure.

The impact of the intervention was evaluated on three aspects: intervention compliance, intervention sustainability, and outcome sustainability[5]. Intervention compliance is defined as the way in which subjects act in accordance with the imposed intervention during the intervention period. If acceptance of those involved is stated, intervention compliance is rated "reasonable" or the acceptance rate is given. An acceptance rate of less than 30% will be rated as poor[13].

Intervention sustainability is defined as compliance with the intervention during the follow-up period; i.e. after the intervention has been imposed. It reveals information about the way in which the subjects still act in accordance with the intervention although the imposed intervention has already been terminated. Intervention sustainability is rated "reasonable" if a favourable outcome over a long period of time is measured or can be expected and "unknown" if no relevant process information is given. Intervention sustainability and intervention compliance is considered "not relevant" for one-step implementation of physical measures, e.g., the introduction of a new chair without alternatives.

Outcome or effect sustainability is defined as a sustained effect of the intervention over a specified period for health outcomes. Effect sustainability is rated "reasonable" if the outcome variables indicate a positive result over the observed period. Short time series, even when follow-up measurements are included, are rated "unknown".

Results

The search initially retrieved about 600 studies. After reading title and abstract 195 potentially eligible studies were identified. After applying the exclusion criteria 40 studies were used for further analysis. Tables 1 and 2 summarise the characteristics of the included studies. Twelve of the included studies (30%) quantified both changes in mechanical exposure and musculoskeletal health (table 1 and 3) whereas the other studies only quantified changes in musculoskeletal health (table 2 and 4).

In total, there were 4 studies with an organisational intervention, 8 studies with an engineering intervention, 9 studies with a personal intervention, and 19 studies with multiple interventions. Engineering (13 of 19; 68%) and education (15 of 19; 79%) were the most important components in multiple intervention strategies. Both engineering intervention and education were used in 10 out of 19 studies (53%).

Most of the studies used a pre-post design (see table 1 and 2). In addition, there were 3 randomised controlled trails[14-16], 3 cross-sectional studies[17-19] and 7 longitudinal studies[20-26]. Of the 34 studies using a pre-post design or longitudinal design only 13 studies (38%) used a control group[20, 26-37].

Tables 3 and 4 summarise the effects of intervention on mechanical exposure and on musculoskeletal health. In general, of the 40 included studies 29 (73%) found a reduction in musculoskeletal symptoms (PF range 0,10 - 0,95). This counted for 75% of the organisational interventions (PF range 0,22 - 0,76), 75% of the engineering interventions (PF range 0,14 - 0,67), 44% of the personal interventions (PF range 0,27 - 0,43) and 84% of the multiple interventions (PF range 0,10 - 0,95). Eighteen out of 29 studies (62%) reported a statistically significant reduction in WRMSD. In 9 out of 12 studies (75%) with quantification of mechanical exposure a reduction of 14% - 87% was observed, which was statistically significant in 8 out of 9 studies (89%). In these 12 studies 8 (67%) also showed a reduced prevalence of musculoskeletal symptoms or reduced sick leave due to WRMSD[18, 21, 26, 27, 29, 38-40].

In table 5 the effects of the four primary preventive intervention strategies on musculoskeletal health and mechanical exposure are summarised. In studies quantifying both mechanical exposure and the occurrence of WRMSD it was shown that in 7 out of 12 studies (58%) a statistically significant reduction in mechanical exposure was attended by a statistically significant decrease in musculoskeletal symptoms. Primary preventive interventions without mechanical exposure information demonstrated only in 11 out of 28 studies (39%) that the intervention was statistically significant with regard to a reduction in WRMSD.

In general, the compliance sustainability was reasonable. In three studies compliance sustainability was relatively low: 43%[14], 36%[41], and 52%[28]. The effect sustainability was rated reasonable in 11 of the 38 relevant studies (29%). Intervention sustainability was rated reasonable in only 9 of the 33 relevant studies (27%).

Table 1. Descriptive information of included primary preventive intervention studies quantifying both mechanical exposure and health outcome (n=12)

Author	Design, period & population	Intervention	Mechanical exposure	Health outcome
		ORGANISATIONAL AND ADMINISTRATIVE INTERVENTIONS		
Wahlstedt et al.[42]	pre-post / 1 year 82 postal workers	Changes in work Organisation	Questionnaire: work Demands & hazards	Questionnaire: 12 months prevalence musculoskeletal symptoms
		TECHNICAL, ENGINEERING OR ERGONOMIC INTERVENTIONS		
Aarås et al.[21]	Longitudinal / 7 years 331 factory workers	Adjustments of the Workstation	EMG: trapezius load inclinometry: head, upperarm, and low back	Questionnaire: 12 month Prevalence musculosk. Sympt. Registrated sick leave
Aarås et al.[27]	pre-post / control/ 2 yrs 150 office workers	new workplaces	EMG: trapezius load Inclinometry: head, upperarm, and low back	Questionnaire: 12 month Prevalence musculosk. symptoms
Fredriksson et al.[20]	pre-post / control/ 1 yr 168 assembly workers	new assembly line	questionnaire inclinometry	Questionnaire: 7 days prevalence
Johansson et al.[17]	cross-sectional / references 45 assembly workers	new assembly line	videorecording: backflexion, elevated arms, material handling	Questionnaire: 12 months Prevalence neck, shoulder & low back symptoms
Kadefors et al.[18]	cross-sectional 5 assembly workers	new assembly line	EMG: trapezius, erector spinae, ext. carp.rad, rectus femoris	questionnaire: physical discomfort
		PERSONAL INTERVENTIONS		
Brisson et al.[29]	pre-post / control / 8 mths 627 office workers	Education program: Adjusting workstation Organise workactivit.	direct observation: 3 postural stressors	Questionnaire: neck-shoulder, hand-wrist, lower back/ ≥3days last 7 days
Lewis et al.[38]	pre-post / 1 year 292 office workers	Education / training For workplace adjustm.	questionnaire: workstation configurat.	questionnaire: neck/upperback, low back, shoulders, elbow/forearm, hand/wrists
		MULTIPLE INTERVENTIONS		
Garg et al.[39]	pre-post / 4 years 57 nursing personnel	Engineering intervent. Education / training	compressive force L5/S1 with 3d model	Accident Invest. Report forms OSHA 200: sick leave
Nygård et al.[45]	pre-post / 2 years 21 store workers	Engineering intervent. Education, training	OWAS: back & leg Postures	Questionnaire: physical discomfort
Reynolds et al.[40]	pre-post / 5 months 18 apparel workers	Engineering interv. Ergon.surveill.progr.	Videorecording Handdynamometrie	Questionnaire: physical discomfort
Wickström et al.[26]	longitudinal / referc./ 5 yrs 88 planners 125 metal workers	Education Physical fitness	Videorecording: load low back with 2d-model	Questionnaire: 12 months Prevalence low back pain Registrated sick leave

Abbreviations: NM=not measured; NA=not applicable

Table 2. descriptive information of included primary intervention studies only quantifying health outcome (n=28)

Author	**Study design, period & population**	**Intervention**	**Health outcome**
		ORGANISATIONAL AND ADMINISTRATIVE INTERVENTIONS	
Christmansson et al.[43]	Pre-post / 1992 pre study 1995/6 post study 18 assembly workers	Changes in work organisation	Physical examination: Musculoskeletal symptoms
Galinsky et al.[51]	pre-post / 16 weeks 48 data-entry workers	Rest-break schedule	Questionnaire: physical discomfort
Henning et al.[41]	pre-post / 9 weeks 92 office workers	rest-break schedule workstation exercises	Questionnaire: low back, leg/feet, Hand/arms, neck/shoulder discomfort
		TECHNICAL, ENGINEERING OR ERGONOMIC INTERVENTIONS	
Demure et al.[44]	pre-post / 1 year 118 office workers	adjustment of the workstation	Questionnaire: symptoms neck/shoulder, wrist/hand, low back
Moore et al.[52]	pre-post / 5 years 5 assembly workers	engineering intervention	Questionnaire: musculoskeletal symptoms OSHA 200: sick leave
Perkiö-Mäkelä et al.[28]	pre-post / 2 weeks 100 tractor drivers	adjustment inclination backrest accessory lumbar support	Questionnaire: 2 weeks prevalence low back & neck-shoulder
		PERSONAL INTERVENTIONS	
Coury et al.[46]	pre-post / 6 weeks 36 office workers	auto-instructional preventive programme	Questionnaire: physical discomfort
Daltroy et al.[16]	RCT / 5,5 years 3597 postal workers	education program	Postal Service Accident Reports
Feldstein et al.[34]	pre-post / control / 1 month 55 nurses / orderlies	education / training on low back safety	Questionnaire: back pain
Gundewall et al.[15]	RCT / 13 months 60 Nursing personnel	physical fitness for low back	Questionnaire: pain diary: sick leave
Silverstein et al.[35]	pre-post / control / 1 year 178 assembly workers	exercise program	questionnaire: neck, shoulder, wrist and hand
Thomas et al.[30]	pre-post / control / 8 weeks 10 assembly workers	biofeedback (EMG) on forearm activity	questionnaire: physical discomfort
Videman et al.[36]	pre-post / control / 4 years 200 nurses	education / training	questionnaire: back pain prevalence
		MULTIPLE INTERVENTIONS	
Bernacki et al.[22]	Longitudinal approx. 20.000 office workers	ergonomic surveillance program	OSHA 200: upper limb symptoms
Chatterjee et al.[23]	longitudinal / 8 years 695 assembly workers	education engineering intervention	OSHA 200: musculosk. symptoms
Evanoff et al.[53]	pre-post / 2 years 99 hospital orderlies	education / training engineering intervention participatory approach	Questionnaire: physical discomfort OSHA 200 log: sick leave
Hinnen et al.[19]	cross-sectional 152 cashier workers	engineering intervention job rotation	Questionnaire: musculosk. symptoms
Kilroy et al.[54]	pre-post / 12 months 14 biomedical scientists	education engineering intervention	Questionnaire: 3 months Prevalence musculosk. symptoms
Lagerström et al.[24]	longitudinal / 3 years 348 nursing personnel	education / training physical fitness	Questionnaire: 12 months Prevalence musculosk. Symptoms

Table 2. Continued

Author	Study design, period & population	Intervention	Health outcome
Leclerc et al.[31]	pre-post / control / 1 year 138 hospital workers 158 warehouse workers 229 office workers	education physical fitness engineering intervention	Questionnaire: 6 months prevalence shoulder, low back, upper back, neck
Lynch et al.[55]	pre-post / 1 year 374 nursing personnel	education / training engineering intervention	questionnaire: low back pain & sick leave
McKenzie et al.[25]	longitudinal / 3 years 6600 assembly workers	engineering intervention education	OSHA 200: musculosk. symptoms
Moore et al.[48]	longitudinal / 7 years 380 assembly workers	training + education engineering interventions	OSHA 200: sick leave & musculoskeletal symptoms
Orgel et al.[56]	pre-post / 4 months 23 cashiers	education engineering intervention	Questionnaire: neck/upperback/shoulder, arm/forearm/wrist, low back/legs
Van Poppel et al.[14]	RCT / 12 months 312 cargo workers	education lumbar support	Questionnaire: low back pain, sick leave
Shi et al.[32]	pre-post / references / 1 yr 4603 office workers	engineering intervention education, training physical fitness	Questionnaire: low back pain prevalence
Vink et al.[33]	pre-post / references / 1 yr 45 office workers	engineering intervention	Questionnaire: 12 months prevalence musculoskeletal symptoms
Wood et al.[37]	longitudinal / control 700 nurses 5 years	education training	accident reports

Abbreviations: NM=not measured; NA=not applicable; *program concerns primary, secondary and tertiary intervention

Table 3. Results of the included primary preventive intervention studies quantifying both mechanical exposure and health outcome (n=12)

Author	**Results** (a) Mechanical exposure (b) Health outcome	**Quantified** (a) %Reduction (b) Preventive Fraction	**Intervention impact** (1) Compliance (2) Intervention sustainability (3) Effect sustainability
	ORGANISATIONAL AND ADMINISTRATIVE INTERVENTIONS		
Wahlstedt et al.[42]	(a) no difference physical work demands (overall) (NC) (b) reduced musculoskeletal symptoms (at <35 year) (S)	-16 0,45	(1) not relevant (2) not relevant (3) unknown
	TECHNICAL, ENGINEERING OR ERGONOMIC INTERVENTIONS		
Aarås et al.[21]	(a) reduction in postural load (S) (b) reduced sick leave (S)	67 0,92	(1) not relevant (2) not relevant (3) reasonable
Aarås et al.[27]	(a_1) decreased static trapezius load in T-group (S) (a_2) decreased static trapezius load in S-group (S) (b_1) reduced shoulder pain in T-group (S) (b_2) reduced shoulder pain in S-group (S)	87 80 0,22 0,43	(1) not relevant (2) reasonable (3) reasonable
Frederiksson et al.[20]	(a) no difference in physical load (b1) increased musculoskeletal symptoms (b2) increased sick-leave	2 -0,8 -0,1	(1) not relevant (2) not relevant (3) reasonable
Johansson et al.[17]	(a) reduced physical load (overall) (b) no difference musculoskeletal symptoms (NS)	1,6 0	(1) not relevant (2) not relevant (3) unknown
Kadefors et al.[18]	(a) reduction in muscular load (S) (b) reduced musculoskeletal discomfort (S)	14 0,50	(1) reasonable (2) poor[4] (3) unknown
	PERSONAL INTERVENTIONS		
Brisson et al.[29]	(a) reduction in postural load (<40 year) (S) (b) decreased musculosk. disorders (<40 year)(S)	42 0,54	(1) 81% (2) reasonable (3) unknown
Lewis et al.[38]	(a) reduced workstation configuration (overall)(S) (b) reduced musculosk.symptoms (overall) (NS)	27 0,15	(1) reasonable (2) unknown (3) unknown
	MULTIPLE INTERVENTIONS		
Garg et al.[39]	(a) reduced compression force L5/S1 (S) (b_1) reduced low back symptoms (NC) (b_2) reduced sick leave	59 0,43 1	(1) approx. 84% (2) unknown (3) unknown
Nygård et al.[45]	(a) no differences in back postures (NS) (b) increase in physical discomfort (NS)	0 0,37	(1) reasonable (2) unknown (3) unknown
Reynolds et al.[40]	(a) reduced daily exposure (overall) (NC) (b) reduced physical discomfort (overall) (S)	52 0,89	(1) not relevant (2) not relevant (3) reasonable
Wickström et al.[26]	(a) reduced back load in sheet metal workers (S) (b_1) no differences in musculosk. sympt. (overall)(NS) (b_2) decreased sick leave (overall) (S)	42 0,07 0,36	(1) unknown (2) reasonable (3) reasonable

Abbreviations: S=significant, NS=not significant, NC=not calculated, NA =not applicable

Notes: [1] =Factory was closed shortly after the study

Table 4; Results of the included primary intervention studies quantifying only health outcome (n=28)

Author	**Results** (b) Health outcome	**Quantified** (a) %Reduction (b) Preventive Fraction	**Intervention impact** (1) Compliance (2) Intervention sustainability (3) Effect sustainability
	ORGANISATIONAL AND ADMINISTRATIVE INTERVENTIONS		
Christmansson et al.[43]	(b) increased musculoskeletal symptoms (NC)	-0,43	(1) reasonable (2) unknown (3) unknown
Galinsky et al.[51]	(b) reduced physical discomfort (S)	0,33	(1) reasonable (2) unknown (3) unknown
Henning et al.[41]	(b_1) reduced leg / feet symptoms in active breaks (S) (b_2) no diff. musculosk. sympt. in passive breaks (NS)	0,22 0	(1) 36% [1] / 68%[2] (2) unknown (3) unknown
	TECHNICAL, ENGINEERING OR ERGONOMIC INTERVENTIONS		
Demure et al.[44]	(b) reduced physical discomfort (overall) (S)	0,43[*3]	(1) >75% (2) unknown (3) unknown
Moore et al.[52]	(b_1) reduced musculoskeletal symptoms (NC) (b_2) reduced sick leave (NC)	0,46 0,86	(1) good (2) reasonable (3) reasonable
Perkiö-Mäkelä et al.[28]	(b) reduced musculoskeletal symptoms (overall) (NS)	0,38[*5]	(1) 58%[6] / 52%[7] (2) unknown (3) unknown
	PERSONAL INTERVENTIONS		
Coury et al.[46]	(b) increased musculosk. discomfort (overall) (S)	-0,32	(1) reasonable (2) unknown (3) unknown
Daltroy et al.[16]	(b_1) increase in low back symptoms (clerks) (NS) (b_2) no diff. in low back sympt. (mail-handlers) (NS) (b_3) no difference in sick leave between intervention and controls (NS)	-0,20 -0,08 -0,07	(1) unknown (2) unknown (3) not relevant
Feldstein et al.[34]	(b) reduced back pain symptoms (NS)	0,14	(1) 59% (2) unknown (3) unknown
Gundewall et al.[15]	(b_1) reduced back pain symptoms(S) (b_2) reduced sick leave (S)	0,43 0,82	(1) unknown (2) unknown (3) unknown
Silverstein et al.[35]	(b) no difference physical discomfort (overall) (NS)	0,05	(1) 80% (2) unknown (3) unknown
Thomas et al.[30]	(b) increase physical discomfort biofeedback vs control (NS)	-1,38	(1) good (2) unknown (3) unknown
Videman et al.[36]	(c) no differences in low back symptoms (NC)	-0,05	(1) unknown (2) reasonable (3) unknown
	MULTIPLE INTERVENTIONS		
Bernacki et al.[22]	(b) reduced musculosk.symptoms (S)	0,80	(1) unknown (2) unknown (3) reasonable

Table 4. Continued

Author	**Results** (b) Health outcome	**Quantified** (a) %Reduction (b) Preventive Fraction	**Intervention impact** (1) Compliance (2) Intervention sustainability (3) Effect sustainability
Chatterjee et al.[23]	(b) reduced musculosk. symptoms (NC)	0,95	(1) reasonable (2) unknown (3) reasonable
Evanoff et al.[53]	(b_1) reduced physical discomfort (S) (b_2) reduced sick leave (NC)	0,50*[8] 0,89	(1) reasonable (2) unknown (3) reasonable
Hinnen et al.[19]	(a) mechanical exposure (total) no differences (b) reduced musculoskeletal symptoms (overall) (no scanner/no jobrotat. vs. scanner/job rotat.) (NC)	NA 0,57	(1) not relevant (2) not relevant (3) unknown
Kilroy et al.[54]	(a) improvement in working postures (NC) (b) reduced muskulosk. symptoms	NA 0,59	(1) reasonable (2) reasonable (3) unknown
Lagerström et al.[24]	(b_1) increase in upperback and hip symptoms (S) (b_2) no differences in other musculosk.sympt. (NS)	-0,34 -0,05	(1) 93% (2) reasonable[9] (3) reasonable
Leclerc et al.[31]	(b) reduced musculoskeletal symptoms intervention groups (overall) compared with controls (S)	0,10	(1) reasonable (2) unknown (3) unknown
Lynch et al.[55]	(b_1) reduced low back symptoms (NC) (b_2) reduced sick leave (NC)	0,29 0,73	(1) unknown (2) unknown (3) unknown
McKenzie et al.[25]	(b_1) reduced musculosk.symptoms (NC) (b_2) reduced sick leave (NC)	0,75 0,87	(1) unknown (2) reasonable (3) reasonable
Moore et al.[48]	(b_1) reduced musculoskeletal symptoms (NC) (b_2) reduced sick leave (S)	0,37 0,86	(1) unknown (2) reasonable (3) unknown
Orgel et al.[56]	(b) reduction in neck/upper back/shoulder sympt. (S)	0,30	(1) not relevant (2) not relevant (3) unknown
Van Poppel et al.[14]	(b_1) no diff. in backpain sympt. in lumb. supp. (NS) (b_2) no diff. in backpain sympt. in education (NS) (b_3) no diff. in sick leave in lumbar support (NS) (b_4) no diff. in sick leave education groups (NS)	-0,06 0 0 0	(1) 43%[10] (2) unknown (3) not relevant
Shi et al.[32]	(b) reduced back pain prevalence rates (S)	0,27	(1) 77% (2) unknown (3) unknown
Vink et al.[33]	(a) most workers adjusted the working conditions (b) reduced musculosk. symptoms (overall) (NC)	NA 0,43	(1) reasonable (2) unknown (3) unknown
Wood et al.[37]	(b_1) reduced wage loss accidents (Pers. Progr.) (S) (b_2) reduced wage loss accidents (exp. & control!) (Back Program) NC	0,76 0,54	(1) unknown (2) reasonable (3) reasonable

Abbreviations: S=significant, NS=not significant, NC=not calculated, NA =not applicable

Notes: [1] =larger work site; [2] =smaller worksite; [3] for back pain frequency; [4]=no significant difference between experimental and controlgroup; [5] =backrest adjustment; [6] =accessory lumbar support; [7] = for neck and knee; [8] =continues follow up sessions are given; [9] =lumbar support

Discussion

We tried to find an answer which performance indicator can be used best for evaluating the efficacy of primary preventive interventions. In 12 of the 40 studies (30%) changes in both mechanical exposure and musculoskeletal health were used as performance indicators for the intervention. Of these studies 8 (67%) showed a reduction in both mechanical exposure (range 14-87 % reduction) and musculoskeletal disorders or sick leave due to musculoskeletal disorders (preventive fraction range 0,15 - 0,92). From these 9 it was seen that a reduction of at least 14% in mechanical exposure resulted in a concomitant improvement in musculoskeletal health. Considering the model presented in figure 1 and the findings from this review, it is assumed that probably mechanical exposure can be used as performance indicator along the pathway of intervention, whilst if the follow-up period is long enough to detect changes in musculoskeletal health, the latter can be taken into account.

Methodological considerations

It was not the intention of the authors to conduct a systematic review with a measure of study quality. In the dynamic environment where primary preventive interventions are taken place, it is not always possible to maintain the best scientific design[9]. So, in our view it is not helpful to skip studies which can not fulfil the criteria for a true experimental design, whilst the data may attribute to the discussion on the efficacy of intervention strategies.

However, a few remarks can be made regarding study design. The most obvious problems in the design of the included studies were lack of a control group and no consideration of important confounding factors. The necessity of an adequate control group in evaluation studies was clearly demonstrated in two studies. In the study by Wood[37] the incidence of back injury dropped dramatically in both the experimental and the control group, suggesting that other factors than the initial intervention determined the outcome. Perkiö-Mäkalä and co-worker[28] found a similar reduction in musculoskeletal symptoms in the experimental groups as well as in the control group. The authors suggested that the overall reduction of symptoms might be due to the attention given during the intervention.

Psychosocial factors[17, 20, 42, 43] and organisational factors[24, 35, 44] played also an important confounding role in the efficacy of primary preventive interventions. In two studies unexpected organisational changes interfered negatively with the intervention[24, 44]. In a study by Silverstein[35] the exercise program was overshadowed by increasing productivity demands thereby masking a potential effect of the exercise program. In other studies the intervention influenced the psychosocial work climate negatively and, hence, no change was found in musculoskeletal health[17, 20, 43].

An other aspect of confounding is the fact that reduction of mechanical exposure on the one hand may lead to an increase on the other hand, shifting the problem to another body part[17, 19, 45]. These experiences strongly suggest that studies on the efficacy of an intervention strategy must take into account these important confounding factors. However, in this review only a small part of the included studies (28%) measured confounding factors.

Table 5. Primary preventive intervention studies divided by intervention strategy and used endpoints. Of both mechanical exposure and health outcome the number of studies with a positive outcome, the percentage reduction in mechanical exposure and/or the preventive fraction and the number of studies that found a statistical significant effect on that particular endpoint are shown.

	Mechanical exposure & Health outcome quantified (N=12)						Only Health outcome quantified (N=28)		
	Mechanical exposure			Health outcome			Health outcome		
	positive outcome / total	% reduction	S	positive outcome / total	Preventive Fraction	S	Positive outcome / total	Preventive Fraction	S
Organizational interventions (n=5)	0 / 1	0	--	1 / 1	0,45	1	2 / 3	0,22 - 0,76	2
Engineering Interventions (n=8)	4 / 5	14 - 87	4	3 / 5	0,22 - 0,50	3	3 / 3	0,38 - 0,46	1
Personal interventions (n=9)	2 / 2	27 - 42	2	2 / 2	0,15 - 0,54	1	2 / 7	0,14 - 0,43	1
Multiple interventions (n=19)	3 / 4	42 - 59	2	3 / 4	0,43 - 0,89	2	13 / 15	0,10 - 0,95	7
- engineering + education (n=10)	1	59	0	1	0,43	0	8	0,10 - 0,95	4

S=significant;

Intervention impact

In the model presented in figure 1 both mechanical exposure and musculoskeletal health are described as time dependent variables. To get an idea of the impact of an intervention on these variables the effect sustainability might be important[5]. In this review, however, effect sustainability remained unknown in 27 of the 40 studies, largely because this information was not presented and, to a lesser extent, the follow up of less than one year was too short to demonstrate the sustainability over time[28-30, 40, 41, 46]. Given the fact that it may take several years to develop WRMSD[8, 11, 35, 47] and, consequently, a reduction in mechanical exposure will not immediately result in an improvement in musculoskeletal health[7, 47], it is questionable whether effect sustainability is an obtainable measure for many primary preventive interventions. In general, the follow up period after the intervention should reflect the latency period needed to develop musculoskeletal disorders when musculoskeletal health is used as outcome.

In this review it was found that a reduction in mechanical exposure of at least 14% would result in a concomitant improvement in musculoskeletal health. However, it must be noted that this result was subtracted from only 12 of the 40 (30%) studies. Regarding the model an improvement in musculoskeletal disorders is more likely to be detected when mechanical exposure is high, because if 14% reduction is found when mechanical exposure is low the time lag before a noticeable change will take place in the prevalence of musculoskeletal disorders will be very long (figure 1). Johansson[17], for example, mentioned that the reduction in back flexion after intervention did not result in a change in musculoskeletal health due to a low exposure. Furthermore, it appeared that psychosocial factors can influence the efficacy of interventions the most when mechanical exposure is low[17, 20]. These results indicate that most likely the best result of a primary preventive intervention on risk factors of physical load can be obtained when the initial exposure to these risk factors is high. Hence, it is important in studies to determine the change in mechanical exposure due to the intervention.

Performance indicators

Regarding the model as presented in figure 1, it can be questioned to what extent mechanical exposure and/or musculoskeletal health are good indicators for the efficacy of intervention over time. Studies focusing solely on changes in musculoskeletal health lack the option for controlling for unforeseen events. Hence, the evaluation of primary preventive intervention programmes based upon information extracted from a general database on occurrence of musculoskeletal disorders might not give enough information[8, 9, 47]. This was demonstrated in two longitudinal studies using OSHA 200 logs as source of information on the occurrence of musculoskeletal disorders, which observed an initial increase in musculoskeletal disorders after intervention, most likely as a result of a better registration because of an increased awareness of ergonomic problems and the linking of these problems to musculoskeletal health[22, 48]. An increase in musculoskeletal disorders after the intervention has been observed in other studies as well[16, 30, 43, 46].

As already stated, to registrar significant changes of interventions on musculoskeletal health, the follow-up period must reflect the latency period needed to develop musculoskeletal disorders[5, 9]. However, the longer this period is the greater the influence of the confounding factors described before. In determining the efficacy of primary preventive intervention effects on WRMSD one has to deal with this contradiction. A possibility to counteract this contradiction might be to document the reduction in mechanical exposure due to the intervention since this will precede any change in musculoskeletal health (see figure 1)[7, 9, 11, 12]. An additional advantage of using changes in mechanical exposure as intermediate measure along the pathway of intervention is, that a non-effective intervention can be detected earlier in this way. In the present review it was shown that in 67% of the 12 studies measuring both mechanical exposure and musculoskeletal health, a reduction occurred in both variables after intervention. However, the magnitude of the effect of intervention on mechanical exposure and musculoskeletal health varied strongly (table 5). In this review only 3 studies tried to relate changes in mechanical exposure to changes in musculoskeletal health[17, 21, 27]. In two studies by Aarås[21, 27] the intervention resulted in a reduction of mechanical exposure and, as a consequence, in a reduction of the occurrence of musculoskeletal disorders. In determining how much reduction in mechanical exposure is needed to have a noticeable impact on the occurrence of WRMSD, more knowledge on dose-response relationships is required[6, 49].

Practical implications and challenges for future intervention studies

From this review it once more appeared that conducting intervention studies in a dynamic work environment brings about many problems. The fact that only 3 randomised controlled trails were included in this review, underlines the opinion that a true experimental design in studies concerning implementation of an intervention at the work place is difficult to realise[7, 9, 26, 49]. Workplaces and work organisations are continuously liable to changes that may interfere with the effects of the intervention. An extreme example is the intervention study by Kadefors[18]. Nevertheless a successful intervention program, the intervention sustainability was poor, since the factory was closed shortly after the study.

More quantitative information is needed to describe the relationship between mechanical exposure and musculoskeletal health as presented in the model. Inclusion of intermediate measures in the etiologic process from mechanical exposure to musculoskeletal disorders will be beneficial[9], but unfortunately, empirical evidence for suitable intermediate measurements is almost completely absent[50]. This review shows that most interventions studies only measure changes in health outcomes and, hence, are not able to demonstrate that these changes in health outcomes are caused by a reduction in mechanical exposure. We recommend in future primary preventive intervention studies to measure not only changes in health outcomes but also changes in mechanical exposure along the pathway of the intervention. This way a better insight will be gained about the dose-response relationships between exposure to physical load risk factors and WRMSD. More insight in these relationships will eventually lead to more efficient implementations of primary preventive strategies.

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PROGNOSTIC FACTORS FOR DURATION OF SICKNESS ABSENCE DUE TO MUSCULOSKELETAL DISORDERS

Adapted from:
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Abstract

Objectives. The purpose of this prospective cohort study with one-year follow up was to determine prognostic factors for return to work after sickness absence due to musculoskeletal disorders.

Methods. Workers where included when on sickness absence for 2-6 weeks due to musculoskeletal disorders. A self-administered questionnaire was used to collect personal and work-related factors, pain, functional disability, and general health perceptions. Statistical analysis was done with Cox proportional hazard regression with an interaction variable with time for every risk factor of interest. Univariate and multivariate analyses were performed on musculoskeletal disorders and, separately, for low back pain.

Results. The main factors that were associated with longer sickness absence were older age, gender, perceived physical workload, and poorer general health, for neck, shoulder and upper extremity disorders, and functional disability, sciatica, worker's own perception of the ability of return to work, and chronic complaints for LBP. Workers with a high perceived physical work load at baseline returned to work increasingly slower over time than expected, whereas workers with a high functional disability at baseline returned to work increasingly faster over time.

Conclusion. High pain intensity is a major prognostic factor for duration of sickness absence, especially in LBP. The different disorder-specific risk profiles for prolonged sickness absence indicate, that LBP and upper extremity disorders need different approaches when applying intervention strategies with the aim of early return to work. The interaction of perceived physical workload with time suggests that perceived physical workload would increasingly hamper return to work and, hence, supports the need for workplace interventions among workers off work for prolonged periods.

Introduction

Many established risk factors are known for the occurrence of musculoskeletal disorders[1-3]. However, considerable less is known whether these factors also contribute to prolonged sickness absence due to musculoskeletal disorders. It has been estimated that 20% of the workers who were still on sick leave at 4 months due to LBP accounted for 60% of the health care costs[4]. Hence, identifying those workers on sick leave who are at risk for longer sickness absence is essential in this respect.

Various studies have indicated risk factors for the transition of an acute injury to a chronic condition of that injury[5]. However, the use of different outcome measures to represent chronicity hampers the comparability of the underlying mechanisms. Chronicity has been described in terms of persisting symptoms, disability, and duration of sickness absence, mainly for low back pain (LBP)[5]. In the present study we are interested in duration of sickness absence as a measure of chronicity for musculoskeletal disorders. In this respect, the main factors that have been associated with sickness absence duration are functional disability, perceived pain, sciatica, older age, being a woman, high physical work load, work-related psychosocial aspects, and psychological distress[5-7]. These factors indicate that, apart from the established risk factors for the occurrence of musculoskeletal disorders, also symptom status, functional status, and general health perception partly determine duration of sickness absence[8]. However, these findings are difficult to interpret when considering return to work as a function of time, since there exists a wide variation in the time window in which these risk factors were determined. Studies have included subjects on sick leave within the first two weeks[9-11], within 10 weeks[12, 13], or after 3 months[14-16] of the initial sick leave date. Krause et al.[6] have stressed the importance of disability phase-specificity, whereby the impact of risk factors may vary across different phases of the disablement process and concomitant return to work[6]. Hence, prognostic factors may act differently depending on the time window in which they were assessed, and on the duration of sickness absence of the subjects under study[6]. Given the established return to work rates, and the need to identify especially those workers at risk for longer sickness absence, it seems reasonable to determine prognostic factors within the (sub-)acute phase, i.e. 2-6 weeks on sickness absence[6, 17].

Regarding return to work as a function of time little is known about the interaction with time of the prognostic factors throughout the sickness absence period. One reason is that most studies have determined the return-to work rate at fixed points in time[10, 15, 18]. By dichotomizing return to work, it is not possible to detect changes in the prognostic factors over time. Few studies have incorporated interaction with time in their analysis. Two studies found that functional disability became less important when sickness absence prolonged[19, 20] and an other study observed that lack of variation in work became more important over time[21]. Two studies used interaction with time by distinguishing the effects of predictor variables during the first 30 days of sickness absence and after 30 days of sickness absence[9, 22]. These studies found that job strain, job control, work flexibility[9], and physical workload and injury factors[22] had a significant and time-varying impact on duration of sickness absence. These findings illustrate the importance of considering interaction with time of prognostic factors for prolonged sickness absence.

The purpose of this study was to determine prognostic factors for return to work after sickness absence due to musculoskeletal disorders, and to evaluate whether these prognostic factors change over time.

Methods

Subjects & study design

This study was a longitudinal study with a 12 months follow up, in which a self-administered questionnaire was used to measure prognostic factors for sickness absence duration. Subjects were enrolled in the study by occupational health physicians during their consults or selected from the absenteeism register of a large Dutch occupational health service. For inclusion into the study a subject had to be on sick leave due to non-specific musculoskeletal disorders for 2 to 6 weeks. Based on the initial diagnosis by the occupational physician, subjects had to fill in a diagnosis specific questionnaire (i.e. low back, hip, knee, ankle/foot, neck/ shoulder or wrist/hand/elbow). Subjects were excluded when they suffered from specific underlying pathology, such as a fractured leg or discus prolaps. After signing an informed consent, subjects were sent the questionnaire. Non-responders were sent a reminder after two weeks and a second reminder with questionnaire after three weeks. The first date of sick leave and the return-to-work data were obtained from the medical records of the occupational health service. Return to work was defined as fully returning to the original job.

Contents of the questionnaires

The selection of potential prognostic factors to be included in the questionnaire was guided by two literature reviews that have identified as important domains: demographic factors, physical and psychosocial factors at work, disease-related factors, and previous sick leave history[6, 7]. Employer factors such as management culture and active safety leadership[6] were not included in the current study due to lack of valid questionnaires. Economic factors and societal/legislative factors[6, 7] were not included since these factors are essentially the same for all workers in the Netherlands. A full overview of all prognostic factors in the study is presented in table 1.

The main personal factors obtained were age, gender, body mass index, marital status, education, and employment status[23]. Work-related physical factors were obtained by using items from the Dutch Musculoskeletal Questionnaire[24]. Selected items concerned manual material handling, frequent bending twisting of the trunk, whole body vibration, working in awkward postures, working in static postures and strenuous work with neck/shoulder and the upper limb. For each item a four-point scale was used between 0 (never) and 3 (always). Subsequently, a sum score across these risk factors was calculated, indicating that the higher the score the more physical risk factors were present. Perceived physical workload was also measured by using a 10-point numerical rating scale[25]. For the psychosocial factors at work the Job Content Questionnaire was used[26]. Within this model three aspects can be distinguished; work demands, skill discretion, and decision latitude. As with the physical factors a four-point scale was used for each item, and subsequently, a sum score by aspect was calculated.

Within the domain disease-related factors pain and functional disability were considered crucial concepts[6, 7]. In addition, measures of general health were included to provide a comprehensive picture of the subject's mental and social health status[8, 27]. We used a modified Nordic Questionnaire for the nature and severity of the complaints[28], and a 10 point numerical rating scale to determine the level of perceived pain[29]. Pain intensity was measured for the body part that represented the initial sick leave diagnosis. From the Nordic Questionnaire more serious complaints were defined when more than three symptoms concerning the initial diagnosis were presented (i.e. pain, local muscle fatigue, cramp, numbness, twinkling, loss of strength, movement reduction, or swelling). Chronicity of complaints was defined as complaints being present for 3 months or more during the 12 months before the present sickness absence period. In the questionnaire concerning low back pain sciatica was defined as radiating pain to the ankle.

The functional disability caused by the complaints was assessed by the Roland Morris Disability Questionnaire for back complaints[30] and a comparable questionnaire for other joints derived from the Roland Morris Questionnaire. For the latter purpose we changed the addition 'cause of my back' into 'cause of my neck', 'cause of my knee' etc. Furthermore, for use of neck, shoulder, and elbow/wrist/hand complaints 6 items concerning walking and standing were substituted by corresponding items from the physical dimension of the Sickness Impact Profile concerning disability due to upper extremity disorders[31]. The Sickness Impact Profile is a general health questionnaire, which formed the basis for the Roland-Morris Disability Questionnaire for low back pain[30]. Finally, general health perceptions were measured by the SF-12[32] and the Euroqol-5d[33]. The SF12 consists of 8 dimensions, i.e. general health, physical functioning, role-physical, bodily pain, vitality, role-emotional, social functioning, and mental health. These dimensions can be summarized into a physical component summary (PCS12) and a mental component summary (MCS12)[34]. The EuroQol Questionnaire distinguishes five dimensions, i.e. mobility, self-care, daily activity, pain, and anxiety or depression. From these items a general health index can be calculated[35]. Besides these dimensions, the EuroQol measures the general health perception also by means of a thermometer (EQ-VAS)[33].

For low back pain the worker's own perception of the ability to return to work within 6 weeks was also included since this has been reported as a strong prognostic factor for return to work among workers on sick leave due to low back pain[25]. This variable was measured on a 10-point numerical scale.

Data analysis

We used Cox Proportional Hazard (PH) regression to determine prognostic factors for return to work after sickness absence. The main assumption of this model is, that the hazard ratio is constant over time[36]. When this assumption is violated, non-proportionality can be addressed by including an interaction term with time for each variable of interest[19, 36]. One way to determine the interaction term, is to calculate the population mean of the log duration of sickness absence, and to subtracted this value from the log of the sickness absence duration for each subject included. Subsequently, this term is multiplied by the independent variable of concern[37]. In formula:

$x_{i,t}$ = independent variable *($log_{i,t}$(sickness absence duration) - logM)) with logM= MEAN(log(sickness absence duration)

Each variable of interest (x_i) was put into the model together with its interaction term with time ($x_{i,t}$). A positive interaction with time indicates that the effect of variable X_i on return to work increases linearly with time (HR>1) and a negative interaction term demonstrates a linear decrease over time (HR<1). Hence, in this study time interaction reflects that the rate of return to work does not remain constant during the follow-up period but will change at different rates for different individuals.

Because subjects were considered not at risk between the first sick leave date and the fill in date of the questionnaire, this lag time was omitted from the total sick leave time by using the fill-in date of the baseline questionnaire as entry date in the Cox PH regression model[36]. Subjects were right censored when they did not return to work after 12 months of follow-up. For the analysis these subjects were assigned to have a sickness absence period of 365 days.

In order to present comparable results for each prognostic factor of interest, all continuous variables were transformed to a 0 - 100 scale. Furthermore, the hazard ratios for continuous variables were presented for the difference of 10 scale units instead of 1 scale unit, in order to avoid small hazard ratios that are difficult to interpret. Variables were coded in such a manner that a hazard ratio above 1 indicated a risk for a slower return to work.
First, a univariate analysis was conducted on all relevant continuous and dichotomous variables included in the questionnaire. Variables with a p-value of ≤ 0.10 in the univariate analysis were initially included in the multivariate model. The multivariate model was calculated using a backward stepwise regression approach with a significance level of ≤ 0.05. Age and gender were forced into the multivariate model, irrespective of their level of significance. Both univariate and multivariate analyses of musculoskeletal disorders were stratified by diagnosis group, i.e. low back, neck/shoulder, upper extremity, or lower extremity, in order to adjust for the body part. Likewise an univariate and multivariate analysis was conducted for low back pain alone. The Cox PH regression analysis was conducted by using the PHREG procedure and survival function curves were calculated with the PROC LIFETEST procedure in SAS version 8.0[36].

Table 1. Potential prognostic factors in a group of workers that were on sick leave for 2-6 weeks due to musculoskeletal disorders.

Domain	Items
Demographic factors	Age (>45 year)
	Gender (female / male)
	BMI
	Education (low / high)
	Marital status (alone vs. married/living together)
	Diagnosis (LBP, neck/shoulder, upper extremity, lower extremity)
	Sports activities (yes / no)
	Household activities (many / few)
Work-related physical factors	Perceived physical workload
	Manual materials handling (yes / no)
	Frequent bending twisting of the trunk (yes / no)
	Whole body vibration (yes / no)
	Repetitive movements hand/arm (yes / no)
	Hand-arm vibration (yes / no)
	Working with bended neck (yes / no)
Work-related psychosocial factors	Work demands
	Skill discretion
	Decision latitude
	Relation with colleagues
	Relation with supervisors
	Conflicts at the workplace (yes / no)
	Own perception for ability to work (only for LBP)
Nature and severity of complaints	Perceived pain intensity
	Sciatica (only for LBP) (yes / no)
	Chronic complaints (12 months prior to inclusion) (yes / no)
	Seriousness of complaints (yes / no)
Functional disability	Perceived functional disability
	Co-morbidity of musculoskeletal complaints (yes / no)
General health	Perceived general health
	Physical health
	Mental health
	Role mental health
	Role emotional
	Social functioning
Medical care & sick leave history	Visiting an occupational physician (yes / no)
(12 months prior to inclusion)	Visiting a general practitioner (yes / no)
	Visiting a specialist (yes / no)
	Visiting a physical therapist (yes / no)
	Prior sick leave (yes / no)

Results

Study population

In total, the occupational physicians included 140 subjects, and 307 subjects were selected from the administration of absenteeism. Of the latter group 59% (n=181) agreed to participate in the study. Of the 321 subjects who initially were included, 287 returned the questionnaire (response 89%). For the final analysis 253 subjects remained, because 34 subjects had already returned to work fully before completing the baseline questionnaire. The mean duration of sickness absence at time of response was 34±15 days. Table 2 shows the baseline characteristics of this population. The mean age of the population under study was 43±9 years, most subjects had a lower educational background (57%), and the majority was male (70%). Table 3 illustrates that most subjects were on sickness absence due to low back pain (51%), followed by neck-shoulder pain (28%), upper extremity disorders (13%), and lower extremity disorders (8%). Chronic complaints were found in 38% of all subjects, whereas 39% stated to have more than 3 musculoskeletal symptoms. Among the subjects with low back pain 33% suffered from sciatica.

Table 2. Population characteristics of the workers on sick leave for 2-6 weeks (n=253).

	Mean (SD)
Age	43 (9)
Body mass index	27 (8)
Work history:	
• Years in same function	5 (11)
• Years at current company	13 (10)
Working hours / week	37 (10)

		N (%)
Gender:	male	177 (70%)
	Female	76 (30%)
Marital status:	single	41 (16%)
	Married	212 (84%)
Education	low	145 (57%)
	Middle	85 (34%)
	High	23 (9%)

Table 3. Cause and duration of sickness absence due to musculoskeletal disorders, stratified by body part (n=253).

Initial diagnose for sickness absence	**Number of subjects (% total)**	**Duration of sickness absence Median (range) (in days)**	**Duration of sickness absence Mean (SD) (in days)**
Total musculoskeletal disorders	253	97 (15 - 365)	130 (97)
Low back	129 (51%)	81 (17 - 365)	122 (101)
Neck/shoulder:	71 (28%)	119 (15 - 365)	144 (93)
- Neck	29 (11%)	87 (15 - 365)	118 (79)
- Shoulder	42 (17%)	126 (34 - 365)	163 (98)
Upper extremity	33 (13%)	98 (20 - 365)	139 (107)
Lower extremity:	20 (8%)	85 (33 - 365)	116 (85)
- Hip	2 (1%)	92 (91 - 92)	92 (0.7)
- Knee	14 (6%)	87 (33 - 365)	123 (94)
- Ankle/foot	4 (2%)	69 (50 - 223)	103 (81)

Duration of sickness absence

Of the 253 subjects in this study, 232 (91%) returned to work fully within the 12 months follow up period. Table 3 presents the sickness absence duration in general and stratified by low back, neck/shoulder, upper extremity, and lower extremity. The median sickness absence duration for the whole population was 97 days, ranging from 15 to 365 days.

Figure 1 presents the survival curves for low back pain and other musculoskeletal disorders. At 8 weeks respectively 33% (95%CI 24 - 41) and 19% (95%CI 12 - 25) of the population returned to work, at 13 weeks 52% (95%CI 43 - 61) and 43% (95%CI 34 - 51), at 26 weeks 80% (95%CI 74 - 87) and 72% (95%CI 64 - 80), and at 36 weeks 85% (95% CI 78 - 91) and 87% (95% CI 81 - 93). Of the 21 subjects that were right censored due to not returning to work within 12 months follow up, 10 subjects had low back pain and 11 subjects had other musculoskeletal disorders. Workers with sickness absence for low back pain showed a non-significant trend of returning to work faster in the first 30 weeks of sickness absence as indicated by the Wilcoxon statistic (p=0.12). Within the group of other musculoskeletal disorders there was no significant difference in duration of return to work.

Figure 1. Survival curves for return to work among subjects with low back pain (n=129) and other musculoskeletal disorders (n= 124), starting at the mean inclusion time of the subjects under study.

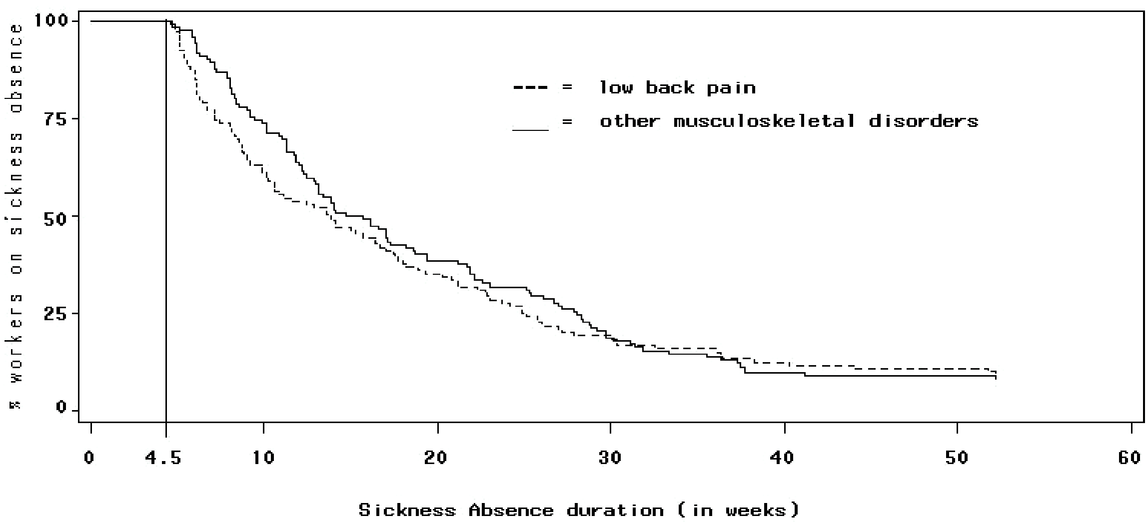

Table 4. Work-related and health-related prognostic factors among subjects (n=253) on sickness absence due to musculoskeletal disorders.

	Mean	Median	SD	Observed Min - max[c]	Original Scale Min - max
Work-related physical factors[a]					
Physical risk factors	38.4	37.5	14.0	6.7 - 75	0 - 60
Perceived physical load	69.3	70.0	20.4	0 - 100	0 - 10
Work-related psychosocial factors[a]					
Work demands	46.2	45.5	15.5	12.1 - 92.6	0 - 33
Skill discretion	48.2	46.7	20.2	0 - 100	0 - 18
Decision latitude	52.2	51.5	20.2	0 - 100	0 - 33
Severity of complaints[a]					
Perceived pain	63.8	70.0	19.4	0 - 100	0 - 10
Functional disability[a]	51.5	52.2	20.8	0 - 95.5	0 - 24
General health[b]					
Physical health (PCS12)	32.6	31.7	7.1	16.7 - 56.6	0 - 100
Mental health (MCS12)	49.6	52.0	11.1	16.5 - 68.4	0 - 100
General health (EuroQol)	75.2	82.8	15.0	32.6 - 96.0	-1 - 1
General health (EQ-VAS)	58.3	60.0	18.9	0 - 100	0 - 100

Abbreviations; PCS12=physical component SF12; MCS12=mental component SF12.
[a]=higher score indicates worse health
[b]=higher score indicates better health
[c]=All continues variables were transformed to a 0 - 100 scale

Prognostic factors for return to work after sickness absence due to musculoskeletal disorders

Table 4 shows the outcomes of the continues variables that were used in the Cox PH regression analysis. The three dimensions of work-related psychosocial factors had approximately the same value (i.e. around 50). Physical health was scored worse than mental health, i.e. 32.6±7.1 and 49.6±11.1, respectively. General health expressed by the five EuroQol dimensions scored higher than general health measured with the thermometer, 75.2±15 and 58.3±18.9, respectively.

Table 5 presents the prognostic factors for return to work after sickness absence due to musculoskeletal disorders in both the univariate analysis and multivariate analysis. In the univariate analysis the presence of more than 3 symptoms, perceived pain, high perceived physical workload, poorer general health, and visiting a specialist 12 months prior to present sickness absence were statistical significant associated with longer sickness absence. Although not statistically significant, being a woman resulted in a higher risk for prolonged sickness absence, indicated by an increase of 23% in the relative hazard.

Table 5. Unadjusted and adjusted hazard ratios for prognostic factors for return to work after sickness absence due to musculoskeletal disorders among workers on sick leave for 2 to 6 weeks (n=253).

	All musculoskeletal disorders			
	Univariate analysis[b]		Multivariate analysis[b]	
Prognostic factors	HR[d]	95%CI	HR[d]	95%CI
Personal factors[a]				
Age (> 45 years)	0.98	0.75 - 1.29	1.21	0.89 - 1.65
Gender (female vs. male)	1.23	0.92 - 1.64	1.25	0.91 - 1.72
Work-related physical factors				
Perceived physical workload	1.08	1.01 - 1.15*	1.09	1.02 - 1.17*
Perceived physical workload*t[c]	1.11	1.00 - 1.23*	1.14	1.03 - 1.26**
Work-related psychosocial factors				
Relation with colleagues	0.91	0.82 - 1.01	(0.93	0.83 - 1.04)[e]
Nature and severity of complaints				
Seriousness (>3 symptoms)	1.31	1.00 - 1.74*	(1.14	0.83 - 1.55)[e]
Perceived pain	1.12	1.04 - 1.20**	1.12	1.04 - 1.21**
General health				
General health (EQ-VAS)	0.93	0.87 - 1.00*	0.93	0.85 - 1.00
General health (SF12)	0.94	0.88 - 1.01	(1.00	1.08 - 0.93)[e]
Functional disability				
Functional disability	1.06	0.99 - 1.14	(0.98	0.89 - 1.07)[e]
Functional disability*t[c]	0.89	0.81 - 0.99*	0.91	0.82 - 1.02
Medical Care & sick leave History				
Specialist (12 months)	1.43	1.04 - 1.95*	1.68	1.17 - 2.40**

Significance level * = p≤0.05, ** =p≤0.01, *** =p≤0.001;
[a]=Age and gender were forced into the multivariate model;
[b]=Only variables with a p≤0.10 are included in the table;
[c]='variable'*t = interaction of the variable with time;
HR >1 indicates that the effect on RTW increases with time;
[d]=HR >1 indicates a risk for longer sickness absence;
[e]=effect size just before removal from the model;

In the multivariate analysis perceived pain, perceived physical workload, and visiting a specialist 12 months prior to the current sickness absence period were statistically significant associated with longer sickness absence. General health (EQ-VAS) was dropped from the multivariate model, although its effect on duration of sickness absence did not change compared with the univariate analysis. The effect of seriousness of complaints decreased with 17% in the multivariate analysis, whereas the Hazard Ratio of older age increased with 21%. Despite their association with longer sickness absence gender and age did not reach the significance level when adjusted for other prognostic factors.

Prognostic factors for return to work after sickness absence due to low back pain

Table 6 shows the significant prognostic factors for return to work after sickness absence due to low back pain. In the univariate analysis perceived pain, sciatica, functional disability, poorer physical health, poorer general health (EQ-VAS), worse relation with colleagues, the worker's own perception of their ability to return to work, and chronic LBP in the past 12 months were statistically significant risk factors for longer sickness absence. The confounding variables age (>45 years) and gender (female versus male) showed a modest, non-significant, association with longer sickness absence.

Perceived pain, the worker's own perception of their ability to return to work, and the presence of sciatica contributed significantly to the multivariate risk model for longer sickness absence. From the variables that were dropped from the model, relation with colleagues, physical health, functional disability, and chronic LBP showed a substantial decrease in effect when adjusted, respectively 14%, 42%, 10%, and 41%.

Interaction of prognostic factors with time

In the univariate analysis of musculoskeletal disorders perceived physical workload and functional disability showed a statistically significant association with time. Workers with a high perceived physical work load at baseline returned to work increasingly slower over time, whereas workers with a high functional disability at baseline returned to work increasingly faster over time. Although in the multivariate analysis the effect of both interactions remained the same, only perceived physical workload was statistically significant, whereas functional disability showed a p-value of ≤ 0.10.

The only variable that showed a statistically significant interaction with time in the univariate analysis of low back pain was manual materials handling. Workers involved in more manual materials handling returned to work increasingly faster over time. Although dropped from the multivariate model, the interaction with time of this variable remained the same as in the univariate analysis.

Table 6. Unadjusted and adjusted hazard ratios for prognostic factors for return to work after sickness absence due to low back pain among workers on sick leave for 2 to 6 weeks (n=129).

	Low back pain			
	Univariate analysis[b]		**Multivariate analysis[b]**	
Prognostic factors	HR[d]	95%CI	HR[d]	95%CI
Personal factors[a]				
Age (> 45 years)	1.09	0.75 - 1.59	1.03	0.65 - 1.64
Gender (female vs. male)	1.09	0.72 - 1.64	1.08	0.67 - 1.72
Work-related physical factors				
lifting*t[c]	0.57	0.30 - 1.09	(0.57	0.26 - 1.24)[e]
Work-related psychosocial factors				
Relation with colleagues	0.88	0.77 - 1.00*	(1.05	0.86 - 1.28)[e]
Own perception RTW within 6 weeks	2.43	1.61 - 3.66***	2.32	1.29 - 3.33***
Nature and severity of complaints				
Perceived pain	1.18	1.07 - 1.29***	1.17	1.05 - 1.29**
Sciatica	1.87	1.24 - 2.82**	1.83	1.12 - 3.00*
General health				
Physical health (PCS12)	0.71	0.54 - 0.94*	(1.09	0.74 - 1.59)[e]
General health (EQ-VAS)	0.87	0.78 - 0.96**	(0.93	0.82 - 1.06)[e]
Functional disability				
Functional disability (RM)	1.15	1.05 - 1.25**	(1.05	0.92 - 1.18)[e]
Medical Care & sick leave History				
Chronic LBP (12 months)	1.50	1.00 - 2.26*	(1.09	0.68 - 1.75)[e]

Significance level * = p≤0.05, ** =p≤0.01, *** =p≤0.001;
[a]=Age and gender were forced into the multivariate model;
[b]=Only variables with a p≤0.10 are included in the table;
[c]='variable'*t = interaction of the variable with time;
HR >1 indicates that the effect on RTW increases with time;
[d]=HR >1 indicates a risk for longer sickness absence;
[e]=effect size just before removal from the model;

Disease-specific risk profiles

In order to reveal disease-specific risk profiles, we conducted separate analyses on low back pain and upper extremity disorders (including neck/shoulder), based on the common variables found in the univariate analyses of MSD and LBP, thereby excluding sciatica and the worker's own perception of work ability. For upper extremity disorders being female, high-perceived physical workload, visiting a specialist, chronic complaints in previous 12 months, and poorer general health (EQ-VAS) were statistically significant prognostic factors for prolonged sickness absence. For LBP only pain intensity showed a statistically significant association with duration of sickness absence, whereas pain was hardly associated with duration of sickness absence for upper extremity disorders. Although not statistically significant, older age (>45 years), visiting a specialist, and chronic complaints had elevated hazard risks (table 7).

Table 7. Disease-specific risk profiles for prolonged sickness absence among workers on sick leave for 2 to 6 weeks. Only predictors that were measured in both diagnosis groups were incorporated in the models.

	Multivariate analysis[b]			
	Low back pain (n=129)		**Neck / shoulder / Upper extremity** (n=104)	
Prognostic factors	HR[d]	95%CI	HR[d]	95%CI
Personal factors[a]				
Age (> 45 years)	1.17	0.74 - 1.86	1.35	0.79 - 2.31
Gender (female vs. male)	0.98	0.62 - 1.54	1.75	1.06 - 2.86[*]
Work-related physical factors				
Perceived physical workload	(0.96	0.86 - 1.08)[e]	1.16	1.02 - 1.32[*]
Perceived physical workload*t	(1.07	0.96 - 1.20)[e]	1.36	1.09 - 1.69[**]
lifting*t[c]	(0.67	0.33 - 1.34)[e]	(1.30	0.57 - 2.94)[e]
Work-related psychosocial factors				
Relation with colleague	(0.97	0.79 - 1.19)[e]	(1.05	0.87 - 1.27)[e]
Nature and severity of complaints				
Seriousness (> 3 symptoms)	(1.07	0.68 - 1.70)[e]	(0.90	0.48 - 1.70)[e]
Perceived pain	1.28	1.10 - 1.33[***]	(1.04	0.90 - 1.20)[e]
General health				
Physical health (PCS12)	(1.05	0.69 - 1.61)[e]	(1.08	0.69 - 1.67)[e]
General health (EQ-VAS)	(0.90	0.78 - 1.03)[e]	(0.96	0.81 - 1.12)[e]
General health (SF12)	(1.09	0.97 - 1.22)[e]	0.89	0.79 - 1.00[*]
Functional disability				
Functional disability (RM)	(0.97	0.84 - 1.13)[e]	(0.93	0.79 - 1.10)[e]
Functional disability*t	(0.93	0.82 - 1.05)[e]	(1.04	0.83 - 1.30)[e]
Medical Care & sick leave History				
Specialist	(1.57	0.90 - 2.75)[e]	2.43	1.30 - 4.55[**]
chronic complaints (12 months)	(1.19	0.71 - 2.00)[e]	0.56	0.34 - 0.93[*]

Significance level [*]= p≤0.05, [**] =p≤0.01, [***] =p≤0.001;
[a]=Age and gender were forced into the multivariate model;
[b]=univariate variables with a p≤0.10 in the MSD analysis and LBP analysis were forced in both models;
[c]='variable'*t = interaction of the variable with time;
HR >1 indicates that the effect on RTW increases with time;
[d]=HR >1 indicates a risk for longer sickness absence;
[e]=effect size just before removal from the model;

Discussion

The present study combined new insights in the analysis of prognostic factors for return to work after sickness absence[6, 7, 17]: a] the time window in which the potential prognostic factors are determined, where the (sub-)acute phase (2-6 weeks) is assumed to be the transition phase from short term to long term work disability , b] the interaction of prognostic factors with time, indicating that for some factors the rate of return to work decreased or increased steadily over the follow-up period, and c] the duration of the sickness absence as continuous variable instead of a dichotomous outcome. Furthermore, this prospective study compared the disease specific profiles of low back pain with upper extremity complaints.

The main factors that were associated with longer sickness absence were older age, gender, perceived physical workload, and poorer general health, for upper extremity disorders (including neck / shoulder), and functional disability, sciatica, worker's own perception of the ability of return to work, and chronic complaints for LBP. Workers with a high perceived physical work load returned to work increasingly slower over time than expected, whereas workers with a high functional disability returned to work increasingly faster over time.

Selective participation and variable inclusion

Approximately 59% of the workers on 2-6 weeks sick leave that were selected from the administration of absenteeism of a large Dutch work health service responded to our request for participation in the study. Most of the workers on sick leave due to musculoskeletal disorders return to work within the first weeks of sickness absence[38]. Hence, the low response can partly be explained by the fact that subjects had already returned to work when receiving our invitation to participate in this study. No differences in baseline characteristics among subjects were found, whether included by the occupational physician or selected from the absenteeism register.

The perceived pain score (63.8±19.4) and the physical component of the SF12 (32.6±7.1) indicated a population that experienced much pain and functional limitations but that did well considering their mental health (MCS12 49.6±11.1)[29, 34]. The initial pain level and functional limitations corresponded with findings in others studies[15, 19-21]. The mental health status of our population was rather high in comparison with Van der Giezen et al., who found mental health a potential predictor for return to work[15]. This difference may be explained by the fact that in the latter study subjects were included after at least 3 months sickness absence, whereas in our study subjects were included earlier.

The potential prognostic factors in this study addressed key domains of determinants for return to work[6, 7]. Since over 100 different determinants for prolonged disability and/or return to work have been identified, it was not possible to include all potentially relevant factors. Two measures of general health were included to reflect the broad array of psychological factors and health-related behaviours[27]. However, the disadvantage of this approach is that the generic measure of mental health does not allow evaluation of specific characteristics such as fear avoidance[39, 40] or particular reactions to pain, such as catastrophizing and kinesiophobia[41].

For variable inclusion into the multivariate analysis we chose for a restrictive cut-off point of $p<=0.10$, due to the fact that several items in the same domain were closely related. Since our sample size did not allow evaluation of interaction between closely related variables, it has to be kept in mind that a significant prognostic factor also reflects the importance of its domain.

Return to work rates

Our results showed that in the first 30 weeks of sickness absence the return to work rate for low back pain was slightly better than for other musculoskeletal disorders (see figure 1). Only two studies presented a return to work curve for general musculoskeletal disorders. Crook and Moldofsky showed a higher return to work rate, whereas Burdorf et al. showed a lower return to work rate than in our study[42, 43]. This is probably due to the time of entering the study, which was after 3 months of sickness absence and at first day of sickness absence, respectively[42, 43]. These findings once more stress the importance of taking the entry time into consideration when comparing studies on return to work.

Of all included workers 8% did not return to work within the 12-month follow up period. The latter finding is in agreement with other studies in subjects on sickness absence due to low back pain[21, 44, 45]. Since our subjects were included between 2 to 6 weeks of sickness absence, the return to work rates cannot easily be compared with other studies that determined return to work curves from the first day of sickness absence. Three studies that included subjects after two weeks on sick leave due to low back pain presented lower median return to work times, i.e. 56 days[21], 43 days[45] and 48 days[19] in comparison with our finding of 97 days. This difference could not be explained by the method of right censoring subjects at 365 days, since, excluding those not returning to work still showed a median return to work time of 73 days.

Prognostic factors for return to work after sickness absence

Our findings on the importance of high pain intensity and sciatica are in agreement with other studies among workers on sickness absence for 2-6 weeks due to low back pain[19-21]. While perceived pain remained an important prognostic factor in the risk profile for LBP, it was hardly associated with duration of sickness absence in the risk profile for upper extremity disorders. Older age, being female, perceived physical workload, poorer general health, and (surprisingly) having a chronic condition appeared to be of more importance in the risk-profile for upper extremity disorders than perceived pain. The fact that a chronic condition of the disorder might speed up RTW, combined with the fact that perceived pain was hardly associated with duration of sickness absence, might suggest that workers with upper extremity disorder are better adapted to the chronic condition of their disorder than workers with LBP, since chronic low back complaints were associated with longer sickness absence.

Surprisingly, when sciatica and the worker's own perception of ability to work were omitted from the model in order to find disease specific risk profiles with similar variables, only perceived pain remained in the model. However, other studies among workers on sick leave due to low back pain did find physical workload to be a significant prognostic factor for duration of sickness absence[9, 19, 44]. This discrepancy is probably due to the fact that the workers with musculoskeletal disorders without return to work, rated their physical work load higher compared with those who returned to work within 12 months (respectively 76$\pm$20 and 69$\pm$20), whereas this was not observed in the low back pain group.

The suggestion that perceived pain is probably closely related to functional disability[8] is best illustrated with the LBP analysis. Functional disability was a statistically significant prognostic factor for prolonged sickness absence when perceived pain intensity was omitted from the multivariate model (HR 1.13, 95%CI 1.02 - 1.25), but its effect reduced considerably when adjusted for perceived pain intensity. The effect of the other variables in the multivariate model for low back pain remained constant and did not confound the findings of the model. The effect of pain intensity on duration of sickness absence remained constant and was independent from adjustment for perceived disability. Although functional disability still is a prognostic factor for prolonged sickness absence, this finding suggests that high initial pain intensity, given the methods of measurements, overrides functional disability. Furthermore, suffering from pain might lead to fear of movement or (re-)injury[40]. Vowles and Gross (2003) have suggested that changing fear-avoidance beliefs is important in improving one's physical ability to safely perform a certain job, and may therefore, enhance a worker's return to work potential. Although we did not measure fear avoidance directly, our observation that the worker's own perception of ability to return to work was a strong prognostic factor for duration of sickness absence might partly originate in the importance of fear avoidance beliefs among workers at risk for prolonged sickness absence[39].

However, the ability to work might also depend on the availability of modified work[10]. This is underlined by the observed effect that high-perceived physical workload prolonged duration of sickness absence in this population of workers who returned fully to their regular job. In an extensive review Krause et al. showed that modified work programs facilitated return to work[46]. Future studies should include more specific psychological and ergonomic measures to get more insight in the influence of these factors on the decision balance of the worker for regaining work activities. In our study we did not find an association of established specific risk factors for the occurrence of MSD with duration of sickness absence, except for manual materials handling. This is probably due to the fact that there is a lack of power, given the exposure prevalence and the size of the study population.

Interaction of prognostic factors with time

The results of the overall analysis of our study mirrored previous observations that workers with high functional disability at inclusion returned to work increasingly faster over time[19, 20]. This suggests that functional disability plays a more important role in the sub-acute phase than in the chronic phase of returning to work. Although the relative hazard did not show a substantial change, it was less prominent in the separate risk profiles, probably due to less power in these analyses.

The interaction of perceived physical workload with time, indicating that workers with a high perceived physical work load returned to work increasingly slower over time, was much stronger for upper extremity complaints than for low back pain. A study by Dasinger et al. on workers with LBP also found no interaction of perceived physical workload with time[22]. Although using the same outcome measure, we could not confirm the findings of Krause et al. regarding the interaction of job control and job strain with time[9]. However, the interaction found in our study suggests that perceived physical workload would increasingly hamper return to work and, hence, supports the need for workplace interventions among workers off work for prolonged periods[47, 46].

Conclusions and practical implications

High pain intensity is a major prognostic factor for return to work after sickness absence, especially in LBP. Although pain seems to override functional disability, the latter prolongs sickness absence although with lower impact. The importance in the prognosis of chronic complaints 12 months prior to inclusion and visiting a specialist in the past 12 months indicate that chronicity of a disorder is important to take into consideration with regard to sickness absence due to LBP.

Age, gender, and perceived physical workload were relevant risk factors for prolonged sickness absence due to upper extremity disorders, whereas their association was much less for LBP. This indicates that both diagnosis groups need different approaches when applying intervention strategies with the aim of early return to work. The findings of interaction of physical workload and functional disability with time suggest that with prolonged sickness absence the content of the intervention must accommodate different prognostic factors.

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5.

THE PROGNOSTIC VALUE OF DEPRESSIVE SYMPTOMS, FEAR-AVOIDANCE, AND SELF-EFFICACY FOR DURATION OF LOST-TIME BENEFITS IN WORKERS WITH MUSCULOSKELETAL DISORDERS

Adapted from:
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Abstract

Objectives. The psychological factors of depressive symptoms, fear avoidance, and self-efficacy are deemed to be important in the work disability process. However, the prognostic value of these factors for time on benefit is not well understood.

Methods. In a longitudinal study of 187 workers receiving total compensation benefits due to musculoskeletal disorders, we analysed the prognostic value of psychological factors measured 4 to 5 weeks post-injury for duration on total compensation benefit over 12 months. Cox Proportional Hazard regression analyses were conducted. Special emphasis was given to variable selection and to the analysis of confounding effects of potential prognostic variables.

Results. The final model indicated that increased depressive symptoms and poorer physical health significantly increase the number of days on total benefit. Confounders included in the final model were pain, and fear of income loss. In the final model the impact of fear-avoidance ceased to be significant when work related variables were included in the fully adjusted model. This illustrates that interrelationships between variables must be taken into account when building multivariate prognostic models. The addition of work related variables to the model did not result in any major changes, which suggests that when measured 4 to 5 weeks post-injury, psychological and physical health factors are strong predictors of time on benefits, while work conditions are less important.

Conclusion. The present study supports that the presence of depressive symptoms and poor physical health in workers on benefit due to musculoskeletal disorders increases the number of days on total compensation benefits significantly, when controlling for confounding variables.

Introduction

Over the past decade, many studies were aimed at finding prognostic factors for time on benefit or duration of sickness absence, hence a diverse set of prognostic factors can de identified from the literature[1, 2]. Unfortunately, the absence of a comprehensive theoretical framework for the nature of the work disability process impedes interpretation of the broad findings on prognoses of time on benefit[1, 3].

The few theoretical frameworks of work disability that do exist point to the multifactorial nature of work disability, and as such, they include psychological factors as determinants of work disability duration. One comprehensive model in the field of work-disability is the biopsychosocial model[4-6]. This model is often used to guide cognitive-behavioral interventions with regard to fear-avoidance and catastrophizing of pain contributing to work disability[7]. Although these interventions treat the "whole" person as the focal point in a comprehensive, integrated therapeutic process to regain daily personal and work activities, they do not address the employee's decision-making and behaviour change processes regarding return to work (RTW)[3]. As indicated by several studies, decision-making towards RTW might be based on the beliefs, attitudes and experiences of the individual towards regaining work activities and consequently be less determined by health status itself[3, 8, 9]. Recently, Franche and Krause proposed a conceptual framework of work disability - the readiness for return to work model[3]. The model considers the multi-factorial nature of the work disability process and identifies social and individual factors impacting on the individuals' ability to initiate and maintain behavior change, in this case the behavior of returning to work[3]. Hence, besides the physical capability of the worker, the work environment, the healthcare system, and the insurance system, psychological factors reflecting the workers' readiness for RTW also play an important role in the decision to regain work activities[3].

In both conceptual models mentioned above, depressive symptoms, fear avoidance, and self-efficacy are deemed to be important in the work disability process. However, the prognostic value of these factors for time on benefit is far less understood and has seldom been studied empirically[1, 2]. In a review by Pincus et al. on psychological factors as predictors for developing chronic low back pain, depressive symptoms showed the strongest evidence as a predictor for the transition from acute to chronic, while there was limited evidence for other psychological factors[2]. The literature to date has focused on the relationship between depressive symptoms and musculoskeletal complaints or symptoms. Less has been done on the relationship between depressive symptoms and work disability and time on benefits[2].

In terms of behavioral change, self-efficacy and fear-avoidance beliefs might play an important role in the work disability process[3, 6]. Although fear-avoidance beliefs are known to be associated with functional disability in general[10] and the occurrence of work disability[11], the evidence of its prognostic value on duration on total compensation benefits is scarce. Self-efficacy, i.e. the belief in one's capabilities to organise and execute the courses of action required to produce given attainments[12], has only recently been applied to workplace health concerns[3, 13]. Recovery expectations, a closely related construct of self-efficacy, have been shown to be important prognostic factors for days on benefit[14, 15]. It is argued that the workers' motivation to resume work following a musculoskeletal disorder (MSD) episode may be a function of expectations of recovery and value of work, balanced by personal costs of coping with pain[16]. However the prognostic value of self-efficacy beliefs on decision to return to work is still unknown.

While a few studies have examined concurrently the prognostic value of depressive symptoms and fear-avoidance[11, 17], no study could be found that included depressive symptoms, fear-avoidance beliefs and self-efficacy into a single prognostic model for return to work. These factors need to be examined concurrently, while controlling for the confounding effect of established prognostic factors[1]. There are indeed a large number of potential prognostic factors for the number of days on total benefit[1, 16], which may have a confounding effect on the psychological variables as prognostic variables for the number of days on total benefit[18, 19]. Correlations between psychosocial workload and work-related physical factors are known[18]. Some studies also mention an interaction effect between psychosocial workload and work-related physical factors regarding the measured outcome such as intensity of pain[18, 19]. However, far less is known about how these work-related factors might interact with individual psychological factors as prognostic factors for the number of days on total benefit being the outcome.

Objectives of this study

The objectives of the study are to:

1. evaluate the prognostic value of depressive symptoms, fear-avoidance, and self-efficacy on the number of days on total benefit in a group of workers receiving compensation benefits due to work-related musculoskeletal disorders.
2. explore the confounding effects of work-related and health-related variables on the psychological variables in a prognostic model with the number of days on total benefit being the outcome variable.

Methods

Study population

In this longitudinal study, the cohort consisted of 187 workers who reported being off work 7 days within the first 14 days after the injury date, with a follow-up period of 12 months. Structured telephone interviews were used for gathering information about potentially prognostic factors for time receiving benefits, approximately 4 weeks post-injury. Included were workers with a lost-time claim due to a musculoskeletal disorder, with no previous claim in the last 3 months. Workers were excluded when suffering from a fracture, amputation, burn, hernia, head injury, concussion or electrocution, or when they where unable to speak English. The eligible population for this study was workers employed by firms that had workers' compensation coverage in the province of Ontario, Canada. In Ontario, approximately 65% of the workforce has Workers Safety & Insurance Board (WSIB) coverage. Potential participants were identified from WSIB data files and, due to privacy protection standards, initially contacted by WSIB staff to determine eligibility. Subjects were recruited approximately 4 weeks after the injury date. Recruiters enquired if potential participants agreed to be contacted by a staff member of the Institute of Work and Health (IWH) research team. It was explained that refusal to be contacted by IWH or to participate in the study would not result in any changes in WSIB services. Claimants agreeing to be contacted were sent an information sheet and a consent form. Individuals who agreed to participate in the study were phoned by an IWH interviewer. The study was approved by the University of Toronto Ethics Review Board.

Instrumentation

Information was gathered on socio-demographic factors, psychological factors, physical factors, work-related psychosocial factors, and work-related physical factors. The reliability and validity was good for all established instruments. For those instruments constructed for the current study, we provide the relevant psychometrics in more detail below.

General health perception was measured by the SF-12[20]. The scores of the SF12 are summarized into a physical component score (PCS12) and a mental component score (MCS12).

To measure depressive symptomatology, we used the Center for Epidemiology Studies Depression scale (CES-D)[21]. For each of the 20 items of this measure, participants were asked to rate their frequency of depressive symptoms during the past week on a 4 point scale, going from 0 (rarely or none of the time) to 3 (most of the time). Item scores are summed together for a total score.

In order to assess the worker's belief about how work might affect their MSD the fear-avoidance work scale (FABQ-W) was used[22]. We did not use the physical scale. For each item, participants were asked to rate their agreement with each of the 7 statements as it pertained to their job, ranging from 0 (strongly disagree) to 4 (strongly agree). Item scores were summed together for a total score.

Items for self-efficacy for return-to-work were generated by a group composed of two clinical psychologists, a psychometrist, and a graduate student in community research, all with expertise in occupational health. The format of the 6 items was based on the Arthritis Self-Efficacy Scale[23]. Principal component analysis with our sample revealed two factors that explained 66% of the variance, i.e. self-efficacy for return to work and assertiveness for return to work. In this study only the former factor is used. For each of the 4 items, participants were asked to rate their confidence with regard to each item, ranging from 0 (not at all certain) to 4 (completely certain). Item scores were summed together for a total score. The Cronbach's Alpha of the self-efficacy measure for RTW in this study was 0.80.

Perceived pain intensity at the moment of the interview (i.e. referring to pain intensity right now) was based on a single 10 point numerical item taken from the Chronic Pain Grade[24], with 0 (no pain) and 10 (pain as bad as could be).

To measure work-related physical factors, a scale was designed to reflect the established risk factors for development of MSD mentioned by the National Research Council and Institute of Medicine (NRC)[25]. Items from the Physical Workload Survey Questions[26] reflecting these risk factors were used and new ones were created for risk factors not addressed in the Physical Workload Survey. For each item, participants were asked the percentage of time their job involves each item, ranging from 0 (not at all) to 5 (almost all the time, 100%). Item scores were summed together for a total score. Factor analysis on these data revealed three major physical load factors, i.e. heavy loading, repetitive movements, and vibration of body parts explaining 81% of the variance. Perceived physical workload was also measured using a 5-point Likert scale ranging from 0 (not at all demanding) to 5 (extremely demanding). For the purpose of comparability with a former study[15], item scores were rescaled to a 0 - 10 scale.

The Job Content Questionnaire[27] was used for determining perceived psychosocial workload and two scales were distinguished representing 'decision latitude' (made up of skill discretion and decision authority) and psychological demands (made up of psychological demands and psychological pace). For each item, participants were asked to rate how much they agree with each statement, ranging from 1 (strongly disagree) to 5 (strongly agree). Item scores were summed within each domain and scaled so that the possible range was from 6 to 30.

The Saskatchewan Comorbidity Scale was used to assess comorbidities[28]. This 15-item self-report scale assesses the presence of 15 types of comorbidities. For each item, participants are asked if they experienced the condition and then how much it affected their health, rating it on a scale from 0 (does not experience the condition) to 4 (experience condition: severely affects health). The test-retest intra-class correlation (ICC) was 0.93 (95%CI 0.91 – 0. 95)[28]. The agreement between individual items was adequate (weighted Kappa ranged from 0.42 – 0.92)[28]. The total score consists of a summative score of all items. One item was added to the version used in the current study for female participants to assess whether they had been pregnant in the last 6 months. Item scores were summed and rescaled to 0 to 100, with 0 representing no comorbidity.

For occupational classification, data were extracted from the WSIB database and coded as white collar, pink collar, or blue collar, using the system devised by Gaudette and colleagues[29].

The availability of workplace accommodations has been shown to have an important impact on prolonged work disability[1]. We therefore asked the worker whether they were offered a work accommodation when they were on compensation due to musculoskeletal disorders.

In order to detect the presence of a fear of income loss as a potential prognostic factor for time on benefit[1, 30] we asked the subjects how often in the past 4 weeks they felt they could not support themselves or their family the same way they were used to, because of their injury. The answers ranged from 1 (never) to 4 (often).

The outcome variable was the cumulative number of calendar days a claimant received total compensation benefits during 1 year *starting from the date of interview*. These data were derived from the administrative database of the WSIB of Ontario.

Data analysis

In order to address generalizability of our findings, participants and potential participants were compared on basic demographic and work-related variables, extracted from the WSIB database.

In order to explore the construct validity of the psychological variables, we conducted a factor analysis with items from the depression scale, SF-12 mental health scale, fear-avoidance scale, and self-efficacy scale. We also included pain in the factor analysis as pain is considered to be both a physical and psychological phenomenon[5]. Subsequently, the model building was done in three steps:

1. Variables with a significant correlation (α=0,05) with at least one of the three main variables – depressive symptoms, fear-avoidance, and self-efficacy for RTW - were considered as potential confounding variables and were selected for the next analysis.
2. A basic Cox Proportional Hazard (PH) regression model was built with age, gender, depressive symptoms, fear avoidance, self-efficacy. Each of the potential confounding variables was put in the basic model one at the time. When the beta values of depressive symptoms, fear avoidance and/or self-efficacy in the model were modified by more than 10% by a given variable, this variable was identified as a significant confounding variable and included in the final model.
3. Two final models were constructed based on the basic model and the significant confounding variables from Step 2. One model included work-related factors and the other did not. This allowed us to reveal the impact of work-related aspects on the model.

Factors considered as potential confounding variables for the psychological variables[31] were: perceived pain, co-morbidity, availability of work accommodation, work related physical factors and general perceived physical workload, perceived psychosocial workload, physical health, income (personal & family), level of education, and workplace size (from WSIB database & self-reported).

We used Cox Proportional Hazard regression to determine the prognostic value of the psychological factors for duration on total compensation. The assumption of non-proportionality is tested by including an interaction term with time for each variable of interest[32]. This method is described in more detail in a previous study[15]. In the Cox PH regression analysis, only the *days on benefit after interview* were counted.

Results

Participant recruitment

Over the course of 12 weeks, 6530 potential participants were identified from WSIB claim records. Due to time and eligibility constraints associated with recruitment criteria, WSIB staff recruiters attempted contact with 3903 potential participants. Recruiters were successful in reaching 1417 individuals. Of those, 68 were ineligible due to injury site or type, 536 had an insufficient number of lost-time days, and one individual could not remember the injury. Another 102 individuals were excluded due to language problems. A group of 503 agreed to be contacted by the IWH research survey unit. It should be noted that a sub-component of the study involved sending a paper and pencil questionnaire to 86 participants to examine the suitability of this methodology. Their data were not included in this paper.

Of the 417 participants who were called by the IWH research team, 63 were unreachable; 17 were found to be ineligible due to injury criteria, language criteria, or other ineligibility (i.e. moved out of province), and 132 refused to participate. Two hundred and five agreed to participate in the study and completed the questionnaire over the telephone. Researchers re-assessed recorded injuries 3 months post injury and a further 18 participants were excluded because their injury type, initially based on original WSIB data entered 3 weeks post injury, had been recoded and fell outside of study eligibility criteria. Hence, the final study sample consists of 187 subjects.

Population characteristics

Table 1 summarizes the population characteristics of the 187 included subjects. The mean number of days on total benefit after interview during the one year follow up was 45±78 days. The median number of days on total compensation benefit after interview was 14 days, ranging from 1 to 365 days. Workers who did not attempt to go back to work between injury and date of interview showed a median of 32 days on total compensation benefit. The mean duration of time between injury and interview was 28±5 days. The mean age of the population in this study was 42±11 years, most subjects had at least finished high school (79%), and the majority was male (60%). Most subjects received compensation due to low back pain (58%).

Analyses comparing study participants (n=187) with potential participants (n= 6530) showed that study participants were slightly older than potential participants. Participants and potential participants were similar in terms of gender and size of company. Participants had a greater number of back injuries than potential participants.

Table 1. Sample characteristics (n=187)

Variables			**Natural units**
Age			Mean (SD) 42 (11)
Cumulative days of total compensation (from day of interview)			
	Total group		Mean (SD) 45 (78), median 14
	Workers with sustainable RTW*		Mean (SD) 13 (41), median 0
	Workers with unsustainable RTW**		Mean (SD) 44 (56), median 26
	Workers with no RTW***		Mean (SD) 68 (93), median 32
Gender	Female		74 (40%)
	Male		113 (60%)
Marital status	Single		51 (27%)
	Cohabiting		136 (73%)
Education	Some high school		39 (21%)
	High school completed		91 (49%)
	University or College completed		57 (30%)
Site of injury	Back		108 (58%)
	Neck & upper extremity		79 (42%)
Employment status	Full-time		162 (87%)
	Part-time		24 (13%)
Collar classification	White collar		25 (13%)
	Pink		58 (31%)
	Blue collar indoor		47 (25%)
	Blue collar outdoor		25 (13%)
Workplace size	< 20 employees		17 (10%)
(WSIB data)	20 to 99 employees		30 (17%)
	100 to 999 employees		56 (32%)
	> 1000 employees		41 (23%)
Work accommodation available		Yes	91 (49%)
		No	94 (51%)
Personal income	<$20.000		35 (19%)
	$20.000 to $39.999		79 (44%)
	$40.000 to $59.999		57 (31%)
	>$60.000		10 (6%)
Family income	<$40.000		49 (29%)
	$40.000 to $59.999		54 (32%)
	$60.000 to $79.999		34 (20%)
	>$80.000		33 (19%)
Work status at time of interview			
	RTW-sustainable		73 (39%)
	RTW-Unsustainable		22 (12%)
	No-RTW		92 (49%)
Claim history past 5 years	(yes / no)		66 (35%) / 121 (65%)

* Sustainable RTW - being at work at time of interview; ** Unsustainable RTW - not at work at time of interview but at least one attempt to RTW in the interval of injury date - interview date; *** No attempt to return to work till time of interview.

Table 2 shows the descriptive statistics of the continuous variables that were used in the analyses. With a mean score of 18±14, depressive symptoms are high in this population sample, taking into account that a score above 16 indicates a high likelihood of the presence of a clinical depressive disorder[21]. The two dimensions of work-related psychosocial factors had approximately the same value (i.e. around 41). Of the work-related physical factors, heavy lifting (17±6) and repetitive movements (20±7) were most prominent. Physical health was scored worse than mental health, i.e. 33±10 and 44±11, respectively, indicating the presence of more physical problems than mental health problems, as 50 is the norm for both summary scales in a healthy population[20].

Table 2. Descriptive statistics of the psychological and work related variables in the participants (n=187).

	Mean	Median	SD	Observed Min – max	Original Scale Min - max
Depression (total score)*	17.9	16.0	13.7	0 - 57	0 - 60
Fear-Avoidance belief about work*	18.3	18.6	4.1	7 - 24	0 - 28
Self-efficacy**	12.6	14.0	3.5	0 - 16	0 - 16
General health**					
- Physical health	33.2	33.3	9.7	10.0 - 65.2	0 - 100
- Mental health	44.2	44.9	10.8	16.0 - 65.2	0 - 100
Perceived pain*	4.8	5.0	2.6	0 - 10	0 - 10
Co-morbidity*	3.8	0	7.1	0 - 38.3	0 - 100
Perceived physical work load*	3.9	4.0	1.0	1 - 5	1 - 5
Work-related physical factors*					
- Heavy loading	16.6	17.0	6.2	0 - 25	0 - 25
- Repetitive movements	19.7	25.0	7.3	0 - 25	0 - 25
- Vibration of body parts	6.6	2.5	8.1	0 - 25	0 - 25
Work-related psychosocial factors*					
- Decision latitude	40.7	42.0	8.3	17 - 57	12 - 60
- Psychological demands	41.3	40.0	8.2	20 - 60	12 - 60

*=higher score indicates worse scores; **=higher score indicates better scores

Variable selection

Factor analysis confirmed the presence of three major constructs within the psychological measures, i.e. depressive symptoms (the mental component score of the SF-12 was associated with this scale), self-efficacy, and fear-avoidance for work (pain was associated with this scale). The explained variance by the three factors was 86%. Because factor structure confirmed the apriori constructs included in the study, depressive symptoms, fear-avoidance, and self-efficacy were included in the primary prognostic model for the number of days on total compensation benefit. Because pain is both a physical and psychological phenomenon[5], it was included in subsequent analyses, despite the fact that it was related to the fear-avoidance factor.

Table 3. Correlation between personal, work-related and health-related factors with depressive symptoms, fear-avoidance, and self-efficacy in workers with a compensation claim due to MSD (n=187).

	Depressive symptoms	**Fear avoidance (for work)**	**Self-efficacy**	**Selected for next analysis**
Perceived physical workload‡	0,14*	0,33***	-0,12	X
Work related physical factors				
-Heavy lifting‡	0,11	0,34***	-0,12	X
-Repetitive tasks‡	0,16*	0,19*	0,03	X
-Vibration‡	-0,03	0,004	0,10	--
Psychosocial workload‡				
-Decision latitude	-0,30***	-0,25***	0,27***	X
-Psychosocial demands	0,32***	0,47***	-0,31***	X
Physical health‡	-0,09	-0,40***	0,16*	X
Pain‡	0,37***	0,43***	-0,30***	X
Co-morbidity‡	0,10	0,06	-0,17*	--
Body part of injury†	-0,11	-0,07	-0,002	--
Family income†	-0,28***	-0,04	0,17*	X
Personal income†	-0,14	-0,17*	0,07	X
Education†	-0,10	0,03	0,02	--
Marital status†	0,11	0,01	-0,04	--
Fear of income loss†	0,55***	0,28***	-0,21**	X
Work accommodation†	-0,003	0,17	0,03	--
Workplace size†	-0,12	0,04	0,06	--
Number of employees working at worksite†	-0,03	0,07	-0,01	--
Part time – fulltime†	-0,07	0,13	-0,07	--
Collar status†	0,001	-0,15	0,07	--
Claim history† (previous 5 years)	0,19**	0,21**	-0,003	X

$^{*}p\leq0.05$, $^{**}p\leq0.01$, $^{***}p\leq0.001$; † =Spearmann rank correlation, ‡ = Pearsons r^2

Table 3 shows the correlation of personal factors, work-related factors and health-related factors with depressive symptoms, fear-avoidance, and self-efficacy. Decision latitude, psychosocial demands, perceived pain and fear of income loss were significantly correlated with all three psychological variables. Physical health was strongly associated with fear avoidance for work. Table 3 also indicates the variables with a significant correlation with at least one of the three psychological variables that were selected for further analyses.

Table 4. Confounding effect of personal, work-related and health-related factors on the Basic Cox PH regression model including depressive symptoms, fear avoidance and self-efficacy as prognostic variables and the number of days on total compensation benefit as outcome variable (n=187). All models are adjusted for age and gender.

	Depressive symptoms		**Fear avoidance (for work)**		**Self-efficacy**	
BASIC β values (no confounding variable)	-0.01381	Difference	-0.04660	Difference	-0.02680	Difference
Factors included One at a time:						
Perceived physical workload	-0.01375	1%	-0.04445	5%	-0.02702	1%
Work-related physical factors						
Heavy lifting	-0.01381	0%	-0.05186	11%	-0.02546	55%
Repetitive tasks	-0.01294	6%	-0.04637	1%	-0.02597	3%
Psychosocial workload						
Decision latitude	-0.01501	9%	-0.05340	15%	-0.01879	3%
Psychosocial demands	-0.01465	6%	-0.05888	26%	-0.02301	14%
Physical health	-0.01862	35%	-0.02541	45%	-0.04246	58%
Pain	-0.01233	11%	-0.02842	39%	-0.03366	26%
Family income*	-0.01613	17%	-0.04381	6%	-0.02533	5%
Personal income**	-0.01359	2%	-0.04642	1%	-0.02677	1%
Fear of income loss***	-0.01042	25%	-0.04136	11%	-0.03643	36%
Claim history (Previous 5 years)	-0.01357	2%	-0.04319	7%	-0.02577	4%

Dummy variables: *= <$60.000; **= <$40.000; *** = often

Table 4 presents the confounding effect of each separate variable on the basic Cox PH regression model (adjusted for age and gender) including depressive symptoms, fear-avoidance, and self-efficacy as prognostic variables and the number of days on total benefit as outcome measure. Physical health and pain had a strong confounding effect on all three psychological variables in the model (difference range 11% to 58%). Physical health had the most impact on all three variables (range 35% to 58%). Additionally, family income and fear of income loss changed the beta of depressive symptoms by 17% and 25% respectively. Fear avoidance for work was mostly influenced by decision latitude (15%) and psychosocial demands (26%). Heavy lifting (55%), psychosocial demands (14%) and fear of income loss (35%) had a clear confounding effect on self-efficacy. Only variables that showed a confounding effect on depressive symptoms, fear avoidance and/or self-efficacy of more than 10% were included as confounding variables in the final Cox PH regression model. None of the variables showed an interaction with time, hence no interaction terms were included in the final model.

Psychological factors and duration on total benefit

In the basic Cox PH regression model with depressive symptoms, fear-avoidance for work and self-efficacy as the prognostic variables, both depressive symptoms (HR 0.99, 95%CI 0.97 - 1.00, p= 0.07) and fear-avoidance (HR 0.95, 95%CI 0.91 -1.00, p=0.06) showed a borderline significant effect on the number of days on total benefit during 12 months follow up, whereas self-efficacy had no effect on the number of days on total benefit. This model was adjusted for age and gender.

The final Cox PH regression model is shown in table 5. A multivariate model is presented without the work-related factors, and subsequently with all factors included. Adding the work-related factors did not change the outcomes on the psychological factors substantially. Depressive symptoms and physical health were significant prognostic factors for the number of days on total benefit during 12 months follow up in both models.

Table 5. Multivariate analyses with work-related and non-work-related factors. Basic model adjusted for age, gender and the variables that showed confounding effects on depressive symptoms, fear avoidance and/or self efficacy (n=187).

	Multivariate analysis with Non-work related factors		**Multivariate analysis with all factors**	
Variables	HR (95%CI)	p-value	HR (95%CI)	p-value
Age	0.99 (0.97 - 1.01)	0.32	0.99 (0.98 - 1.01)	0.55
Gender	1.05 (0.70 - 1.56)	0.83	1.11 (0.74 - 1.67)	0.62
Depressive symptoms	0.98 (0.97 - 1.00)	0.05^{+}	0.98 (0.95 - 1.00)	0.04^{+}
Fear-avoidance (work)	0.99 (0.94 - 1.04)	0.57	0.98 (0.92 - 1.04)	0.50
Self-efficacy	0.96 (0.90 - 1.01)	0.12	0.96 (0.91 - 1.02)	0.23
Physical health	1.03 (1.00 - 1.05)	0.02^{+}	1.03 (1.01 - 1.05)	0.02^{+}
Pain	0.97 (0.89 - 1.07)	0.57	0.98 (0.89 - 1.07)	0.62
Family income*	1.26 (0.87 - 1.83)	0.22	1.23 (0.85 - 1.79)	0.28
Fear of income loss**	0.74 (0.47 - 1.16)	0.18	0.70 (0.44 - 1.11)	0.13
Heavy lifting	--	--	0.99 (0.96 - 1.03)	0.75
Decision latitude	--	--	0.98 (0.95 - 1.01)	0.13
Psychosocial demands	--	--	1.00 (0.98 - 1.03)	0.91

Dummy variables: *= <$60.000; **= often ; $^{+}$=statistical significant

Discussion

We analysed the prognostic value of psychological factors for the number of days on total compensation benefit during 12 months, adjusting for confounding variables. Special emphasis was given on variable selection and relationships between potential prognostic variables. Increased depressive symptoms and a poorer perceived physical health were significant predictors of more days on total compensation benefit and, as such, appear to be important risk factors for prolonged work disability. Physical health (concomitantly a significant predictor), perceived pain, psychosocial workload and fear of income loss showed the most profound confounding effect on depressive symptoms, fear-avoidance for work and/or self-efficacy beliefs. In the final prognostic model, adding work-related variables did not change the model in any meaningful way. Taken together, our results suggest that when measured 4 to 5 weeks post-injury, depressive symptoms and physical health factors are strong predictors of prolonged time on benefits, while work-related factors are less important.

Psychological factors and duration on total benefit

Several studies have shown that relationships between prognostic variables must be taken into account when building a multivariate model[18, 19]. However these studies were directed at finding associations between work-related physical and psychosocial variables. Few studies, if any, have studied the interrelationship between individual psychological variables and potential prognostic variables for the number of days on total benefit, and subsequently studied their confounding effect in a prognostic model with total days on total benefit during one year as outcome.

Lower family income of the worker was highly associated with more depressive symptoms, and subsequently had an substantial impact on the beta values of all psychological variables in the Cox PH regression model. This suggests that within the work disability process, depressive symptoms are highly associated with workers' socio-economical status, which is consistent with earlier findings[33]. Despite the confounding effect of physical health on depressive symptoms, both constructs were significant prognostic factors for the number of days on total benefit during 12 months follow up. This is in agreement with findings of earlier studies[34, 35]. However, it should be noted that these studies did not use a comprehensive way of selecting and including confounding variables for the psychological variables of interest as was done in the present study.

The fact that high perceived physical workload, poor physical health, and perceived pain were strongly associated with fear-avoidance for work can easily be interpreted within the 'fear-avoidance' model[5]. Pain-related fear is characterized by escape and avoidance behaviours of which the immediate consequences are that work activities, expected to produce pain, are avoided. Physical health is perceived as poor and avoidance of work activities results in work disability[36]. Furthermore, our data indicate that one can expect fear avoidance for work to be higher in workers with high physical and psychosocial work load. Psychosocial workload showed a confounding effect on fear-avoidance in the Cox PH regression model. The effect of fear-avoidance found in the basic model (with only the psychological variables included) was diminished in the multivariate model, which is probably due to the high association of physical health with this variable. This association has also been found in other studies[10, 36]. Hence, it may remain difficult to disentangle the effects of perceived physical health and fear avoidance as they are so intertwined[2].

Both decision latitude and psychosocial demands were associated with self-efficacy towards work. Surprisingly they hardly showed a confounding effect on the prognostic value of self-efficacy with regard to the number of days on total benefit[31]. In contrast, perceived physical health was moderately associated with self-efficacy whereas its confounding effect on the prognostic value of self efficacy for days on benefits was strong. Fear of income loss due to work disability could influence the return to work decision. Although not statistically significant, the effect of fear of income loss indicated that workers who feared income loss were likely to return to work sooner than those who did not. In a study by Van der Giezen it was found that being the main bread winner shortened the duration of work disability[30], whereas other studies found prolonged work disability in workers with a high level of wage replacement benefits[1]. The foregoing suggests that the perception of some financial and/or economic threat, probably acts as an economic incentive to regain work activities earlier in time.

Limitations of the study

The comparison of the participants with potential participants on select WSIB variables revealed several differences that may limit generalizability of results. Participants in our sample were older. This is not surprising as younger workers change jobs more frequently, are more difficult to contact, and are commonly under-represented in worker surveys. In this respect, our sample is likely to be more work disabled than the population of potential participants since work disability has been shown to increase with age[37]. The final sample also had fewer upper extremity disorders than the non-participants. Further, we found that in terms of gender, employment classification and firm size, our sample was similar to the population of interest, increasing the generalizability of the study results. Unfortunately, it was impossible to compare our participants to potential participants on all variables of interest because the WSIB does not collect data on personal income, worksite size and employment status (i.e. working full-time or part-time) and collar status at time of injury.

Due to the cross-sectional measure of the prognostic variables at baseline, it remains unclear whether the occurrence of a depressive state is due to being work disabled, or if instead it precedes work disability and might actually be a risk factor for a work related injury claim. Hence, depressive symptoms might already be present prior to injury.

For the purpose of this study, an explorative measure of self-efficacy was developed. A factor analysis confirmed its factor structure, however, its complete psychometric properties are not established yet. To develop a adequate measure of self-efficacy for return to work, the theoretical construct of self-efficacy beliefs within the work disability process needs further exploration[13]. Social cognitive theory may give some clues for providing an adequate measure for self efficacy combined with its companion construct of outcome expectancies. This theory posits a multifaceted causal structure in which self-efficacy beliefs operate together with goals, outcome expectations, and perceived environmental impediments and facilitators in the regulation of human motivation, behaviour, and well-being[38].

Conclusions

The present study clearly shows that the presence of depressive symptoms in workers on total compensation benefit due to musculoskeletal disorders significantly increase the number of days on benefit. Although an increased emphasis on psychological factors is being placed in current occupational guidelines[39], a comprehensive picture of the role of individual psychological factors on development and duration of work disability is still lacking. Our study makes a significant contribution in clarifying the role of psychological factors in the work disability process, in view of its rigorous control of confounding variables. This has implications for policies and interventions: Work disabled individuals would benefit from early identification of depressive symptoms and from interventions which target psychological factors such as depressive symptoms.

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6.

THE INFLUENCE OF MODIFIED WORK ON RETURN TO WORK FOR WORKERS ON SICK LEAVE DUE TO MUSCULOSKELETAL COMPLAINTS

Adapted from:
Duijn van M, Lötters F, Burdorf A. The influence of modified work on return to work for workers on sick leave due to musculoskeletal complaints. *J Rehab Med* 2005; 37:172-179.

Abstract

Objectives. To determine which individual and work-related factors are associated with performing modified work and to evaluate the influence of modified work on the duration of sickness absence and health-related outcomes among workers with musculoskeletal complaints.

Study design. A prospective study with 12 months follow-up.

Methods. In this prospective study a total of 164 workers on sickness absence for 2-6 weeks due to musculoskeletal complaints completed two questionnaires. At baseline we gathered information about individual characteristics, physical and psychosocial workload, and disease specific and general health. The follow-up questionnaire, sent to respondents who returned in their original job on full duty, collected information about having performed modified work, and disease specific and general health.

Results. Workers were less likely to perform modified work when their regular work was characterised by frequent lifting and their relationship with colleagues was less than good. Workers were more likely to return in modified work when they had a better mental health, had prolonged periods of standing in their regular job, and had less skill discretion. Duration of sickness absence was influenced by chronicity of complaints and disability, but not by modified work.

Conclusion. Modified work, as solitary advise of the occupational health physician, did not influence the total duration of sickness absence nor the improvement in health during sick leave for workers on sickness absence due to musculoskeletal complaints.

Introduction

Programmes for the timely return to work of workers with musculoskeletal complaints have received much attention in the past decade. A key element in these programmes is the provision of modified work whereby activities in the job are adapted to the possibilities of the disabled employee. In general, the worker will start with a strongly reduced workload which will be gradually increased until full duty is commenced[1]. Since high physical load at work is a risk factor for the onset of musculoskeletal complaints[2], modified work seems to be highly relevant for workers on sickness absence due to musculoskeletal disorders.

There is some evidence that the provision of modified work may reduce the duration of sickness absence. In two reviews it has been suggested that employees with temporarily modified work returned to work twice as often as employees without access to any form of modified work[1, 3]. Moreover, it was estimated that, on average, a reduction of 50% in days lost from work could be expected for those workers with modified job activities. However, these results summarise a wide range of different interventions, ranging from modified work as a solitary advice to modified work as one of the elements in a multidisciplinary rehabilitation programme.

In the Netherlands every employee is tied to an occupational health service and, generally, is called up when on sick leave for more than two weeks. When appropriate, the occupational health physician will advise to return to work with a strong reduction in work tasks and/or working hours. Occupational health physicians will discuss the advice for modified work with the worker on sickness absence and the supervisor. Together, they will plan the temporarily work situation, determine which work tasks should be carried out, and what should be the maximum number of working hours.

Based on results of randomised controlled trials, existing guidelines on musculoskeletal complaints within occupational health care recommend to stay active or become active as soon as possible[4-7]. However, questions remain about the use of modified work as part of return-to-work programmes. On the one hand, occupational physicians are positive about modified work since employer and employee keep in touch with each other. On the other hand, there is some doubt that a recurrence of complaints might be the consequence of a too early return to work. In addition, recent studies have shown that implementation of modified work is complicated by a substantial number of work-related barriers[8-11]. According to occupational health physicians and human resource managers, lack of possibilities to change the work tasks and insufficient knowledge about the effects hamper the introduction of modified work[8]. Studies also suggest that individual characteristics of the worker on sick leave may play an important role in the decision to return to work with modified duties[9, 11, 12].

In order to evaluate the influence of modified work on return to work a longitudinal study was performed among workers on sick leave due to musculoskeletal complaints. In this study two questions will be answered:

1. Which individual and work-related factors are associated with performing modified work?

2. Is there a difference in duration of sickness absence and health outcomes for workers performing modified work compared with workers returning to their regular job straight in full duty?

Methods

Study population and data collection

The subjects of the study were workers on sickness absence due to musculoskeletal complaints for 2-6 weeks at the time of inclusion. Workers were excluded if they suffered from specific underlying pathology, such as a fractured leg or discus prolaps. Subjects were enrolled in the study by occupational health physicians during their consults or selected from the absenteeism register of a large Dutch occupational health service. If the worker on sickness absence was willing to participate, an informed consent was signed. Based on the initial diagnosis by the occupational physician, subjects received a diagnosis specific questionnaire (i.e. low back, hip, knee, ankle/foot, neck, shoulder, or wrist/hand/elbow). Non-responders were sent a reminder after two weeks and a second reminder with questionnaire after three weeks. Follow-up questionnaires were sent to respondents when full return-to-work was established or one year after inclusion. The date of full return to the original job as well as the first day of sickness absence were obtained from the occupational health services.

Contents of the questionnaire

At baseline we gathered information about individual characteristics, physical and psychosocial workload, disease specific and general health, and medical consumption. The main individual characteristics obtained were age, gender, body mass index, marital status, and education.

Work-related physical factors were derived from a self-reported assessment of physical load at work. The questions primarily concerned lifting of loads, pushing/pulling, working with hands above shoulder level, bending/ twisting of the trunk, and standing for long periods during a regular workday. On a four point scale respondents were asked about the frequency of these activities during a normal working day; ' never', 'sometimes', 'frequently', and 'always'[13, 14]. For lifting weights over 25 kg the answer 'never' was considered as low workload. With regard to standing 'never', 'sometimes' and 'frequently' were defined as a low workload. For all other work-related physical factors the answers 'never' and 'sometimes' were considered as low workload. Perceived physical workload was also measured by using a 10-point Numerical Rating Scale (NRS), ranging from 0 (very, very light) to 10 (very, very heavy). Regular working hours per week and the duration of employment were included in the questionnaire. For psychosocial factors at work the Job Content Questionnaire was used[15]. In this questionnaire three dimensions can be distinguished: work demands, skill discretion, and decision authority. Work demands were measured by 11 questions related to working fast, working hard, excessive work, insufficient time to complete the work, and conflicting demands. Skill discretion and decision authority were measured by 6 and 11 questions pertained to aspects such as required skills, task variety, learning new things, and amount of repetitive work. All items used a four-point scale, ranging from ´seldom-never´ to ´always´, and a sumscore was calculated for each dimension. The perceived relationship with colleagues and with supervisors was measured on a 10-point scale, and a score below the mean of the population was characterised as less than good.

We used a modified Nordic Questionnaire for the nature and severity of musculoskeletal complaints[16]. Chronic complaints were defined as pain which was present almost every day in the preceding 12 months with a minimal presence for at least 3 months. We chose a NRS for pain as measure of the intensity of musculoskeletal complaints[17]. The NRS involves asking patients to rate their pain from 0 to 10, with the understanding that 0 represents no pain at all, and 10 pain as bad as it can be. Patients were asked to rate the pain intensity at the moment of filling in the questionnaire for the body part underlying the initial diagnosis.

For low back pain the Roland-Morris Disability Questionnaire was used as a condition-specific health status measure, designed to assess physical disability through the presence of 24 activity limitations on a dichotomous scale. Subsequently, the number of positive limitations has to be converted into a sum score ranging from 0 (no functional limitations) to 24 (maximum functional limitations)[18]. For other musculoskeletal complaints we used a comparable questionnaire. For the latter purpose we changed the addition 'because of my back' into 'because of my neck', 'because of my knee' etc. Furthermore, for use of neck, shoulder, and elbow/wrist/ hand complaints 6 items concerning walking and standing were substituted by corresponding items from the physical dimension of the Sickness Impact Profile (SIP). The SIP is a general health questionnaire which formed the basis for the Roland-Morris Disability Questionnaire. The SIP as well as a similarly modified version of the SIP have reliability coefficients of 0.7 and higher[18, 19].

We measured general health with the SF12, an instrument that is derived from the SF36[20, 21]. It is a generic measure of health with 12 items covering eight dimensions, i.e. general health, physical functioning, role-physical, bodily pain, vitality, role-emotional, social functioning, and mental health. These dimensions were aggregated into two scores: the physical component summery scale (PCS12), and the mental component summary scale (MCS12). Each component is expressed on a 0-100 scale with '0' representing the worst health status as possible and '100' the best health status as possible[20].

The EuroQol5 dimensions (EQ5d) were used as a measure of preference-based quality of life, evaluating five domains: mobility, selfcare, activity, pain, and depression/anxiety[22]. Each of these domains has three possible levels: no impairment, mild to moderate impairment, and severe impairment. An overall index score was computed. The preference scores for each worker were calculated using weights for different health states as obtained from a general population in the United Kingdom[23]. A score of '0' represents the worst possible health status and '1' the best possible health status. Since in some extreme situations the preference-adjustment may result in a negative score, scores below zero were rounded off to zero.

Modified work

The follow-up questionnaire, sent to respondents who returned in their original job on full duty or one year after inclusion, was a shorter form of the baseline questionnaire and gathered information about having performed modified work, and disease specific and general health. The presence of modified work was defined by three criteria: (1) work activities were carried out during the sickness absence period, (2) this work was characterised by a substantial reduction in work tasks or working hours, and (3) the modified work during sick leave was advised by the occupational health physician.

Sickness absence

The most important outcome was time until return-to-work on full duty in the regular job. In The Netherlands the endpoint of an episode of sickness absence is marked by the date of fully return to work in the regular job. In almost all situations of sickness absence the worker will be paid a full salary during the first year of sickness absence. Under the collective labour agreements companies are responsible to pay full wages during sickness absence and, in general, do not have a possibility to terminate employment of sick listed workers. Companies are legally bound to report the date of full return to work in the original job to the occupational health service.

Data analysis

Differences between continuous variables were tested with the Student t-test and differences between dichotomous variables with the chi-square test . All health outcomes were measured on the original ordinal scales, but treated as continuous variables after ensuring that each variable did not violate the assumption of normality. Kaplan-Meier curves were produced to describe the proportion of workers returning to work full duty as a function of duration of sickness absence. A logistic regression model was used to identify determinants for performing modified work during sickness absence. For the initial selection of variables a $p<0.10$ was considered as relevant. In the final model only variables with $p<0.05$ were retained. An Odds Ratio above one indicates an increased likelihood of having performed modified work. In order to present comparable results for each prognostic factor of interest, all continuous variables were transformed to a similar 10 point scale. This implies that the score on the Roland Morris Disability Questionnaire was converted from 24 to 10, with one scale unit in the logistic regression analysis equalling 2.4 points on the original disability scale. Likewise the measures of physical and mental general health from the SF-12 questionnaire were converted with one scale unit in the logistic regression analysis representing 10 points on the original scales. We used Cox Proportional Hazards (PH) regression analysis to determine prognostic factors for duration of sickness absence. Since subjects were considered not at risk between the first date of sick leave and the fill-in date of the questionnaire, this time lag was omitted from the total duration of sick leave in the Cox PH-regression model. Subjects were right censored when they did not return to work after 12 months of follow-up. Variables were coded in such a manner that a Hazard Ratio (HR) above 1 indicates no return to work at a given time 't', implying a slower return to work over the total follow up period. For the initial selection of variables a p<0.10 was considered and in the final multivariate model only variables with p <0.05 were retained. Age was forced into the multivariate model, irrespectively of the level of significance.

Table 1. Characteristics of workers on sick leave for 2-6 weeks due to musculoskeletal complaints, stratified by performing modified work during sick leave (n=164).

	Modified work (n=65)	**No modified work (n=99)**	**p-value**
Individual characteristics			
Sex, woman %	43	30	0.09
Age, mean (sd)	43.0 (8.5)	43.0 (9.1)	0.99
Body Mass Index >30 kg/m^2 (%)	11	20	0.13
Single (%)	26	14	0.06
Low Education (%)	62	57	0.53
Sick leave 12 months prior to current absence (%)	33	25	0.30
Work-related factors			
Fulltime (%)	66	68	0.84
Years in same job, mean (sd)	12.3 (10.3)	14.8 (11.3)	0.17
Prolonged standing, (%)	70	43	0.0006*
Frequently lifting 10-25 kg, (%)	45	66	0.009*
Frequently lifting >25 kg, (%)	26	65	<0.0001*
Frequently kneeling, (%)	17	31	0.05*
Frequently bending/ twisting, (%)	64	72	0.31
Frequently pushing/ pulling, (%)	17	24	0.30
Arms frequently above shoulder level, (%)	21	35	0.07
Perceived physical workload, mean (sd) (0-10)	6.5 (2.1)	7.3 (2.0)	0.008*
Skill discretion, mean (sd) (0-18) [1]	9.8 (3.9)	8.5 (3.2)	0.02*
Decision authority, mean (sd) (0-33) [1]	15.8 (7.3)	16.4 (6.9)	0.56
Work demands, mean (sd) (0-33) [1]	14.5 (5.0)	15.4 (4.9)	0.25
Less good relationship with colleagues, (%)	35	57	0.005*
Less good relationship with supervisor, (%)	52	42	0.21
Health outcomes[3]			
Chronic complaints, (%)	16	36	0.005*
Severity of pain, mean (sd) (0-10) [1]	5.9 (1.8)	6.4 (2.1)	0.18
Disability, mean (sd) (0-24) [1]	12.9 (5.2)	12.8 (4.8)	0.88
General physical health, mean (sd) (0-100)[2]	32.1 (7.1)	32.8 (7.3)	0.55
General mental health, mean (sd) (0-100) [2]	52.6 (9.2)	46.8 (10.3)	0.0004*
Quality of life, mean (sd) (0– 1) [2]	0.52 (0.3)	0.52 (0.3)	0.93

*p <0,05

[1] A higher score indicates a worse status.

[2] A higher score indicates a better status.

[3] Disability = functional limitations of Roland-Morris disability questionnaire; general physical health = physical component summary scale of SF-12 questionnaire; general mental health = mental component summary scale of SF-12 questionnaire; Quality of life = EuroQol 5d preference-based quality of life

Results

Study population

Occupational health physicians included 196 respondents on sickness absence for 2-6 weeks with musculoskeletal complaints. Another 116 workers were selected from absenteeism registers from occupational health services and 66 subjects agreed to participate in the study (57%). In total, 262 workers received the baseline questionnaire of which 225 subjects returned a complete questionnaire (86%). The follow-up questionnaire was filled out by 164 (73%) subjects, of which 6 cases were not returned to work within 12 months. Among the remaining 61 workers who did not respond to the follow-up questionnaire, 29 were lost to follow-up, 21 subjects changed job towards less strenuous activities immediately after the date of full recovery, and 11 respondents were lost due to administrative loss at the occupational health services. Of the 164 workers who completed the study, 65 (40%) reported that they had performed modified work during their recent episode of sickness absence. The remaining 99 (60%) respondents returned to work straight into their original job.

Table 1 shows the baseline characteristics of the workers on sickness for 2-6 weeks at the time of inclusion. Most of the respondents were blue-collar workers, from a wide range of companies, including construction work, post delivery services, food services, and security firms. Another substantial part of the subjects worked in nursing homes or hospitals. Of all workers, 48% had low back pain complaints, 36% were on sick leave due to upper extremity disorders, and another 16% due to lower extremity complaints. Workers returning in modified duties reported at baseline less chronic complaints and a better mental health than those without modified work during the follow-up. Workers with modified work also reported less physical workload such as heavy lifting, kneeling, and working above shoulder level in the regular job.

Modified work

The Odds Ratios for performing modified work during sick leave due to musculoskeletal complaints are presented in table 2. Workers were less likely to perform modified work when their regular work was characterised by frequent lifting (OR 0.16, 95%CI 0.07-0.40) and their relationship with colleagues was less than good (OR 0.29, 95%CI 0.12-0.69). Workers were more likely to return in modified work when they had a better mental health (OR 1.89, 95%CI 1.22-2.93), had prolonged periods of standing in their regular job (OR 5.21, 95%CI 2.13-12.75), and had less skill discretion (OR 1.24, 95%CI 1.01-1.52). Health outcomes such as pain, disability, and general health were not related to performing modified work. The location of musculoskeletal complaints also did not predict modified work.

Table 2. Prognostic factors for performing modified work during sick leave among workers on sick leave due to musculoskeletal disorders (n= 164).

Prognostic factors	Univariate analysis			Multivariate analysis		
	OR[1]	95% CI	p	OR[1]	95% CI	P
Individual characteristics						
Female (1/0)	1.74	0.91 - 3.34	0.10	---	---	---
Single (1/0)	2.15	0.98 - 4.74	0.06	---	---	---
Physical work load						
Prolonged Standing (1/0)	3.18	1.62 - 6.22	0.0007	5.21	2.13 - 12.75	0.0003
Frequently lifting 10-25 kg (1/0)	0.43	0.22 - 0.82	0.01	---	---	---
Frequently lifting >25 kg (1/0)	0.20	0.10 - 0.40	<.0001	0.16	0.07 - 0.40	<0.001
Frequently kneeling (1/0	0.46	0.21 - 1.00	0.05	---	---	---
Frequently working above shoulder level (1/0)	0.51	0.25 - 1.05	0.07	---	---	---
Perceived physical workload (0-10)	0.81	0.69 - 0.95	0.01	---	---	---
Psychosocial work characteristics						
Skill discretion (0-18)	1.21	1.02 - 1.42	0.03	1.24	1.01 - 1.52	0.04
Less good relationship with colleagues (1/0)	0.40	0.21 - 0.77	0.006	0.29	0.12 - 0.69	0.005
Health outcome[2]						
Chronic complaints (1/0)	0. 33	0.15 - 0.74	0.007			
General mental health (0-10)[3]	1.83	1.28 - 2.61	0.0009	1.89	1.22 - 2.93	0.004

[1] OR > 1 indicates a higher probability of performing modified work.

[2] See table 1 for explanations

[3] One scale unit represents 10 points on the original scale

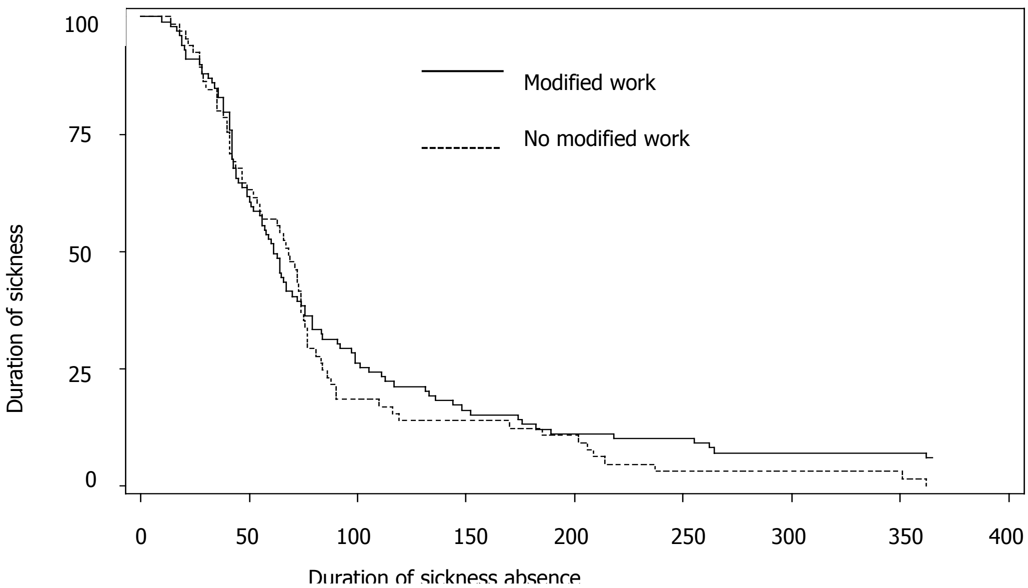
Health related outcomes

The respondents reported significant improvements for pain, disability, physical general health, and quality of life, irrespectively of performing modified duties (table 3). Workers staying home until full return to work showed a modest decrease in mental health, whereas workers on modified duty slightly improved in mental health.

Duration of sickness absence

Figure 1 depicts the survival curves for returning to work among workers with musculoskeletal complaints. There was no difference in duration of sickness absence for workers performing modified duties compared with workers returning in full duty. The duration of sickness absence was not affected by the type of modified duty, i.e. reduction in work time or change towards less strenuous tasks. However, the time of onset with modified work had an significant impact on the duration of sickness absence (figure 2). Onset with modified work after seven weeks was associated with a longer sickness absence, whereas there was no difference in duration of sickness absence between workers with onset of modified work before week 7 and workers without modified duties.

Figure 1. Survival curves for return to work among subjects with modified work (n= 65) and workers without modified work (n= 99) during their sick leave.



Prognostic factors for sickness absence

Table 4 shows the prognostic factors for the duration of sickness absence. In the univariate analyses duration of employment in the same job (HR 1.41, 95%CI 1.01-1.95), sickness absence due to musculoskeletal complaints in the 12 months before the current episode (HR 1.50, 95%CI 1.03-2.17), chronic musculoskeletal complaints (HR 1.60, 95%CI 1.20-2.32), pain intensity (HR 1.08, 95%CI 1.01-1.17), and a high level of disability (HR 1.12, 95%CI 1.03-1.22) were associated with a longer duration of absence. A good quality of life (HR 0.94, 95%CI 0.89-1.0) and physical health (HR 0.81, 95% CI 0.63-1.04) resulted in a shorter duration of absence. In the multivariate analysis disability (HR 1.11, 95%CI 1.02-1.21) and chronic complaints (HR 1.55, 95%CI 1.06-2.27) showed the strongest associations with longer sickness absence. Performing modified work, age, and gender were not related to duration of sickness absence.

Table 3. Health outcomes of workers on sick leave due to musculoskeletal complaints at 2-6 weeks of sick leave and after return to work, stratified by performing modified work during sick leave (n=164).

	Modified work		**No modified work**	
	Baseline (t_1)	After return to work (t_2)	Baseline (t_1)	After return to work (t_2)
Severity of pain (0-10)[2]	5.9	3.6*	6.4	4.7*
Disability (0-24)[2]	12.9	6.6*	12.8	6.6*
Physical general health (0-100)[3]	32.1	43.9*	32.8	45.9*
Mental general health (0-100)[3,4]	52.6	55.1	46.8	41.4
Quality of life (0 –1.0)[3]	0.52	0.78*	0.51	0.73*

*p < 0.05; [1] See table 1 for explanations;

[2] A higher score indicates a worser health;

[3] A higher score indicates a better health.

[4] Improvement on mental general health was significantly (p<0001) better among workers with modified work than those without.

Table 4. Prognostic factors for return to work after sickness absence (Cox proportional hazards regression analysis) among workers on sick leave due to musculoskeletal disorders.

Prognostic factors	**Univariate analysis**			**Multivariate analysis**		
	HR	95% CI	p	HR	95%CI	p
Modified work	1.11	0.80 - 1.53	0.53	(1.06	0.75 - 1.51	0.73)[1]
Individual characteristics						
Older age (> 43) (1/0)	0.88	0.64 - 1.21	0.43	0.82	0.60 - 1.15	0.83
Work-related factors						
Many years in same job (>14 yr) (1/0)	1.41	1.01 - 1.95	0.04	---	---	---
Sick leave 12 months prior to current absence (1/0)	1.50	1.03 - 2.17	0.03	---	---	---
Health outcome[2]						
Chronic complaints (1/0)	1.60	1.20 - 2.32	0.01	1.55	1.06 - 2.27	0.02
Severity of pain (0-10)	1.08	1.01 - 1.17	0.06	---	---	---
Disability (0-10)[3]	1.12	1.03 - 1.22	0.01	1.11	1.02 - 1.21	0.02
Physical general health (0-10)[4]	0.81	0.63 - 1.04	0.10	---	---	---
Quality of life (0-10)[4]	0.94	0.89 - 1.0	0.04	---	---	---

HR: hazard ratio, >1 means a higher risk for longer absence

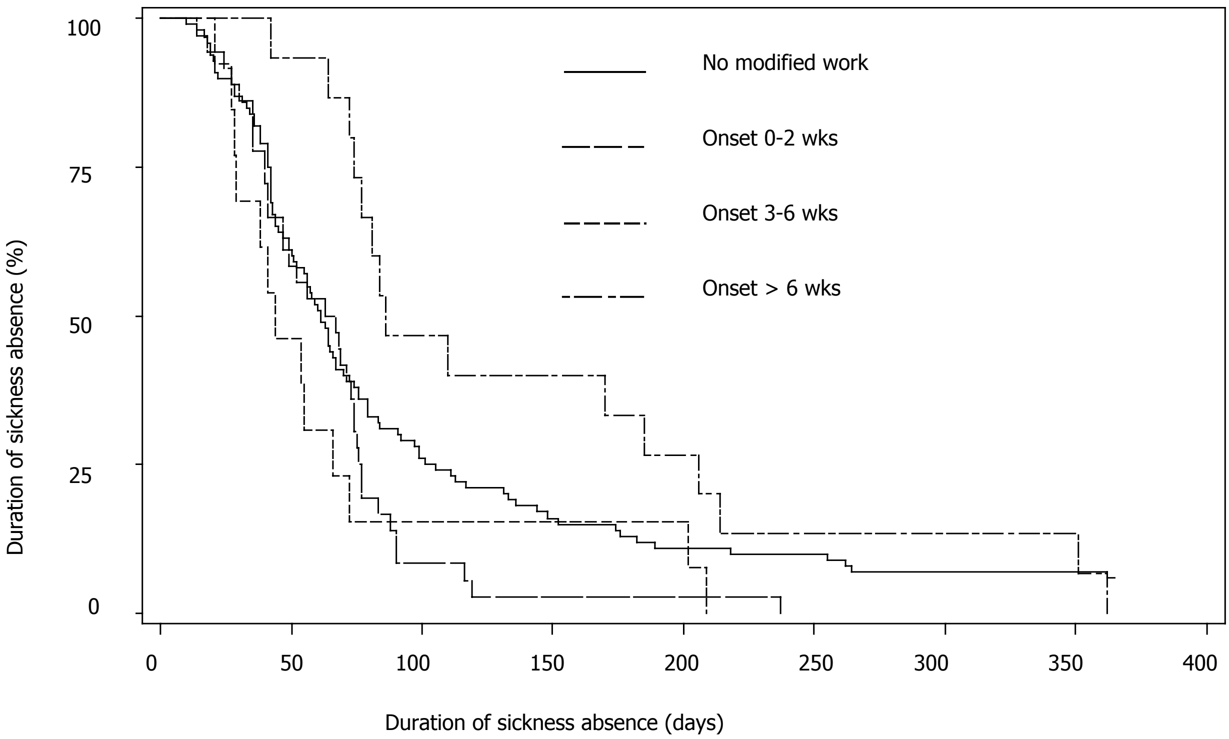
[1] Effect of modified work when introduced into the multivariate model

[2] See table 1 for explanations

[3] One scale unit represents 2.4 points on the original scale

[4] One scale unit represents 10 points on the original scale

Figure 2. Survival curves for return to work among subjects with workrelated factors, stratified for time of start with modified work.



Discussion

Study design and study population

The results of this study could be influenced by the study design. Although originally designed as a randomised controlled trail to evaluate the effect of modified work, major barriers with the randomisation of respondents made it necessary to change the trial into a prospective study. In some occupations, for example roofers and scaffolders, it proved to be too difficult to define modified work with a strong reduction in work load for workers with musculoskeletal complaints, since in these jobs all activities involved a considerable physical work load[8]. On the other hand, in several companies modified work was the starting point of departure in the management of sickness absence, due to health-related as well as financial motives. In The Netherlands most employers are legally bound to pay full wages in the first and second year of sickness absence. When their medical situation is not affected, employees are required to accept modified duties. During the study period a new law was enforced which put strong emphasis on the provision of modified work to sicklisted workers and, as a consequence, randomisation was no longer acceptable in various companies. Only among companies with a less developed management system on sickness absence, mostly small and medium sized businesses, a reasonable proportion initially agreed with the required randomisation procedure. A randomised controlled trial is traditionally the gold standard for judging the benefits of treatment. However, due to a strong selection by companies and occupational health physicians who would agree with randomisation, which is partly considered as conflicting to common law, the basic principle of randomly selected groups would not have been reached in this study. A prospective study without randomisation was regarded as the best alternative with potentially less selection bias. The inclusion in the study population was limited to subjects who in principle could perform modified work. As appears from the health outcomes at baseline, there was no strong a priori selection among those advised modified duty and those without, except for chronicity of complaints and general health. The choice for the prospective study design also enabled us to analyse who performed modified work and who did not.

Although selection bias seems to be limited in our study, it could still have influenced the results. Some selection bias may occur due to inclusion of cases from the absenteeism register of occupational health services. Workers selected from the absenteeism register had a lower response than those included by the occupational health physicians. Since most workers on sick leave due to musculoskeletal disorders will return to work within the first weeks of sickness absence, the lower response may partly be explained by subjects already returned to work when receiving our invitation to participate in the study[24]. However, the route of entry in the study population was not associated with the health status at baseline and also not a factor influencing the return to work and/or the possibilities of having performed modified work. In this study, 6 subjects into the control group had not returned to work after one year. Exclusion of this small number of cases will not change the overall findings.

In The Netherlands early return to work during sickness absence is by law only possible after an advice of an occupational health physician, which is included in our definition of modified work. For the major part of the population modified work was initiated by an occupational health service, however, it is possible that the decision on modified work was influenced by other parties involved in sickness management. The small number of respondents representing the three types of modified duties (reduced working hours, adjusted tasks, or a combination of both) is another methodological disadvantage of this study, since a clear distinction cannot be made between the effects of these three types of modified work on duration of sickness absence.

Modified work

Our findings of no impact of pain on the provision of modified work is supported by several studies suggesting that pain is not a barrier for return-to-work[4, 25]. Our results also show no impact of functional disability on performing modified work. Although in various international occupational health guidelines the use of general health outcomes in return-to-work decisions is not advocated[25, 26], disabilities seem to be most relevant for deciding on the capabilities of a sicklisted worker to perform modified work. Our results suggest that disability as an outcome measure is not frequently used by occupational physicians advising on modified duties or that this measure of general disability is not specific enough to assess the presence of work-related disability as a potential obstacle for performing modified work.

Work-related physical factors were associated with performing modified work. Workers who were required to lift heavy loads were assigned less often modified work by the occupational physician and more often returned directly in their regular job when sufficiently recovered. This is a rather surprising finding. Since high physical load at work is a well-established risk factor for musculoskeletal complaints[2], modified work seems to be highly relevant for workers on sickness absence due to musculoskeletal disorders. However, as already observed in other studies a lack of possibilities to change work tasks is a substantial barrier for realising modified work[8-10]. In jobs with a high physical load there may be fewer opportunities to reduce the heavy work load to an acceptable level. Another explanation could be related to the physician's fear for recurrence or worsening of the complaints, which has been reported as a barrier for return to work[10, 12]. Although the results of our study indicate a strong improvement on health-related outcomes for workers performing modified work as well as those returning directly to full duty, occupational physicians may act cautiously when advising modified work for workers with a high physical load in their regular job.

A good relationship with colleagues supported the implementation of modified work. When colleagues are willing to take over those tasks with a high physical load, it might be easier for a sicklisted worker to return to work in modified duties. In two other studies occupational physicians and general practitioners also reported social support of colleagues as a key element in recovery and return to work[8, 10].

Sickness absence

Overall, in this study we found no difference in duration of sickness absence for workers with modified work compared with workers returning directly to full duty in their regular job. This is in line with results of some studies[27-29] but contradicts the conclusion drawn in two reviews[1, 3]. The lack of any effect in our study may be explained by the fact that the recommendation for early return to work, given by the occupational physician, more often was a solitarily advise and not part of a multidisciplinary programme. Modified work as part of a broader rehabilitation intervention seems to be effective[30]. A graded activity programme at a Dutch airline company showed a significant decrease in sickness absence among workers sicklisted with back pain for more than 50 days[31]. However, such an extensive type of rehabilitation is not common in small and medium-sized companies. There is still a need for an effective and simple intervention such as provision of modified work.

Starting with modified work after seven weeks was associated with a longer sickness absence. In the subgroup with delayed start substantially more workers had chronic complaints and their average level of disability was slightly higher than other workers. However, none of these differences were statistically significant but remained persistent after adjustment for chronic complaints and disability. The expectation of the occupational physician may have influenced these results. When a worker is absent for a prolonged period, the physician will assume serious health problems and most likely be more careful with advising return to work. Alternatively, when it is expected that the worker will return to work within one or two weeks, physicians may not see the need for modified work. However, the comparison of health outcomes at baseline suggests that those performing modified work had a similar health status as those returning to their original work.

Although a negative effect on return to work was found for a delayed start of modified work, there was no difference between workers with an early return to work compared with workers staying home until return in full duty. Among the cases a high return-to-work rate is expected due to the natural course of sickness absence[24, 29]. Our study population may be too small to detect meaningful differences between modified work and returning directly in full duty. The provision of modified work could in principle also have delayed the return to full duty. Working on modified duties may imply an accepted status quo for both employee and employer and, as a consequence, result in less pressure to return to the original job. Therefore, provision of modified work for a clearly limited period is advised[26].

In conclusion, workers on sick leave for musculoskeletal complaints in jobs characterised by a high physical work load were less often assigned modified work by the occupational physician. All workers showed a strong improvement in pain, disability, and general health at return to work. Duration on sickness absence was influenced by chronicity of complaints and disability. Modified work during sickness absence did not influence the total duration of sickness absence nor the improvement in health during sick leave.

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7.

HEALTH STATUS,
ITS PERCEPTIONS AND EFFECT ON RETURN TO WORK AND RECURRENT SICK LEAVE

Adapted from:
Lötters F, Hogg-Johnson S, Burdorf A. Health status, its perceptions and effect on return to work and recurrent sick leave. *Spine* 2005;30(9):1086-92.

Abstract

Study design. Prospective cohort study with one year follow up

Objectives. The purpose of this study is to describe the improvement in several health outcomes during sick leave due to musculoskeletal disorders in the first months after return to work, and to evaluate the personal and work-related factors associated with these health outcomes, in order to provide some insight in the timing of return to work (RTW).

Summary of Background data. Although improvements in pain perception and functional disability appear to be associated with time of RTW, little is known about the required improvement enabling RTW, the additional health improvement after RTW, and whether the health status at the time of RTW is associated with the probability of a recurrence of sick leave.

Methods. Workers were included when on sickness absence between 2 to 6 weeks due to musculoskeletal disorders. Self-administered questionnaires at baseline, after RTW, and at 12 months follow up were used to collect information on changes in symptom status, functional status, and general health.

Results. All health outcomes were improved significantly at time of RTW, whereas perceived pain, functional disability, and physical health also improved significantly in the first months after return to work. Previous sick leave 12 months before study entry was significantly associated with the level of functional disability and general health at time of RTW and also predictive for recurrence of sickness absence. Personal and work-related factors showed little if any association with health status at RTW and improvement thereafter.

Conclusion. Being fully recovered is not a stipulation for regaining work activities. We hypothesize that workers with musculoskeletal disorders may need additional medical guidance shortly after RTW, especially those with a history of sick leave.

Introduction

Musculoskeletal disorders (MSD) are common health problems in working populations, sometimes resulting in sickness absence. The majority of workers on sick leave due to MSD will return to work within six weeks. However, the workers remaining off work after 2-3 months have a substantial risk for long-term disability and are known to be responsible for the majority of the associated health care costs[1, 2]. Identifying those workers on sickness absence who are at risk for a prolonged period of sickness absence is, therefore, essential for intervention purposes directed at early return to work. Hence, many studies have addressed prognostic factors for duration of sickness absence due to MSD[3]. High initial pain intensity, functional disability, and worse general health have been established as important prognostic factors for duration of sickness absence due to musculoskeletal disorders[3, 4]. However, it has also been shown that many subjects who returned to work were not fully recovered from their initial complaints[5-7]. It has been suggested that after return to work (RTW) residual functional disability should be addressed in workplace-based intervention programmes[5, 6].

This brings attention to the aspect of the timing of initiating return to work[8]. Although improvements in pain perception and functional disability appear to be associated with time of RTW[4, 9-11], little is known about the required improvement enabling RTW, the additional health improvement after RTW, and whether the health status at the time of RTW is associated with the probability of a recurrence of sick leave. Furthermore, it is unclear to what extent the health status at the time of RTW is determined by personal and work-related factors that, in turn, may predict the likelihood of recurrence. The scientific literature provides a few treatment process variables such as pain intensity, functional disability, coping strategies, and beliefs about pain[11], but offers little insight in the course of health improvement in relation to the time of RTW and subsequently continuing recovery at work.

The purpose of this study is to describe the improvement in several health outcomes during sick leave due to MSD in the first months after return to work, and to evaluate some personal and work-related factors associated with these health outcomes, in order to provide some insight in the timing of RTW.

Methods

Subjects and study design

A longitudinal study with 12 months follow up was conducted, in which self-administered questionnaires were used at baseline, at return to work, and 12 months after the first day of sick leave. Subjects were enrolled in the study by occupational health physicians during their consults or selected from the absenteeism register of a large Dutch occupational health service. Potential participants were approached with a written informed consent and baseline questionnaire. Subjects were included ranged from April 2001 till January 2002.

For inclusion into the study a subject had to be on sick leave due to non-specific musculoskeletal complaints for 2 to 6 weeks, as registered by the occupational physician using the CAS code system[12]. Based on this initial diagnosis, subjects had to fill in a diagnosis specific questionnaire (i.e. low back, hip, knee, ankle/foot, neck/shoulder, or wrist/hand/elbow). Subjects were excluded when they suffered from specific underlying pathology, such as a fractured leg, discus prolaps, or carpal tunnel syndrome. These specific pathologies were identified and coded by the occupational physician using the CAS code system[12]. After signing an informed consent, subjects were sent the baseline questionnaire and when necessary, two reminders within three weeks. The dates of start and end of sick leave were obtained from the medical records of the occupational health service. Return to work was defined as returning on full duty in the original job. Subjects were sent a follow up questionnaire within the first two weeks of return to work and after 12 months of the initial sick leave date. Subjects who did not return to work within 12 months were not eligible for this study.

Contents of the questionnaires

The baseline questionnaire gathered information on personal factors, work-related factors, nature and severity of the musculoskeletal complaints, functional disability, and general health. The main personal factors obtained were age, gender, body mass index, marital status, education, and employment status[13].

Perceived physical workload was measured by using a 10-point numerical rating scale, with 0 as not strenuous at all and 10 as very strenuous[14]. For psychosocial factors at work the Job Content Questionnaire was used[15]. Within this model three domains can be distinguished; working demands (with 11 items) skill discretion (with 6 items), and decision authority (with 11 items). For each item a four-point scale was used between 0 (never) and 3 (always). Subsequently, a sum score by domain was calculated. The variable low job control combined skill discretion and decision authority. Workers at risk (high demands and low job control) were classified using the median scores on the working demands and job control sum scores.

Pain intensity was measured for the body part that represented the initial sick leave diagnosis. We used a 10 point numerical rating scale to determine the level of perceived pain[16]. Functional disability was assessed by the Roland Morris Disability Questionnaire for back complaints[17] and comparable questionnaires for other joints derived from the Roland Morris Questionnaire. For the latter purpose we changed the phrase 'because of my back' into 'because of my neck', 'because of my knee' etc. Furthermore, for use in neck, shoulder and elbow/wrist/ hand complaints six items concerning walking and standing were substituted by corresponding items from the physical dimension of the Sickness Impact Profile concerning disability due to upper extremity disorders[18]. The Sickness Impact Profile is a general health questionnaire which formed the basis for the Roland-Morris Disability Questionnaire for low back pain[17]. Finally, general health were measured by the SF-12[19] and the Euroqol-5d[20]. The SF12 is composed of twelve items covering eight dimensions of health-related quality of life, i.e. general health, physical functioning, role-physical, bodily pain, vitality, role-emotional, social functioning, and mental health. These items were summarised into a physical component summary (PCS12) and a mental component summary (MCS12)[21].

The EuroQol Questionnaire distinguishes five dimensions, i.e. mobility, self-care, daily activity, pain, and anxiety or depression. From these items a general health index was calculated[22], which was transformed to a 0 - 100 scale. In addition, the EuroQol questionnaire was also used to measure the general health by means of a thermometer (EQ-VAS) on a 0-100 scale[20].

The history of sick leave in the 12 months prior to inclusion and the recurrent sick leave during the follow-up were measured with questions on the frequency and duration of sick leave, derived from a questionnaire with high specificity and sensitivity for sickness absence due to back pain[23]. Chronic complaints in the 12 months prior to entry in the study referred to musculoskeletal complaints that were present almost every day with a minimal presence for at least 3 months.

With the second questionnaire, administered shortly after subjects had returned to work in their original job, and the third questionnaire at 12 months follow up we gathered again information on perceived pain, functional disability, and general health.

Data analysis

Improvement in perceived pain, functional disability, and general health was calculated as the absolute difference between baseline values and values at time of return to work, and between values at time of return to work and 12 months follow up since initial sick leave. A repeated measurement analysis was used to evaluate changes over time. To distinguish recovery till RTW and recovery after RTW, a contrast analysis was used between time of RTW and respectively baseline scores and scores at 12 month follow up.

In order to analyze the determinants of the health status at baseline, time of RTW, and 12 months follow up we conducted multiple regression analyses on all health outcomes at their concomitant time window with personal factors (age, gender), work-related factors (perceived physical and psychosocial workload, worked hours per week), and diagnosis group (low back and other MSD) as explanatory variables. In the analysis at time of RTW and 12 months follow-up the health outcomes at, respectively, baseline and at time of RTW, and duration of sickness absence were incorporated in the model. Additionally, in the analysis at RTW the history of sick leave due to MSD was incorporated, whereas in the analysis at 12 months follow up recurrent sick leave during the follow-up was included. A linear regression model was created in order to evaluate the influence of the health outcome in the previous measurement, duration of sickness absence, and personal and work-related co-variates. The regression coefficient (β) of a particular factor indicates the change in health outcome due to an increase of 1 unit of this factor. For this model the R-square was calculated as measure of the strength of the model, i.e. the explained variance for that particular health outcome.

Subsequently, we analysed whether there was a difference in health status at time of RTW between workers with recurrent sickness absence(s) during their follow up and those without. Recurrence was defined as at least one new episode of sickness absence due to the initial MSD during the follow-up period after RTW.

The multiple regression analyses and ANOVA with repeated measurements were conducted by using the GLM procedure in SAS version 8.0[24, 25]. The significance level was set at a p-value of ≤ 0.05.

Results

Study population

In total, occupational physicians directly included 140 subjects and 307 subjects were selected from the administration of absenteeism. Of the latter group, 59% (n=181) agreed to participate in the study. Of the 321 subjects willing to participate, 287 returned the baseline questionnaire (response 89%). For the final sample 253 subjects remained, because 34 subjects had already returned to work fully before completing the baseline questionnaire. From the 253 subjects, 232 (91%) returned to work fully within the 12 months follow up period. An overview of the characteristics of these subjects is given in table 1. Of the 21 workers that did not return to full duty within 12 months 50% had LBP. In this sample of 232 subjects, 204 returned the questionnaire at time of return to work (response 88%), 196 returned the 12 months follow up questionnaire (response 84%), and 184 subjects had filled out all three questionnaires (response 79%). The characteristics of the non-respondents on the second and third questionnaire did not differ at baseline from the respondents.

Table 1. Population characteristics of the workers that returned to work after a sickness absence due to musculoskeletal disorders

		Included from Absenteeism register (n=111)	**Included by Occupational physician (n=121)**
Diagnosis group:	LBP	55 (50%)	64 (52%)
	Other MSD	56 (50%)	58 (48%)
Gender	Male	81 (74%)	83 (68%)
	Female	29 (26%)	39 (32%)
Marital Status	Single	95 (86%)	101 (83%)
	Married	16 (14%)	21 (17%)
Education	Low	58 (52%)	70 (60%)
	Mid	42 (38%)	36 (31%)
	High	11 (10%)	10 (9%)
Age (mean (SD))		43.2 (9.2)	42.1 (9.1)
BMI (mean (SD))		27.1 (5.5)	25.7 (3.7)
Work history [mean (SD)]			
• Years in same function		14.5 (11.5)	13.5 (9.1)
• Years at current company		13.2 (10.2)	14.7 (10.4)
Working hours / week [mean (SD)]		38.4 (10.4)	35.1 (9.7)

The mean duration of sickness absence at time of inclusion in the study was 34±14 days. The median sickness absence duration for the 204 subjects was 84 days, ranging from 15 to 362 days. The median follow-up duration was 261 days ranging from 42 to 362. The mean age of the population in this study was 42±9 years, most subjects had a lower educational background (56%), and the majority was male (73%). Most subjects were on sickness absence due to low back pain (51%), followed by neck-shoulder pain (27%), upper extremity disorders (13%), and lower extremity disorders (9%). Of the 232 subjects that returned to work 74 (31%) reported chronic complaints at baseline.

Health status at time of return to work

Perceived pain, functional disability, and all general health measures were improved significantly at time of return to work (paired t-test, $p<0.001$), as shown in table 2. Perceived pain, functional disability, and physical health improved additionally after being returned to work ($p<0.001$).

Table 3 shows the associations of personal and work-related factors with the specific and generic health measures at baseline. Subjects with LBP reported less pain, more functional disability, and a poorer physical health at baseline than those with other MSD. Older workers reported more functional disability. A high perceived psychosocial workload was associated with a poorer mental health at baseline.

Table 2. Health outcomes at baseline, at RTW, and after 12 months follow-up among subjects with initial sick leave due to musculoskeletal complaints of 2-6 weeks (n=232).

	Baseline Mean (SD)	**RTW Mean (SD)**	**Follow up 12 months Mean (SD)**	**Absolute difference Mean (SD) Baseline versus RTW**	**Absolute difference Mean(SD) RTW versus 12 months follow up**
Perceived pain (0-10)[a]	6.3 (2.0)	4.5 (2.6)	3.8 (2.8)	1.7 (2.9)***	0.8 (2.9)***
Functional disability (0-24)[a]	12.3 (4.9)	7.0 (5.3)	5.5 (5.8)	5.3 (5.3)***	1.4 (4.1)***
Physical health (PCS12) (0-100)[b]	32.6 (7.0)	42.4 (9.2)	45.5 (9.9)	9.7 (10.4)***	2.6 (9.2)***
Mental health (MCS12)(0-100)[b]	49.5 (11.2)	53.1 (8.5)	53.2 (8.6)	3.7 (11.7)***	0.2 (9.4)
General health (EQ5d)(0-100)[b]	75.6 (14.9)	87.1 (9.5)	89.2 (11.1)	11.0 (15.6)***	1.5 (9.6)
General health (EQ-VAS)(0-100)[b]	59.0 (17.9)	73.0 (15.4)	74.8 (16.8)	13.5 (18.5)***	1.3 (14.6)

[1]= significant improvement; ***=$p \leq 0.001$;

[a]=higher score indicates higher exposure/worse health

[b]=higher score indicates lower exposure/better health

As illustrated in table 4, the baseline score of each health outcome was strongly associated with the health score at time of RTW. Duration of sickness absence was only significantly associated with general health, indicating a better perceived general health when sickness absence was prolonged. Older age showed a lower physical health and being female was associated with poorer perceived general health at RTW. Working fewer hours per week was associated with a better general health. A previous episode of sick leave, reported by 39%, resulted in a higher perceived pain and functional disability and a poorer general health at time of RTW. For example, the occurrence of previous sick leave resulted in a increase of 2.6 points on the functional disability scale (range 0 – 24) and more than 1 point on the pain scale (range 0 - 10)(see table 4). Personal and work-related factors showed little if any association with health status at RTW. The explained variance was highest for functional disability (31%) and general health (23%).

Table 3. Associations of personal and work-related factors with health outcomes at baseline among subjects with sick leave due to musculoskeletal complaints for 2-6 weeks (n=232).

	Natural units	Health outcome at Baseline (dependent variable)				
		Perceived Pain β (SE)	Functional disability β (SE)	Physical health β (SE)	Mental Health β (SE)	General health β (SE)
Age (years)	42.6 (± 9.2)	-0.004 (0.02)	0.09 (0.04)*	-0.04 (0.06)	-0.08 (0.09)	-0.24 (0.14)
Gender (%male)	71%	0.28 (0.37)	-0.66 (0.94)	-0.22 (1.39)	-0.90 (2.20)	-3.33 (3.49)
Working hours per week	36.7 (±10.1)	0.02 (0.02)	-0.04 (0.04)	0.04 (0.06)	-0.12 (0.10)	-0.01 (0.15)
Perceived physical workload (0-10)	6.9 (±2.0)	0.11 (0.07)	0.08 (0.17)	-0.10 (0.26)	0.35 (0.41)	1.86 (0.64)**
High psychosocial workload (1/0)	63 (28%)	-0.27 (0.31)	-0.25 (0.79)	-1.05 (1.20)	-4.74 (1.90)**	-1.18 (2.93)
LBP versus other MSD (1/0)	119 (51%)	-0.64 (0.27)*	2.55 (0.68)***	-2.19 (1.04)*	-1.37 (1.65)	-3.49 (2.53)
Sick leave prior 12 months (1/0)	91 (39%)	0.23 (0.28)	1.33 (0.70)	-2.64 (1.06)	-0.04 (1.68)	-2.43 (2.61)
Explained variance R^2		0.05	0.11**	0.05	0.05	0.07*

Significance level * = p≤0.05, ** =p≤0.01, *** =p≤0.001; WL=work load, MSD=musculoskeletal disorders, LBP=low back pain

Model: $Y_{health\ outcome}=\beta_1$ *(variable 1) + β_2 *(variable 2)+ β_i *(variable i).

The value and the sign of 'beta' indicate the effect of a change of 1 unit in the variable on the value of the health outcome.

Recurrence

In the follow up, with a median duration of 261 days, the recurrence of new sick leave episodes for the same musculoskeletal complaints was 30% (table 5). The recurrence rate (Expressed in person-days, i.e. total days of follow up of all workers) was 0.12 per 100 person-days in the follow-up, implying a recurrence rate of 44% over a period of 365 days. Those workers with a history of musculoskeletal sick leave in the 12 months before the initial sick leave had an almost threefold risk on recurrent sickness absence than those without (OR 2.7, 95%CI 1.5-5.1, p=0.002) and subjects with chronic complaints also had an increased risk on recurrent sickness absence (OR 2.0, 95% 1.0-3.8, p=0.04). The duration of the initial sick leave period for the non-recurrent group was significantly longer than in the recurrent group, respectively 118 and 91 days (F=5.37, p=0.02). Perceived pain, functional disability, physical health, and general health (EQ-VAS) at RTW were significantly poorer among workers with recurrent sick leaves during the follow-up (table 5).

Table 4. Associations of health outcomes at baseline, duration of sickness absence, personal factors and work-related factors with the health outcomes at time of return to work among subjects that fully returned to work after a sickness absence period due to musculoskeletal complaints (n=204)

	Health outcome at RTW (dependent variable)				
	Perceived Pain β (SE)	Functional disability β (SE)	Physical health β (SE)	Mental health β (SE)	General health β (SE)
Health outcome at baseline	0.24 (0.11)*	0.42 (0.08)***	0.36 (0.10)***	0.23 (0.06)***	0.32 (0.06)***
Duration of sickness absence	-0.004 (0.003)	-0.001 (0.005)	0.005 (0.01)	-0.003 (0.009)	0.04 (0.02)**
Age (years)	0.04 (0.02)	0.08 (0.04)	-0.20 (0.08)*	0.10 (0.07)	-0.16 (0.12)
Gender (male vs. female)	0.58 (0.60)	0.23 (1.05)	-2.83 (1.95)	0.42 (1.75)	-6.46 (3.07)*
Working hours per week	0.03 (0.03)	0.06 (0.05)	-0.09 (0.09)	-0.09 (0.08)	-0.37 (0.13)**
Perceived physical workload	0.12 (0.10)	0.26 (0.18)	-0.52 (0.34)	-0.45 (0.30)	0.26 (0.53)
High psychosocial workload	0.60 (0.48)	0.81 (0.83)	0.07 (1.57)	-1.21 (1.43)	-0.04 (2.40)
LBP versus other MSD	-0.44 (0.41)	0.08 (0.74)	1.04 (1.41)	-0.19 (1.25)	-0.56 (2.10)
Sick leave prior 12 months	1.06 (0.42)**	2.56 (0.76)**	-2.15 (1.43)	-2.16 (1.26)	-4.36 (2.16)*
Explained variance R^2	0.14*	0.31***	0.15**	0.17***	0.23***

Significance level * = p≤0.05, ** =p≤0.01, *** =p≤0.001; WL=workload, MSD=musculoskeletal disorders, LBP=low back pain

Model: $Y_{health\ outcome}=\beta_1$ *(health outcome at baseline) +β_2 *(duration of sickness absence)+ β_i *(co-variate i).

The value and the sign of 'beta' indicate the effect of a change of 1 unit in the variable on the value of the health outcome.

Table 5. Differences in health outcomes at time of RTW between workers with recurrent sick leave, and those without recurrent sick leave in the subsequent follow-up (n=184)

	Recurrent sick leave (n=55)	**Non-recurrent sick leave (n=129)**	
	Mean (SD)	Mean (SD)	F-value
Perceived pain (0-10)	5.6 (2.3)	4.1 (2.6)	12.5***
Functional disability (0-24)	9.6 (5.4)	5.9 (4.9)	20.0***
Physical health (0-100)	39.7 (8.2)	43.8 (9.2)	7.8**
Mental health (0-100)	51.4 (9.0)	54.2 (7.8)	4.4*
General health (EQ-VAS) (0-100)	67.3 (16.0)	76.0 (13.7)	14.0***

Significance level * = p≤0.05, ** =p≤0.01, *** =p≤0.001;

Workers with higher perceived pain and functional disability, and poorer physical health at RTW also experienced higher pain and disability, and poorer physical health at the end of the follow-up (table 6). In addition, recurrent sick leave due to MSD had a profound impact on perceived pain, functional disability and physical health at 12 months follow up. Older workers showed more perceived pain and functional disability whereas all work-related factors were not associated with health status at 12 months follow-up. The explained variance of the three health outcomes at 12 months follow-up varied between 27% and 60%.

Table 6. Associations of health outcomes at time of return to work, duration of sickness absence, personal factors and work-related factors with health outcomes at 12 months follow-up among subjects who fully returned to work after a sick leave period due to musculoskeletal complaints (n=184).

	Health outcome at 12 months (dependent variable)		
	Perceived Pain β (SE)	Functional disability β (SE)	Physical health β (SE)
Health outcome at RTW	0.30 (0.08)***	0.69 (0.06)***	0.51 (0.08)***
Duration of sickness absence	0.004 (0.003)	0.008 (0.004)	-0.01 (0.01)
Age (years)	0.05 (0.02)*	0.07 (0.04)*	-0.07 (0.08)
Gender (male vs. female)	0.89 (0.58)	1.46 (0.86)	-0.84 (1.99)
Working hours per week	0.01 (0.03)	0.05 (0.04)	-0.09 (0.08)
Perceived physical workload (0-10)	0.04 (0.10)	-0.11 (0.14)	0.39 (0.33)
High psychosocial workload (1/0)	1.22 (0.46)**	0.58 (0.68)	0.16 (1.59)
LBP versus other MSD (1/0)	0.15 (0.39)	-0.05 (0.59)	0.54 (1.35)
Recurrent sick leave during follow up (1/0)	1.42 (0.45)**	2.75 (0.70)***	-6.66 (1.56)***
Explained variance R^2	0.27***	0.60***	0.38***

Significance level * = $p \leq 0.05$, ** = $p \leq 0.01$, *** = $p \leq 0.001$; MSD=musculoskeletal disorders, LBP=low back pain

Model: $Y_{\text{health outcome}} = \beta_1$ *(health outcome at RTW) $+ \beta_2$ *(duration of sickness absence)+ β_i *(co-variate i).

The value and the sign of 'beta' indicate the effect of achange of 1 unit in the variable on the value of the health outcome.

Discussion

Our study clearly demonstrated that returning to work after significant improvement in health is not synonymous with being fully recovered from a MSD. An additional improvement was seen for pain, functional disability, and physical health in the first months after return to work. Workers with recurrent sick leave already had a poorer health status at RTW and also a poorer health status at 12 months follow-up. We could not detect the characteristics of the group of workers with recurrent sick leave, because personal factors and work-related factors showed little if any association with health status at RTW. However, previous sick leave in the 12 months before study entry was significantly associated with the level of pain, functional disability and general health at time of RTW and also predictive for recurrence of sick leave.

Limitations of the study

Approximately 59% of the workers on 2-6 weeks of sick leave that were selected from the administration of absenteeism of a large Dutch work health service responded on our request for participation in the study. Unfortunately, due to the inclusion method and concomitant privacy aspects, we were not allowed to gather more information than necessary for recruitment of potential participants. Hence we were not able to describe the non-participants. Most of the workers on sick leave due to musculoskeletal disorders return to work within the first weeks of sickness absence[1]. Hence, the low response can partly be explained by the fact that subjects had already returned to work when receiving our invitation to participate in this study. Furthermore, the participants were required to be still off work when filling out the questionnaire. No differences in baseline characteristics among subjects were found, whether included by the occupational physician or selected from the absenteeism register.

Our study described the natural course of improvement in health status directly related to the time of RTW, without the aim of finding all relevant factors contributing to return to work. Due to the time lag between date of RTW and date of filling out the second questionnaire of approximately 30 days, the observed improvement after RTW would have been larger with a measurement more closely to the exact date of RTW. For a better insight into the course of improvement more measurements in time are desirable. We only measured the health outcomes twice in the time window between baseline till return to work. Hence, nothing can be said about the course of the improvement being linear or non-linear.

In this study we eliminated those workers that did not return to work within 12 months follow-up because no information on health status at RTW was available. Hence, it remains unclear how this might influence the association of patient characteristics and work related factors on heath status over time.

Readiness of RTW

Our data clearly confirmed the suggestion made by other authors that fully returning to work not necessarily implicates full recovery from a musculoskeletal disorder[5-8]. Especially perceived pain, functional disability, and physical health improved significantly in the first months after regaining work activities. Some studies have mentioned improvement in functional disability[9, 10] and decrease in pain intensity over 4 weeks to be decisive for RTW[4]. However, in all these studies improvements on health outcomes were not directly linked to the time of RTW, because measurements were done at fixed time intervals and not immediately after time of RTW. Our findings on perceived general health may suggest that workers tend to wait till a certain health status is reached before returning to work fully. However, for the specific health outcomes such as perceived pain and functional disability this association with the duration of sickness absence was not found. Return to work is probably more prompted by a relative improvement for these specific health outcomes, given the strong association with the baseline scores and the ongoing improvement in the follow up. This suggests that the large differences in perceived health outcomes can be seen as a reflection of a workers' experience with the disorder[26]. Hence, to define a fixed cut off of these measures as a way to indicate readiness for RTW is probably not useful.

The health outcomes at 12 months follow up, that showed additional improvement after RTW, were strongly influenced by recurrent sick leave due to the initial MSD. The estimated recurrence rate of 0.12 per 100 person-days was higher than in earlier studies[27-29], but similar to the recurrence rate of 44% of sickness absence due to low back pain among industrial workers who completed a 1 year follow-up[30]. We found that the group of workers with relapse of work absence had poorer levels of health at time of RTW.

It was somewhat surprising that most personal factors or work-related factors were not associated with the health status at baseline, at time of RTW, and at 12 months follow-up. Although high perceived physical workload may cause sickness absence and subsequently may determine duration of sickness absence[3], our results indicated that this factor probably does not play a role in determining one's health. Although older workers tended to perceive more functional disability than younger ones, we were not able to discriminate between health status of those workers who encountered recurrent sick leave, and workers who regained their work activities without experiencing any problem during the follow up. It has been shown that personal beliefs about having a MSD, the attitude of coping with the problem, and also economic incentives will influence the return to full duty[8, 11, 31, 32]. Since our study focussed on the particular role of improvement in health and disability in RTW, we do not have information on these important barriers for RTW. However, a previous history of sick leave was associated with a poorer outcome on functional disability and general health. Furthermore, a poorer health status at time of RTW and chronic complaints at start of the sick leave period put the workers at risk for a recurrent sickness absence. In this respect it might be reasoned that "being better" is not only reflected in changes in the state of the disorder but also in an adjustment of life to work around the disorder (readjustment) or an adaptation to living with the disorder (redefinition)[26]. We hypothesize that workers with musculoskeletal disorders who have returned to work full duty, especially those with previous episodes of sick leave, may require additional guidance in order to further improve their physical health and functional capabilities.

Conclusions

Health status at time of RTW, and subsequently at 12 months follow up after initial sick leave indicated that being fully recovered is not a stipulation for regaining work activities. Although older workers tended to show more functional disability, personal and work-related factors were not associated with the health status at RTW and 12 months follow up. However, previous sick leave in the 12 months before study entry was significantly associated with the level of functional disability and general health at time of RTW and also predictive for recurrence of sickness absence. Moreover, subjects with chronic complaints at baseline put workers at risk for recurrent sick leave after a sickness absence period due to MSD.

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8.

REDUCED PRODUCTIVITY AFTER SICKNESS ABSENCE DUE TO MUSCULOSKELETAL DISORDERS AND ITS RELATION TO HEALTH OUTCOMES

Adapted from:
Lötters F, Meerding WJ, Burdorf A. Reduced productivity after sickness absence due to musculoskeletal disorders and its relation to health outcomes. *Scand J Work Environ Health* 2005;(in press).

Abstract

Objectives. The aim of this prospective cohort study is to quantify reduced productivity of workers on full duty after a sickness absence period due to musculoskeletal disorders (MSD), and to determine how reduced productivity is affected by health parameters such as perceived pain, functional disability, and general health.

Methods. Workers were included when on sickness absence between 2 to 6 weeks due to musculoskeletal disorders. Self-administered questionnaires at baseline, after return to work (RTW), and at 12 months follow up were used to collect information on productivity and health status. Logistic regression analyses were used to evaluate the determinants for reduced productivity and to determine the level of productivity loss shortly after RTW.

Results. Reduced productivity was prevalent in 60% of the workers after RTW and in 40% at 12 months follow-up. The initial MSD causing the prior sick leave was the cause for 75% of the subjects to report productivity loss shortly after RTW and for 60% at follow-up. Among those with self-reported productivity loss the median productivity loss on an 8-hour working day due to MSD was 1.6 hours a day shortly after RTW and also at 12 months follow up. A worse physical health, more functional disability, and a poorer relation with the supervisor were associated with the presence of productivity loss shortly after RTW, whereas recurrent sick leave was the most profound predictor for productivity loss at 12 months follow up.

Conclusion. Reduced productivity was highly prevalent among workers who returned to full duty after a sickness absence due to MSD. The occurrence of productivity loss illustrates the importance of timing of RTW, especially among those workers with residual functional disability after RTW. Moreover, our data indicated that the supervisor should be engaged early in the RTW process, to guarantee an early, sustainable, and productive RTW of his employee.

Introduction

Musculoskeletal disorders (MSD) are well recognised as a major public health problem with substantial human and economic costs[1, 2]. In the general Dutch population the 12 months prevalence for MSD has been estimated to be around 75% of which 44% was due to low back pain and 45% to neck/shoulder complaints[3]. These high prevalences lead to substantial costs, such as hospital care, general practice costs, and paramedical costs. These direct costs were estimated as 7.3% of the allocated health care costs in The Netherlands, thereby being one of most expensive health areas[4]. In addition, indirect costs due to sickness absence and work disability are substantial since MSD accounted for 31% of the total costs of long-term work disability.

However, aforementioned aspects on direct and indirect costs do not cover the full burden of MSD, because a health problem might also affect work ability, causing reduced productivity while still on the job, i.e. sickness presenteeism[5-7]. Hence, both absenteeism and presenteeism should be taken into consideration when calculating indirect costs due to MSD. In a study among the Swedish workforce approximately one third of all workers reported that they had gone to work twice or more during the preceding year, despite the feeling that, in the light of their perceived health status, they should have taken sick leave[6]. Brouwer et al. found that on an average workday over 7% of the workers indicated to experience health problems while being at work, resulting in an estimated productivity loss of 10% of the working hours[5]. In a study among telephone customer-service employees 32% failed to meet the productivity standard due to health problems, resulting in a loss productivity time of almost 4 hours per week[7].

Little information is available on productivity loss due to MSD. Hagberg et al. determined reduced productivity in computer users due to neck/shoulder or upper extremity disorders and observed a productivity loss of approximately 4 hours per week for 10% of the workers with a neck/shoulder or upper extremity disorder[8]. In an extensive study among over 28.000 workers a productivity loss of approximately 4 hours per week was found in 8% of the workers with MSD[9]. Furthermore, it is known that many workers who have returned to full duty work still report some functional limitations due to the initial MSD[10, 11]. Evanoff et al. found that despite 83% of the cohort with initial sick leave due to MSD worked full duty at 6 months follow up, 24% of these workers reported that they considered themselves to be still disabled by their MSD[10]. These findings suggest that residual disability might lead to productivity loss, and hence, that indirect costs of MSD may continue after return to work (RTW). However, little is known about reduced productivity after a sickness absence period due to MSD and, subsequently, about the health parameters that determine this reduced productivity.

Hence, the aim of this study is to quantify reduced productivity of workers on full duty after a sickness absence period due to MSD, and to determine how reduced productivity is affected by health parameters such as perceived pain, functional disability, and general health.

Methods

Subjects & study design

A longitudinal study with 12 months follow-up was conducted, in which self-administered questionnaires were used at baseline, at return to work, and 12 months after the first day of sick leave. Subjects were enrolled in the study by selected from the absenteeism register of a large Dutch occupational health service or by the occupational health physicians during their consults. For inclusion into the study via the absenteeism register the researcher selected those subjects who were on sick leave due to non-specific musculoskeletal complaints for 2 to 6 weeks, as registered by the occupational physician using the CAS code system[12]. In the second inclusion method the occupational health physician was asked to include all workers with non-specific musculoskeletal disorders who attended his/her consulting hour. Subjects were excluded when they suffered from specific underlying pathology, such as a fractured leg, prolapsed intervertebral disc, or carpal tunnel syndrome. These specific pathologies were identified and coded by the occupational physician using the CAS code system[12]. Based on the initial diagnosis, subjects had to fill in a diagnosis specific questionnaire (i.e. low back, hip, knee, ankle/foot, neck/shoulder, or wrist/hand/elbow). After signing an informed consent, subjects were sent the baseline questionnaire and if necessary, two reminders within three weeks. The dates of start and end of sick leave were obtained from the medical records of the occupational health service. Return to work was defined as returning on full duty in the original job. Subjects were sent a follow up questionnaire within the first two weeks of return to work and after 12 months of the first day of sick leave. Subjects who did not return to work within 12 months were not eligible for this study.

Contents of the questionnaires

The baseline questionnaire gathered information on personal factors, work related factors, nature and severity of the musculoskeletal disorders, functional disability, and general health. The main individual characteristics obtained were age, gender, body mass index, marital status, education, and employment status[13].

Perceived physical workload was measured by using a 10-point numerical rating scale, with 0 as not strenuous at all and 10 as very strenuous[14]. For psychosocial factors at work the Job Content Questionnaire was used[15]. Within this model three dimensions can be distinguished; work demands (11 items) skill discretion (6 items), and decision authority (11 items). For each item a four-point scale was used between 0 (never) and 3 (always). Subsequently, a sum score by dimension was calculated. A 10-point numerical scale was used to determine the relation with colleagues and supervisors, with 0 'don't get along well at all', and 10 'get along very well'[14].

We used a 10 point numerical rating scale to determine the level of perceived pain, with 0 'no pain at all' and 10 'as worse as it can get'[16]. Pain intensity was measured for the body part that represented the initial sick leave diagnosis. Functional disability was assessed by the Roland Morris Disability Questionnaire for back complaints[17] and comparable questionnaires for other joints derived from the Roland Morris Questionnaire. For the latter purpose we changed the phrase 'because of my back' into 'because of my neck', 'because of my knee' etc. Furthermore, for use in neck, shoulder and elbow/wrist/ hand complaints 6 items concerning walking and standing were substituted by corresponding items from the physical dimension of the Sickness Impact Profile concerning disability due to upper extremity disorders[18]. The Sickness Impact Profile is a general health questionnaire which formed the basis for the Roland-Morris Disability Questionnaire for low back pain[17].

Finally, general health was measured by the SF-12[19] and the Euroqol-5d[20]. The SF-12 consists of 8 dimensions, i.e. general health, physical functioning, role-physical, bodily pain, vitality, role-emotional, social functioning, and mental health. These dimensions were summarized into a physical component summary (PCS12) and a mental component summary (MCS12)[21]. The EuroQol Questionnaire distinguishes five dimensions, i.e. mobility, self-care, daily activity, pain, and anxiety or depression. From these items a general health index was calculated[22], which was transformed to a 0 - 100 scale. In addition, the EuroQol questionnaire was also used to measure general health by means of a thermometer (EQ-VAS) on a 0 - 100 scale[20].

With the second questionnaire, administered shortly after subjects had returned to work in their original job, and the third questionnaire at 12 months follow up, we gathered again information on perceived pain, functional disability, and general health. In both questionnaires productivity after return to work was measured, using the Quantity scale of the method described by Brouwer et al[23]. The respondents were asked how much work they actually performed during regular hours on the most recent workday compared with a normal workday, using a 11-point numerical scale with 0 presenting "nothing" and 10 representing "normal quantity". For the quantity loss the score was normalised to the number of working hours per day with the formula: Q_T = ((10-quantity score)/10)*working hours per day[23]. In addition, we asked for the reason of self reported productivity loss. Reasons were classified as: the initial MSD causing the prior sick leave period, other health problems, work-related problems such as equipment failure, and miscellaneous reasons.

Data analysis

For reasons of comparability, only those subjects were included in the analysis who filled out both the RTW questionnaire and 12 months follow up questionnaire. Since we were interested in productivity loss after RTW due to MSD, we distinguished those subjects that reported the initial MSD to be the reason for their productivity loss from those that did not report productivity loss due to MSD.

The prevalence of productivity loss due to MSD was determined by all subjects reporting less than normal productivity (score <10) due to MSD. The level of productivity loss shortly after RTW was calculated for those workers who reported lost work time due to MSD. The median productivity loss was used to dichotomise productivity into high and low productivity loss. Risk factors for the occurrence of productivity loss and the determinants of the high versus low productivity loss were derived through stepwise backward logistic regression. In both analyses perceived pain, functional disability, physical health, mental health, general health (EQ-VAS), low back pain (LBP) or other MSD, duration of prior sickness absence period, perceived physical workload, perceived psychosocial workload, relation with colleagues, and relation with supervisors were the independent variables. In these analyses two models were built, one model with the baseline values of the health variables and subsequently a model with the cross-sectional measured values of these variables. All results were adjusted for age and gender, independent of their significance.

A third analysis was performed to determine whether a recurrent sickness absence period during the follow up influenced the self-reported reduced productivity at the end of follow-up and, retrospectively, shortly after RTW. A recurrent sickness absence period was defined as at least one sick leave period due to the same MSD causing the initial sickness absence.

Results

Study population

In total, the occupational physicians included 140 subjects, and 307 subjects were selected from the administration of absenteeism. Of the latter group, 59% (n=181) agreed to participate in the study. Of the 321 subjects willing to participate, 287 returned the baseline questionnaire (response 89%). For the final sample 253 subjects remained, because 34 subjects had already returned to work fully before completing the baseline questionnaire. From the 253 subjects, 232 (91%) returned to work fully within the 12 months follow up period. In this sample of 232 subjects, 204 returned the questionnaire at time of return to work (response 88%), 196 returned the 12 months follow up questionnaire (response 84%), and 184 subjects had filled out all three questionnaires (response 79%).

The mean duration of sickness absence at time of response on the baseline questionnaire was 34±14 days. The median sickness absence duration for the 204 subjects with RTW was 84 days, ranging from 15 to 362 days. The median follow-up duration after RTW was 261 days ranging from 42 to 362 days. Most of the respondents were blue-collar workers, from a wide range of industrial settings. Another substantial part of the subjects worked in the health care sector. The mean age of the subjects was 43±9 years, most subjects had a lower educational background (56%), and the majority was male (73%). Most subjects were on sickness absence due to low back pain (51%), followed by neck-shoulder pain (27%), upper extremity disorders (13%), and lower extremity disorders (9%).

Table 1. Prevalence of productivity loss and average productivity loss due to musculoskeletal disorders among those workers with lost work time who returned to work after a sickness absence period due to MSD (n=184).

		Productivity loss (in hours per day)			
	Prevalence	Median	Range	Geometric Mean	Geometric SD
Shortly after RTW	83 (45%)	1.6	0.6 – 5.3	1.7	1.8
At 12 months follow-up	44 (24%)	1.6	0.8 – 6.0	1.7	1.8

Productivity and health parameters

Shortly after RTW 111 subjects (60%) showed a loss in amount of work done on a regular working day, of which 83 (75%) reported production loss due to MSD. These numbers were 73 (40%) and 44 (60%) at 12 months follow up, respectively. Of the subjects who reported reduced productivity due to MSD shortly after RTW, 67% did not report productivity loss due to MSD at 12 months follow-up. Furthermore, the occurrence of productivity loss due to MSD at 12 months follow-up was significantly lower than shortly after RTW (χ^2=6.17, p=0.01). The median productivity loss shortly after RTW and at 12 months follow-up for those workers who reported lost work time due to MSD was 1.6 hours per day (table 1). Productivity loss at 12 months occurred significantly more in those workers with recurrent sick leave during the follow up period (χ^2=11.30, p=0.001). Retrospectively, 58% of the workers that showed recurrent sick leave had productivity loss shortly after RTW (χ^2=5,09, p=0.02).

Table 2. Risk factors for occurrence of reduced productivity due to MSD after RTW and 12 months follow up (n=184).

	Productivity loss shortly after RTW OR (95% CI)		**Productivity loss after 12 months follow up OR (95% CI)**	
Variables	Health variables at baseline	Health variables shortly after RTW	Health variables shortly after RTW	Health variables at 12 months follow-up
Age (years)	1.0 (0.96 – 1.04)	0.97 (0.93 – 1.01)	0.98 (0.93 – 1.03)	0.96 (0.92 – 1.02)
Gender (male vs. female)	1.31 (0.96 – 1.04)	1.02 (0.42 – 2.47)	0.79 (0.31 – 2.02)	0.88 (0.32 – 2.39)
MSD (LBP versus other)	0.63 (0.62 – 2.77)	0.63 (0.29 – 1.38)	0.61 (0.27 – 1.37)	0.49 (0.19 – 1.26)
Perceived physical workload (0-10)	1.05 (0.89 – 1.24)	0.97 (0.79 – 1.19)	0.98 (0.79 – 1.23)	1.19 (0.93 – 1.52)
Psycho-social work load (1/0)	0.64 (0.29 – 1.41)	0.56 (0.24 – 1.31)	1.45 (0.62 – 3.42)	1.72 (0.60 – 4.94)
Relation with colleagues (0-10)	1.24 (0.95 – 1.60)	1.15 (0.83 – 1.58)	1.13 (0.82 – 1.57)	1.28 (0.95 – 1.72)
Relation with supervisor (0-10)	0.83 (0.69 – 0.99)*	0.76 (0.60 – 0.95)**	0.90 (0.71 – 1.14)	0.86 (0.67 – 1.11)
Perceived pain (0-10)	1.08 (0.88 – 1.32)	1.01 (0.84 – 1.22)	0.92 (0.74 – 1.14)	0.96 (0.75 – 1.22)
Functional disability (0-24)	0.93 (0.86 – 1.02)	1.11 (1.02 – 1.22)*	1.07 (0.97 – 1.18)	1.24 (1.14 – 1.35)***
Physical health (0-100)	0.96 (0.92 – 1.01)	0.92 (0.87 – 0.97)**	0.93 (0.89 – 0.98)**	0.96 (0.91 – 1.01)$^{+}$
Mental health (0-100)	0.97 (0.94 – 0.99)*	0.97 (0.93 – 1.02)	0.97 (0.93 – 1.02)	1.04 (0.99 – 1.01)
Sickness absence period (days)	1.0 (0.99 – 1.00)	1.0 (0.93 – 1.00)	1.0 (0.93 – 1.00)	1.0 (0.99 – 1.01)
Recurrent sick leave (1/0)	----	----	2.63 (1.18 – 5.88)*	1.48 (0.55 – 4.00)
Explained variance of the final model	7%	26%	11%	21%

*p≤0.05, **p≤0.01, ***p≤0.001; $^{+}$= p≤0.10 (when excluded from the model);
Age and gender were forced in the model. Values of non-significant variables were derived when dropped from the model.

A one-point increase at the functional disability scale, measured cross-sectionally, increased the odds ratio for reduced productivity due to MSD shortly after RTW by 11% and after 12 months follow-up by 24% (table 2). A one-point increase in physical health decreased the odds ratio for productivity loss due to MSD shortly after RTW with 9%. A better relation with supervisors was associated with a decrease in the prevalence of reduced productivity due to MSD shortly after RTW (table 2). Recurrent sick leave during the follow up period was highly predictive for the occurrence of productivity loss at 12 months follow up (OR 2.63, 95%CI 1.18 – 5.88). The explained variances on occurrence of productivity loss shortly after RTW and after 12 months follow-up were higher in the cross-sectional analyses (26% and 21% respectively) than in the longitudinal analyses (7% and 11%, respectively).

None of the health variables measured at baseline contributed significantly in predicting the level of productivity loss shortly after RTW. When measured cross-sectionally only the level of perceived pain was significantly associated with the level of productivity loss Although not statistically significant, having an upper extremity disorder appeared to be associated more with the level of productivity loss than low back pain (table 3).

Table 3. Determinants of the level of reduced productivity loss shortly after RTW among those with lost work time due to MSD (n=83). (outcome = productivity loss>1.6 hours per day)

	Health variables at baseline OR (95% CI)	**Health variables shortly after RTW OR (95% CI)**
Age (years)	1.0 (0.94 – 1.05)	0.99 (0.93 – 1.06)
Gender (male vs. female)	1.07 (0.38 – 3.03)	0.70 (0.22 – 2.18)
MSD (LBP versus other)	0.43 (0.16 – 1.14)$^{+}$	0.54 (0.18 – 1.69)
Perceived physical workload (0-10)	0.91 (0.69 – 1.18)	0.89 (0.67 – 1.18)
Psycho-social work load (1/0)	1.28 (0.30 – 5.35)	1.47 (0.36 – 5.90)
Relation with colleagues (0-10)	0.83 (0.49 – 1.41)	0.85 (0.49 – 1.46)
Relation with supervisor (0-10)	0.81 (0.60 – 1.11)	0.76 (0.55 – 1.06)$^{+}$
Perceived pain (0-10)	1.17 (0.79 – 1.73)	1.43 (1.01 – 1.86)**
Functional disability (0-24)	1.12 (0.99 – 1.26)$^{+}$	1.00 (0.84 – 1.17)
Physical health (0-100)	1.05 (0.94 – 1.17)	0.99 (0.91 – 1.08)
Mental health (0-100)	0.97 (0.93 – 1.02)	1.02 (0.96 – 1.08)
Sickness absence period (days)	0.99 (0.99 – 1.00)	1.00 (0.99 – 1.01)
Explained variance of the final model	0.1%	11%

$^{**}p \leq 0.01$; $^{+}= p \leq 0.10$ (when excluded from the model)

Age and gender were forced in the model. Values of non-significant variables were derived when dropped from the model

Discussion

Reduced productivity was found to be prevalent in 60% of the workers after RTW and in 40% at 12 months follow up. The initial MSD causing the prior sick leave was the cause for 75% of the subjects to report productivity loss at time of RTW and for 60% at 12 months follow-up. Among those with self-reported productivity loss the median productivity loss on an 8-hour working day due to MSD was 1.6 hours shortly after RTW and also at 12 months follow up. A worse physical health, more functional disability, and a poorer relation with the supervisor were associated with the presence of productivity loss shortly after RTW, whereas recurrent sick leave was the most profound predictor for productivity loss at 12 months follow-up.

Reduced productivity after RTW

Our study confirmed previous findings that remaining at work while being impaired by a health problem may result in a decrease in performance, as measured by reduced productivity[7-9, 23]. The one study where reduced productivity was measured shortly after return to work showed that about 20% of the workers experienced reduced productivity due to their health problems with an average productivity loss of approximately 7%[5]. However, the mean duration of sickness absence in this study was 4.0 days, whereas in our study we included only workers who already were on sick leave for at 2 to 6 weeks, and had a median sick leave of 84 days. This selection is probably the reason for the higher productivity loss found in the present study. Brouwer et al. estimated that the average period of reduced performance for those workers returning to work after a period of sickness absence was approximately 13 days[23]. In our study we still found a reduced performance after 30 days, i.e. the average lap time between time of RTW and filling out the second questionnaire. In our population of workers returned to work after a sickness absence period due to MSD, we observed higher prevalences of reduced productivity due to MSD than in cross-sectional studies among all workers in a workforce[8, 9]. Productivity loss shortly after RTW was associated with physical health and functional disability, indicating that residual disability among subjects who returned to work is important due to its effects on health and work productivity[10, 11, 24, 25].

A remarkable finding in this study is the strong association of the relation with the supervisor and productivity loss shortly after RTW. A one-point decrease on the relationship scale raised the odds of productivity loss with approximately 25 %. Moreover, a worse relationship with the supervisor measured at baseline was predictive for productivity loss to occur shortly after RTW. Although not statistically significant, a better relationship with one's supervisor was also associated with a low level of productivity loss in those workers with lost work time. These findings stress the fact that a supervisor should be engaged in the RTW process of his employee in order to guarantee an early and sustainable RTW. Recent studies have already emphasised the necessity of such occupational management strategies at the work place in bringing the worker back to work in a more efficient way[26, 27].

Health outcomes and reduced productivity

Data on reduced productivity measured shortly after RTW and the concomitant health status are scarce. In their review Loeppke et al. reported an association of the SF12-questionnaire with productivity loss[28]. Previous studies have shown that a poorer mental health status was associated with more productivity loss[7, 29]. This is in agreement with our finding that the mental health status was predictive for the occurrence of productivity loss shortly after RTW. However, in our study a poorer physical health status had a more profound impact on productivity loss. This is due the fact that we specifically studied workers on sick leave due to MSD, thereby expecting more physical than mental problems. A study conducted among workers suffering from upper extremity disorders showed that a greater persistence of pain was associated with a higher prevalence of productivity loss and a greater magnitude of productivity loss[8]. The latter is in agreement with our finding that higher perceived pain intensity and having an upper extremity disorder were associated with more productivity loss.

Since productivity loss after RTW was strongly associated with functional disability and physical health, and the fact that these health outcomes improved progressively in the first months after RTW[25], the present findings indicate that productivity loss occurred primarily among those workers whose recovery is still progressing during the follow up. Additional analysis confirmed that 60% of the workers with a large improvement in physical health showed a significant productivity loss compared to those workers (33%) who showed no or minor improvement in physical health after having returned to work (χ^2 = 13.8; p=0.0002). For functional limitations these numbers were respectively 59% and 35% (χ^2 = 10.4; p=0.001). In a large study of sickness presenteeism, Aronsson et al. questioned whether there is a risk that the sickness presenteeism of today will become the sickness absenteeism of tomorrow[6]. Retrospectively, we observed a strong association between recurrent sick leave and productivity loss shortly after RTW, indicating that indeed sickness presenteeism increased the risk of future sickness absenteeism. Although one could argue that returning to work in a lower productivity state is better than prolonging the sickness absence period and not being productive at all, the concomitant risk of recurrent sick leave suggests that timing of initiating RTW is important.

The economic consequences of our findings can be illustrated by the following example. Suppose, a worker with reduced productivity due to MSD of approximately 20% on an eight hour workday (as observed in the present study), with an average annual salary for a Dutch worker of €33.000 (including 32% employer costs)[30], and a duration of reduced productivity of 1 month after RTW. The yearly based working hours (without vacation hours, and non working hours due to festivity days) is 1650. This presenteeism will incur productivity losses amounting to €550,- per worker per month after RTW (€2750*0,2), which roughly equals the costs of a sick leave period of 3,5 workdays (€550 per month / €160 per normal workday). However, the real costs of presenteeism are difficult to access since colleagues might compensate a declined work performance, which reduces the associated costs of productivity loss[31]. Moreover, we were unable to determine, whether a good worker – supervisor relationship, as observed in this study, has increased the likelihood of performing modified work, and, as a consequence, may have resulted in a lower perceived productivity loss.

Limitations of the study

Approximately 59% of the workers on 2-6 weeks sick leave that were selected from the administration of absenteeism of a large Dutch work health service responded to our request for participation in the study. Unfortunately, due to the inclusion method and concomitant privacy aspects, we were not allowed to gather more information than necessary for recruitment of potential participants. Hence we were not able to describe the non-participants. Most of the workers on sick leave due to musculoskeletal disorders return to work within the first weeks of sickness absence[32]. Hence, the low response can partly be explained by the fact that subjects had already returned to work when receiving our invitation to participate in this study. Furthermore, the participants were required to be still off work when filling out the questionnaire. Selection bias also might have occurred due to confounding by indication (i.e. the occupational health physician suspects a prolonged sickness absence and submits these workers for inclusion). However, no differences in baseline characteristics among subjects were found, whether included by the occupational physician or selected from the absenteeism register[25]. Moreover, the method of inclusion had no effect on the results of the study.

A drawback in the present study is the fact that no objective measures of work productivity were used[7, 8, 33]. However, objective measures of productivity are difficult and time consuming to obtain[7]. In a single study objective measurements of reduction in productivity were associated with health problems[7]. Unfortunately, no studies have measured productivity loss both objectively and subjectively in order to validate self-reported productivity loss, and hence, no gold standard for productivity measurement is available[33]. Moreover, the most accurate way of determining self-reported productivity loss is still subject of debate[31]. In our study the productivity loss measured on a 11-point numerical scale(Q_T) was converted to the number of working hours per day instead of directly asking the number of hours needed to compensate for lost work due to health problems, as for example is done in the Health and Labour Questionnaire (HLQ)[34]. Problems with this HLQ method include that respondents may judge their efficiency by the potential amount of work they could have done rather than the normal amount of work they usually do without health problems, thereby overestimating productivity loss. On the other hand, the HLQ method may underestimate the real productivity loss when colleagues or temporary workers make up for the lost work[5]. The Q_T method may be preferred since it indicates how much work was lost or had to be made up for during overtime or during regular work time, but the Q_T may underestimate productivity loss when lost work may be compensated during regular work hours. Although both methods have a good correlation[5], the Q_T appears to be more responsive to health indicators and job characteristics. A recent study showed that the external validity of the Q_T, in relation to actual production output, was acceptable[34]. Referring to the comparison of methods, we chose a self-administered questionnaire where both health outcomes and productivity measures were included that were filled out at the same time. Although subjects reported their productivity over a regular workday and, thus, we were not able to establish the total duration of productivity loss, our findings indicated that 33% of the subjects who reported productivity loss shortly after RTW still showed some decrease in work performance at 12 months follow up.

Conclusions

Reduced productivity was highly prevalent among workers who returned to full duty after a sickness absence due to MSD. The strong associations with functional disability and physical health indicated that workers with ongoing recovery on these health outcomes are at risk for productivity loss shortly after RTW. The occurrence of productivity loss after RTW might result in recurrent sickness absence. This illustrates the importance of the timing of facilitating RTW activities, especially in those workers with residual functional disability and a poorer physical health after RTW due to their MSD. Moreover, our data emphasised that the supervisor should be engaged early in the RTW process in order to guarantee an early, sustainable and productive RTW of his employee.

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9.

GENERAL DISCUSSION

General discussion

In this thesis the problem of musculoskeletal disorders (MSD) within the workforce is addressed. In chapter 1 the work disability process was described within its socio-demographic and socio-political context. Due to the complexity of this process, the scope of this thesis was restricted to demographic, health-related and work-related factors that may influence the work disability process. These factors were used to investigate risk factors for the occurrence of MSD, prognostic factors for prolonged sickness absence, and factors that determine residual MSD problems after return to work. The next five paragraphs will address the key objectives from this thesis.

What is the probability that for an individual worker his LBP is caused by exposure to hazardous work?

Based on a meta-analysis manual material handling, frequent bending and twisting of the trunk, whole body vibration, and low job satisfaction were identified as most important risk factors for the occurrence of LBP. With these factors a decision model is proposed in which the attributable fraction among those workers exposed was used to assess the probability that work load was responsible for the episode of LBP in an individual worker (level of work-relatedness)(chapter 2). In an international workshop the model has been slightly modified according to the general consensus in this group of international experts[1].

Although the decision model provides a more evidence based approach for determining the probability that non-specific low back pain in an individual worker is work-related, given its constraints, it is not a 'stand alone tool' for a judgement on the work relatedness of LBP, since adjustment may be required to accommodate individual characteristics and exposure to specific work-related risk factors[1, 2].

What are the effects of primary preventive interventions on both mechanical exposure and musculoskeletal complaints?

To find out whether primary preventive interventions aimed at reducing the exposure to physical load (i.e. mechanical load) will indeed reduce the risk on musculoskeletal complaints a systematic review was conducted (chapter 3). In this review it was shown that a substantial reduction in exposure to physical load will result in a concomitant improvement in musculoskeletal health, as measured by a reduced prevalence of musculoskeletal symptoms or by a reduced musculoskeletal discomfort. It is suggested that the improvement in musculoskeletal health depends on the magnitude of the mechanical exposure at start; in a working situation where mechanical exposure is low the time lag before a noticeable change, if any, will take place in the occurrence of musculoskeletal complaints will be very long. This time lag between reduction in exposure and appreciable effect on musculoskeletal health will most likely reflect the latency period[3], and for some musculoskeletal complaints a latency period of several years is assumed[4]. However, most intervention studies have used a follow up period of 1 year, which might not be enough to detect a significant improvement in musculoskeletal health over time. Hence, it is recommended in primary preventive intervention studies to measure not only changes in health outcomes, but also the changes in physical load. This will also facilitate a better insight into the exposure-response relationships between physical load and musculoskeletal complaints.

What are prognostic factors for return to work after sickness absence due to musculoskeletal complaints?

In chapter 4 it was questioned whether the established risk factors for the occurrence of musculoskeletal complaints should also be considered as prognostic factors for prolonged sickness absence due to musculoskeletal complaints. In a prospective cohort study among 253 Dutch workers on sick leave for 2-6 weeks due to musculoskeletal disorders no association of established work-related risk factors with return to work was found, except for manual materials handling and LBP sick leave. The main factors that were associated with prolonged sickness absence due to neck, shoulder and upper extremity disorders were older age, being female, perceived high physical workload, and poorer general health. Functional limitations, sciatica, worker's own perception of the ability of return to work, and chronic complaints were important prognostic factors for sick leave due to LBP. Workers with a high perceived physical work load returned to work increasingly slower over time than expected, whereas workers with more initial functional limitations returned to work increasingly faster over time. These findings indicate that well-established risk factors for the occurrence of MSD only play a modest role in the prognosis of RTW.

The observation that the worker's own perception of his ability to return to work was a strong prognostic factor for return to work after sickness absence due to LBP might partly originate in fear-avoidance beliefs among workers[5], and hence, the decisional balance of the worker to regain work activities[5, 6]. In the cohort study among Canadian workers in the State of Quebec it was found that depressive symptoms and a poor perceived physical health were significant predictors for more days on total compensation benefit and, as such, appear to be important risk factors for prolonged work disability. Physical health, perceived pain, psychosocial workload, and fear of income loss were important confounding effects on depressive symptoms, fear-avoidance for work, and self-efficacy beliefs. Work-related variables played a minor role in the prognosis for total days on benefit (chapter 5). Overall, it can be stated that working conditions seem less important for the prognosis of sickness absence than psychological and physical health factors when measured 4 to 5 weeks post-injury. Hence, these factors have to be accounted for by the general practitioner or occupational physician when facilitating a work related rehabilitation program.

What is the influence of modified work on return to work among workers on sick leave due to musculoskeletal complaints?

Some studies already stated that the ability to return to work might also depend on the availability of modified work[7]. From the longitudinal study on the influence of modified work on sickness absence it was concluded that modified work, as solitary advice often used by the occupational health physician, did not influence the rate of return to work nor the improvement in health for workers on sick leave due to musculoskeletal complaints (chapter 6). It appeared that workers were less likely to perform modified work when their regular work was characterised by frequent lifting and their relationship with colleagues was less than good. Workers were more likely to return in modified work when they had a better mental health, had prolonged periods of standing in their regular job, and had less skill discretion. These findings indicate that the occupational physician is less likely to advise modified work to those workers with chronic complaints and high perceived work loads. The results of this study support the advice to integrate modified work in a multidisciplinary rehabilitation program were communication between all stakeholders plays a key role in successfully applying modified work[8-10]

What is the contribution of perceived health status in the decision to return to work and the risk of a recurrent sick leave after a sick leave episode due to musculoskeletal complaints?

Given the impact of individual and health-related prognostic factors on sickness absence duration, it would be interesting to find out the necessary improvement in health to resume working in the original job, in other words, the timing of the moment of returning to work. In chapter 7 it was shown that being fully recovered is not a stipulation for regaining work activities. Health status shortly after having returned to work was best predicted by health status at time of sickness absence for 2 to 6 weeks and, to a lesser extent, by a history of previous sickness absence. Individual characteristics and work-related risk factors were only predictive for general health, but not for perceived pain, functional limitations, and physical and mental health after return to work. These findings indicate that return to work is probably more prompted by a relative improvement in perceived pain and physical health factors than by an improvement to a required minimal level of health status. Health status shortly after return to work was predictive for recurrent sick leave. Moreover, subjects with chronic complaints before their initial sickness absence period were also at risk for a recurrent sick leave due to MSD. This illustrates that chronicity of complaints has to be taken into account when initiating return to work activities.

In the same cohort study it was found that reduced productivity was highly prevalent among workers who returned to full duty after a sickness absence due to MSD (chapter 8). Since productivity loss after RTW was strongly associated with functional limitations and physical health, and the fact that these health outcomes improved progressively in the first months after RTW, the present findings indicate that productivity loss occurred primarily among those workers whose recovery still progressed during the follow up (sickness presenteeism). An additional analysis confirmed that productivity losses were indeed more present among workers with a large improvement in physical health and a large reduction in functional limitations. Retrospectively, we observed a strong association between productivity loss shortly after RTW and recurrent sick leave, suggesting that sickness presenteeism will increase the risk of future sickness absenteeism[11].

The fact that the relation with one's supervisor at baseline as well shortly after RTW was associated with productivity losses shortly after RTW, indicated that the supervisor should be engaged early in the RTW process in order to guarantee an early, sustainable, and productive RTW of his employee.

Methodological considerations

Although the research questions were linked together, the data collection was drawn from different sources, i.e. international peer-reviewed literature, and three prospective cohort studies. This diversity in data collection may hamper the direct comparison between studies, but the broad scope of the studies conducted presents valuable insight into to the impact of work on musculoskeletal complaints and work disability.

The results of the literature reviews were directed by the available epidemiological information. Unfortunately, there was too little information to define hazardous physical load according to magnitude, frequency and duration of the distinguished risk factors. Since epidemiological studies usually do not have sufficient power to measure all relevant dimensions of exposure (and its large variation across workers and time), there is a paucity of information on exposure-response relationships between physical load and musculoskeletal disorders. This is an important drawback for the measurement of relevant risk factors at work and the decision as to the required reduction in characteristics of physical load in primary preventive intervention studies.

To determine the magnitude of work-relatedness of non-specific low back pain in an individual worker, several constraints of the decision model have to be taken into consideration when applying the model in occupational practice[2]. The definition of work-related risk factors in the model was based on the definition of exposure levels with an increased risk on low-back pain in national and international guidelines. In the absence of sound information on exposure-response relationships, these definitions in the model are inevitable arbitrary to some extent. Although the preventive effects on musculoskeletal health of working conditions below the threshold limit values for exposure in these guidelines still have to be corroborated, it was concluded that these guidelines present a suitable starting point for distinguishing between hazardous and harmless work situations. A certain disadvantage of these predefined cut-off points of exposure is that this procedure may obscure the presence of a high risk among subjects with exposure well above the defined cut-off value. It is, therefore, recommended not only to judge presence or absence of exposure to the risk factors based on the threshold limit values, but also to consider the actual exposure levels, and be attentive when these levels are much higher than the threshold limit values[2].

An important assumption is that the attributable fraction among exposed workers at group level may be interpreted as the best estimate for the attributable fraction at individual level, given the definition of low-back pain used in the epidemiological literature included in the meta-analysis. Hence, the application of the probability model is limited to a worker with non-specific low-back pain. It remains to be seen whether the model is also applicable to a worker with low-back pain seeking health care or on sick leave, since the decision to seek care or to take sick leave will depend on several factors not included in the model[12]. The conversion from relative risks, assessed in the meta-analysis, to an individual attributable fraction in the model assumes an average worker. Except for age, the knowledge on the influence of other individual characteristics on the occurrence of an episode of LBP is insufficient, let alone the influence of these characteristics on the observed exposure-response relationships in the meta-analysis. Thus, is was not feasible to tailor the decision model to individual characteristics. A sensitivity analysis was conducted showing that the attributable fraction was influenced by the effect of statistical uncertainty of the population-based risk estimates. This analysis demonstrated that a departure from the baseline prevalence of 30% (assuming a range of 10% to 50%) in combination with observed 95% confidence intervals around the risk estimates resulted for manual materials handling in attributable fractions varying from 13% to 40% relative to the 23% in the original model. For frequent bending and/or twisting of the trunk these figures were 13% and 45% (relative to 28% in the model), and for whole-body vibration 9% and 30% (relative to 18% in the model)[2].

In both Dutch cohort studies the population of interest was included in two ways, i.e. by the occupational health physician during his consulting hour and by selection from the absenteeism register. Considering the latter, approximately 60% of the workers on 2-6 weeks sick leave responded to our request for participation in the study. It is known that most of the workers on sick leave due to musculoskeletal disorders return to work within the first weeks of sickness absence[13]. Hence, the low response can partly be explained by the fact that subjects had already returned to work when receiving our invitation to participate in this study. The way of inclusion did not have any influence in the analyses presented in chapters 4, 6, 7, and 8 thus it is unlikely that the route of inclusion will have biased the results.

Selection bias also might have occurred due to confounding by indication (i.e. the occupational health physician suspects a prolonged sickness absence and submits these workers for inclusion). However, no differences in baseline characteristics among subjects were found, whether included by the occupational physician or selected from the absenteeism register. The advice of performing modified work might also have been influenced to some extent by confounding by indication. In order to overcome this potential bias a randomised controlled trial is needed, but in our experience this is difficult to achieve since the current legislation requires employers and employees to actively strive to return to work and modified work has been targeted is an essential tool.

Although in both Dutch cohorts care seeking behaviour among participants during the follow up was asked, this information may be insufficient to identify specific interventions undertaken during the sickness absence period to accommodate return to work, such as ergonomic adjustment of the workplace or change in work content. However, none of the subjects was involved in a special RTW rehabilitation training program.

In the Canadian cohort study the outcome variable was total days on total compensation benefit during one year, whereas in both Dutch cohort studies the amount of days from the initial sick leave till fully returning to the original job was used. In a study by Krause et al. it was shown that time to first return to work underestimated the duration of work disability compared to measures based on all wage replacement benefits[14]. However the median duration of sickness absence in the Dutch cohort was 97 days versus 32 days in the Canadian cohort. This discrepancy is probably due to the different workers compensation systems in which both studies are conducted. In the Dutch context the employer pays total wages during the first 12 months of sick leave, whereas in Canada the workers gets temporarily compensated when his disorder is defined as being work-related. Hence, this financial incentive might have influenced the decision to return to work in the Canadian cohort.

Interpretation of the findings

The work disability process

Several established work-related risk factor for the occurrence of low back pain are known[15], however, no sound criteria on their contribution to the occurrence of LBP in an individual worker can be found in occupational guidelines for diagnosis and treatment of workers with LBP. At individual level it is impossible to determine the causal relationship between those risk factors and the occurrence of an episode of LBP, because these risk factors per sé are not specific for the development of LBP. However, techniques within decision modelling enabled us to develop a decision model which is based upon the baseline probability of having non-specific LBP among workers without any relevant exposure to physical load, and the increase in probability due to exposure to specific work related determinants of physical load[16]. The presented model is the first model that tries to determine the attribution of work to low back pain of a worker more objectively. An international workshop was organised to discuss this model with regard to its constraints and usability in clinical practice. With the input of the international members of this workshop the model was modified to the general consensus of the group[1]. The model still has to show its merits by using it in clinical practice.

The decision model may be used in occupational health care practice on an individual level as well as on a group level. At the individual level, it can support professionals in their diagnosis of the level of work-relatedness of non-specific low-back pain in a worker presenting with this complaint and also guide the decision whether the complaint should be notified as an occupational disease. On a group level, the model can provide an indication of the relative contribution of work-related risk factors to the occurrence of non-specific low back pain and provide guidance in deciding upon the most relevant preventive interventions in that occupation group[2].

It has been shown that work-related risk factors, as included in the decision model for LBP, seem less important than individual characteristics in the decision to take sick leave for a MSD[12]. This thesis has provided further evidence that these work-related risk factors also play only a modest role in the prognosis of prolonged sickness absence. Working conditions were less important for the prognosis of return to work than individual factors, such as pain intensity, perceived physical health, functional limitations, fear-avoidance beliefs, one's own expectation, and depressive symptoms. Moreover, the observed large differences in perceived health among workers who had just returned to work can be seen as a reflection of a worker's experience to cope with the disorder[17]. Although functional limitations and general health partly predicted earlier return to work, the exact timing of the decision to return to work was not determined by a predefined clinically relevant improvement in health status. This apparent contradiction may be explained by the fact that these health outcomes do not have sufficient predictive power to encapsulate individual behaviour towards the timing of returning to work. Hence, to define a fixed cut off of these measures or a specific required clinical improvement, as a way to indicate readiness for RTW, is probably not very useful. In this respect, it can be stated that recovery is not synonymous with return to work and that return to work is not only prompted by the worker's health status but also by his perception of readiness for return to work. The importance of this finding has recently been addressed in the readiness for return to work model[6]. However, hardly any study has made it the primary aim of investigation yet. Hence, future studies are challenged to put this concept more at front when investigating the topic of return to work.

This thesis showed that the ongoing improvement after fully return to work, as was also found in other studies[18, 19], has a sound impact on the recurrence of sickness absence and productivity loss due to residual functional limitations. Workers with more chronic complaints and a history of previous sick leave appeared to be more prone to residual health problems and concomitantly productivity loss. Hence, it is suggested that the workers who encounter these features need special attention during the whole work disability process to avoid recurrent complaints or sick leave due to musculoskeletal disorders. This may entail continued care after a worker has returned to work aimed at further improvement in health. In the current practice of occupational health care there seems too little attention for workers after their sickness absence.

Little is known about productivity loss shortly after RTW. One study reported on productivity loss due to MSD, however, this study did not measure productivity shortly after RTW, hence productivity could not be compared with recovery[20]. Although the current results in chapter 8 certainly add to the knowledge of productivity loss and the health parameters that determine this reduced productivity, it is not possible to generalise these findings to the total working population, due to confounding by specific work and organisational factors[21]. More studies are needed that measure productivity loss shortly after a sickness absence period due to MSD, taking into account the specific work and organisational factors that may influence productivity loss.

Intervention strategies

Various studies have demonstrated that a reduction in occurrence of musculoskeletal complaints can be achieved by a reduction in the magnitude of work-related risk factors, as included in the decision model[22, 23]. However, primary preventive interventions do not necessarily have a similar impact on frequency and duration of sickness absence because work-related risk factors played only a modest role in the decision to take sick leave and in the prognosis of prolonged sickness absence[12]. It is therefore suggested that interventions within the work disability process need different approaches over time depending on the primary target of the intervention.

The only intervention studied in this thesis was modified work. As already observed in other studies, the lack of possibilities to change work tasks is a substantial barrier for realising modified work[10, 24, 25]. In jobs with a high physical load in core tasks there may be few opportunities to reduce the heavy work load to an acceptable level. Another reason for not offering modified work could be related to the physician's fear for recurrence or worsening of the complaints, which has also been reported as a barrier for return to work[24, 26]. The occupational physicians in our cohort on workers on sick leave were indeed less likely to advise modified work for workers with chronic complaints and those exposed to high physical work loads. In order to counteract potential barriers for return to (modified) work[10] the advice for modified work should be integrated in a case management strategy or job coaching while gradually increasing work exposure over time[27-29].

Recommendations

- The merits of the decision model for work-relatedness of LBP of an individual worker can only been determined by application in (occupational) health care. Hence, it is recommended to investigate the usability of the modified model[2] and to evaluate whether the application of the model has an impact on the proposed treatment and intervention at the workplace.
- The substantial time lag between reduced physical work load and improved musculoskeletal health emphasises the need to measure not only changes in health but also changes in physical load in primary preventive intervention studies. Furthermore, it is recommended to choose a follow up of at least two years to determine more accurately the effects of exposure reduction on musculoskeletal complaints.
- Since the risk factors for the occurrence of MSD are not equal to the prognostic factors for prolonged sickness absence, it is suggested that both time windows in the work disability process need different accents when initiating intervention strategies
- Given the observation that full recovery from a musculoskeletal disorder is not synonymous with return to work, it is recommended to provide after-care for workers

who have returned to work, especially those with chronic complaints and a history of sick leave.

- The worker's perception and behaviour in the work disability process are poorly understood. Future studies should put the readiness for return to work approach more at front when investigating effective management of sickness absence.

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SUMMARY

Chapter 1. Introduction

In this thesis the problem of musculoskeletal disorders (MSD) within the work situation is addressed using a model describing the work disability process within its socio-demographic and socio-political context. Due to the complexity of this model, the scope of this thesis was restricted to demographic, health-related and work-related factors that influence the work disability process. These factors were used to gain more information on the specific role of work-related risk factors and individual characteristics in the onset of MSD (in particular low back pain), duration of sickness absence, recovery, and return to work.

Chapter 2. Model for the work-relatedness of low back pain

In order to indicate the level of work-relatedness of LBP, we presented a decision model based on the available epidemiological information from the literature. Techniques from clinical decision modelling enabled us to present a model that may help the general practitioner and the occupational health physician in determining the level of work-relatedness of LBP for an individual worker, given his personal exposure profile to well-established risk factors.

Based on a meta-analysis manual material handling, frequent bending and twisting of the trunk, whole body vibration, and low job satisfaction were identified as most important risk factors for the occurrence of LBP. With these factors a decision model is proposed in which the attributable fraction among those workers exposed was used to assess the probability that work load was responsible for the episode of LBP in an individual worker (level of work-relatedness).

Chapter 3. Are changes in mechanical exposure and musculoskeletal health good performance indicators for primary preventive interventions?

The purpose of this systematic review was to present more insight into the effects of primary preventive interventions on both mechanical exposure and musculoskeletal health and to determine whether these outcomes are good performance indicators of such interventions.

In 12 of the 40 included studies (30%) changes in both mechanical exposure and musculoskeletal health were measured after implementation of an intervention. Of these studies 8 (67%) showed a reduction in both mechanical exposure (range 14-87 % reduction) and musculoskeletal disorders or sick leave due to musculoskeletal disorders (preventive fraction range 0,15 - 0,92). From these 8 it was seen that a reduction of at least 14% in mechanical exposure resulted in a concomitant improvement in musculoskeletal health.

It is recommended to measure not only changes in health outcomes but also changes in mechanical exposure along the pathway of the intervention in primary prevention intervention studies. This way a better insight will be gained about the dose-response relationships between exposure to physical load risk factors and MSD.

Chapter 4. Prognostic factors for duration of sickness absence due to musculoskeletal disorders

In a prospective cohort study with one-year follow among 253 Dutch workers on sick leave for 2 to 6 weeks due to musculoskeletal disorders, prognostic factors for duration of sickness absence were determined.

The main factors that were associated with prolonged sickness absence were older age, being female, perceived high physical workload, and poorer general health for upper extremity disorders (including neck / shoulder), and functional disability, sciatica, worker's own perception of the ability of return to work, and chronicity of complaints for LBP. Workers with a high perceived physical work load at baseline returned to work increasingly slower over time than expected, whereas workers with a high functional disability at baseline returned to work increasingly faster over time. Well-established work-related risk factors for the occurrence of MSD only played a modest role in the prognosis of return to work (RTW).

High pain intensity is a major prognostic factor for duration of sickness absence, especially in LBP. The different disease-specific risk profiles for prolonged sickness absence indicate that LBP and upper extremity disorders may need different approaches when applying intervention strategies with the aim of early return to work. The interaction of perceived physical workload with time suggests that perceived physical workload will increasingly hamper return to work and, hence, supports the need for workplace interventions among workers off work for prolonged periods.

Chapter 5. The prognostic value of depressive symptoms, fear-avoidance, and self-efficacy for duration of lost-time benefits in workers with musculoskeletal disorders

In a longitudinal study among 187 Canadian workers receiving total compensation benefits due to musculoskeletal disorders, we analysed the prognostic value of depressive symptoms, fear avoidance, and self-efficacy for prolonged duration on total compensation benefit over 12 months.

Increased depressive symptoms and a perceived poor physical health were significant predictors of more days on total compensation benefit and, as such, appear to be important risk factors for prolonged work disability. Physical health (concomitantly a significant predictor), perceived pain, psychosocial workload and fear of income loss showed the most profound confounding effect on depressive symptoms, fear-avoidance for work and/or self-efficacy beliefs. Work-related variables did not change the prognostic value of depressive symptoms and poor health in any meaningful way.

Taken together, our results suggest that when measured 4 to 5 weeks post-injury, depressive symptoms and physical health factors are strong predictors of prolonged time on benefits, while work-related factors are less important.

Chapter 6. The influence of modified work on return to work for workers on sick leave due to musculoskeletal complaints

In order to determine which individual and work-related factors are associated with performing modified work and to evaluate the influence of modified work on the duration of sickness absence and health-related outcomes, another (Dutch) cohort study was performed on 164 workers on sick leave for 2 to 6 weeks due to musculoskeletal complaints.

Workers on sick leave for musculoskeletal complaints in jobs characterised by a high physical work load were less often assigned modified work by the occupational physician. Workers were more likely to return in modified work when they had a better mental health, had prolonged periods of standing in their regular job, and had less skill discretion. Modified work, as solitary advice of the occupational health physician, did not influence the total duration of sickness absence nor the improvement in health during sick leave for workers on sickness absence due to musculoskeletal complaints.

The results of this study support the advice to integrate modified work in a multidisciplinary rehabilitation program where communication between all stakeholders plays a key role in successfully applying modified work.

Chapter 7. Health status, its perception and effect on return to work and recurrent sick leave

The purpose of this prospective cohort study is to describe the improvement in several health outcomes during sick leave due to musculoskeletal disorders in the first months after return to work, and to evaluate the personal and work-related factors associated with these health outcomes, in order to provide some insight in the timing of return to work (RTW).

This study clearly demonstrated that returning to work after significant improvement in health is not synonymous with being fully recovered from a MSD. An additional improvement was seen for pain, functional disability, and physical health in the first months after return to work. Workers with recurrent sick leave after RTW already had a poorer health status at RTW and also a poorer health status at 12 months follow-up. Previous sick leave in the 12 months before study entry was significantly associated with the level of functional disability and general health at time of RTW and also predictive for recurrence of sickness absence. Moreover, subjects with chronic complaints at baseline were at risk for recurrent sick leave after a sickness absence period due to MSD.

We hypothesise that workers with musculoskeletal disorders may need additional medical guidance shortly after RTW, especially those with a history of sick leave.

Chapter 8. Reduced productivity after sickness absence due to musculoskeletal disorders and its relation to health outcomes

The aim of this prospective cohort study among 253 Dutch workers on sick leave for 2 to 6 weeks is to quantify reduced productivity of workers on full duty after a sickness absence period due to musculoskeletal disorders (MSD), and to determine how reduced productivity is affected by health parameters such as perceived pain, functional disability, and general health.

Reduced productivity was found to be prevalent in 60% of the workers shortly after RTW and in 40% at 12 months follow up. The initial MSD causing the prior sick leave was the cause for 75% of the subjects to report productivity loss shortly after RTW and for 60% at 12 months follow-up. Among those with self-reported productivity loss the median productivity loss on an 8-hour working day due to MSD was 1.6 hours. A poorer physical health, more functional disability, and a poorer relation with the supervisor were associated with the presence of productivity loss shortly after RTW, whereas recurrent sick leave was the most profound predictor for productivity loss at 12 months follow up.

Reduced productivity was highly prevalent among workers who returned to full duty after a sickness absence due to MSD. The strong associations with functional disability and physical health indicated that workers with ongoing recovery on these health outcomes are at risk for productivity loss shortly after RTW. Data of this study indicated that the occurrence of productivity loss after RTW might result in recurrent sickness absence. This illustrates the importance of the timing of facilitating RTW activities, especially in those workers with residual functional disability and a poorer physical health due to their MSD. Moreover, the presented data emphasised that the supervisor should be engaged early in the RTW process in order to guarantee an early, sustainable and productive RTW of his employee.

Chapter 9. General Discussion

The answers on the research questions stated in the introduction were integrated in a general interpretation of the findings in the context of the model describing the work disability process within its context socio-demographic and socio-political context.

Methodological issues within and between the studies included in this thesis are considered and recommendations for clinical practice and future research are given.

Key recommendations include (1) the need to measure not only changes in health after an intervention but also determine the intermediate effect of the intervention on the physical load, (2) the advice to provide after-care for workers who have returned to work since their recovery from MSD will continue, and (3) to address worker’s perception and behaviour as important determinant in effective management of sickness absence.

SAMENVATTING

Hoofdstuk 1. Introductie

In dit proefschrift wordt het probleem van klachten van het houdings- en bewegingsapparaat (HBA) in de arbeidssituatie benaderd middels een model dat het arbeidsongeschiktheidsproces beschrijft binnen de socio-demografische en socio-politieke context. Gegeven de complexiteit van het model, zal de scoop van dit proefschrift worden beperkt tot demografische, gezondheidsgerelateerde en werkgerelateerde factoren die het ziekteverzuim proces beïnvloeden. Deze factoren zijn gebruikt om informatie te verkrijgen over de specifieke rol van werkgerelateerde factoren en individuele karakteristieken in het ontstaan van HBA klachten (in het bijzonder lage rugklachten), duur van ziekteverzuim, herstel en werkhervatting.

Hoofdstuk 2. Model voor de arbeidsgerelateerdheid van lage rugklachten

Om een indicatie te kunnen geven van de werkgerelateerdheid van lage rugklachten presenteren we een model dat is gebaseerd op beschikbare epidemiologische informatie uit de literatuur. Technieken vanuit de klinische besliskunde stelde ons in staat om een model te presenteren dat door de huisarts en de bedrijfsarts gebruikt kan worden in het bepalen van de mate werkgerelateerdheid van lage rugklachten bij een individuele werknemer, gegeven diens persoonlijke blootstellingsprofiel aan bewezen risicofactoren.

Gebaseerd op een meta-analyse werden tilhandelingen/hanteren van lasten, frequent buigen en draaien van de romp, lichaamstrillingen en een lage arbeidssatisfactie geïdentificeerd als de belangrijkste risicofactoren voor het ontstaan van lage rugklachten. Gegeven deze factoren wordt een beslissingsmodel gepresenteerd, waarin de attributieve fractie van geëxposeerde werknemers wordt gebruikt om te bepalen in hoeverre het werk verantwoordelijk was voor de episode van lage rugklachten bij een individuele werknemer (de mate van werkgerelateerdheid).

Hoofdstuk 3. Zijn veranderingen in de mechanische exposure en de gezondheid van het bewegingsapparaat goede prestatie indicatoren voor primaire preventie interventies?

Het doel van deze systematische review was het verkrijgen van meer inzicht in de effecten van primaire preventie interventies op mechanische blootstelling en de HBA gezondheid en te bepalen of deze uitkomstmaten goede prestatie indicatoren zijn voor dergelijke interventies.

In 12 van de 40 geïncludeerde studies (30%) werden veranderingen in zowel mechanische exposure als de HBA gezondheid gemeten na implementatie van een interventie. Van deze studies lieten 8 studies (67%) een reductie zien in mechanische blootstelling (range 14-87%) en in HBA klachten of verzuim ten gevolge van deze klachten (preventive fractie range 0,15 – 0,92). Uit deze 8 studies kon worden opgemaakt dat een reductie van tenminste 14% in mechanische exposure gepaard ging met een verbetering in de HBA gezondheid.

Het wordt aanbevolen om niet alleen veranderingen in gezondheidsuitkomsten maar ook veranderingen in mechanische blootstelling te meten gedurende de interventie in primaire preventie studies. Op deze manier kan een beter inzicht worden verkregen in de dose-respons relatie tussen blootstelling aan fysiek belastende risicofactoren en HBA klachten.

Hoofdstuk 4. Prognostische factoren voor de duur van ziekteverzuim ten gevolge van klachten aan het houdings-en bewegingsapparaat

In een prospectieve studie met een follow-up van één jaar onder 253 Nederlandse werknemers met ziekteverzuim van 2 tot 6 weken ten gevolge van HBA klachten, werden prognostische factoren voor de duur van het ziekteverzuim bepaald.

De belangrijkste factoren die werden geassocieerd met langdurig verzuim waren oudere leeftijd, vrouw zijn, hoog ervaren fysieke werkbelasting en een slechtere algemene gezondheid bij aandoeningen van de bovenste extremiteit (inclusief nek/schouder). Bij lage rugklachten waren dit functionele beperkingen, radiculaire klachten, de perceptie van de werknemer op de mogelijkheid tot werkhervatting en het chronisch zijn van de klachten. Werknemers met een hoog ervaren fysieke werkbelasting bij begin van de studie keerden in toenemende mate langzamer terug naar het werk over de tijd genomen, terwijl werknemers met veel functionele beperkingen in het begin van de studie in toenemende mate sneller het werk hervatte over de tijd genomen. Werkgerelateerde risicofactoren voor het ontstaan van een HBA aandoening speelden maar een matige rol in de prognose van werkhervatting.

Hoge pijnintensiteit is een belangrijke prognostische factor voor de duur van het ziekteverzuim, vooral bij lage rugklachten. De verschillende aandoening-specifieke risico profielen voor langdurig ziekteverzuim geven aan dat lage rugklachten en klachten van de bovenste extremiteit mogelijk een andere benadering vragen bij toepassing van interventies met als doel vroegtijdige werkhervatting. De interactie van ervaren fysieke werkbelasting met de tijd suggereert dat ervaren fysieke werkbelasting in toenemende mate in de tijd werkhervatting zal belemmeren, hetgeen de vraag naar werkplek gerichte interventies ondersteund onder werknemers met langdurig ziekteverzuim.

Hoofdstuk 5. De prognostische waarde van depressieve symptomen, bewegingsangst en zelfvertrouwen voor de duur van ziekteverzuim uitkering bij werkers met klachten aan het houdings- en bewegingsapparaat

In een longitudinale studie onder 187 Canadese werknemers die een ziekteverzuim uitkering kregen ten gevolge van een HBA aandoening, hebben we de prognostische waarde geanalyseerd van depressieve symptomen, bewegingsangst en zelfvertrouwen in het werk, op de duur van deze uitkering over 12 maanden.

Verhoogde depressieve symptomen en een slechter ervaren fysieke gezondheid waren significante voorspellers voor het aantal gecompenseerde dagen en zijn daardoor belangrijke risicofactoren voor langdurig verzuim. Fysieke gezondheid (bijkomend een significante voorspeller), ervaren pijn, psychosociale werkbelasting en angst voor inkomensverlies waren de belangrijkste confounders voor depressieve symptomen, bewegingsangst en/of zelfvertrouwen. Werkgerelateerde variabelen daarentegen veranderden de prognostische waarde van depressieve symptomen en fysieke gezondheid niet noemenswaardig.

De resultaten uit deze studie geven aan dat depressieve symptomen en fysieke gezondheid, gemeten 4 tot 5 weken na ontstaan van de aandoening, sterke voorspellers zijn voor het aantal dagen ziekteverzuim uitkering, terwijl werkgerelateerde factoren hierin minder belangrijk zijn.

Hoofdstuk 6. De invloed van aangepast werk op werkhervatting onder werknemers die verzuimen ten gevolge van klachten aan het houdings- en bewegingsapparaat.

Om te bepalen welke individuele en werkgerelateerde factoren zijn geassocieerd met het uitvoeren van aangepast werk en om de invloed van aangepast werk op de duur van het ziekteverzuim en gezondheidsgerelateerde uitkomstmaten te evalueren, werd een andere cohort studie uitgevoerd bij 164 Nederlandse werknemers met een ziekteverzuim tussen 2-6 weken ten gevolge van HBA klachten.

Werknemers die verzuimden door HBA klachten en werkzaam waren in banen waarin de fysieke werkbelasting als hoog werd ervaren kregen minder vaak aangepast werk voorgeschreven door de bedrijfsarts. Werknemers keerden sneller terug in aangepast werk bij een betere mentale gezondheid, wanneer ze lang moesten staan in hun reguliere werk en wanneer dit werk minder vaardigheden vereiste.

Aangepast werk als een op zich zelfstaand advies van de bedrijfsarts beïnvloedde niet de totale duur van ziekteverzuim en gaf geen verbetering in gezondheid gedurende het verzuim bij werknemers met ziekteverzuim ten gevolge van HBA klachten. De resultaten van deze studie ondersteunen het advies om aangepast werk te integreren in een multidisciplinair reïntegratie programma waarbij communicatie tussen alle betrokkenen een essentiële rol speelt voor het succesvol inzetten van aangepast werk.

Hoofdstuk 7. Gezondheidsstatus, de perceptie en het effect hiervan op werkhervatting en terugkerend ziekteverzuim.

Het doel van deze prospectieve cohort studie was om de verbetering op diverse gezondheidsmaten gedurende een verzuimperiode ten gevolge van HBA klachten te beschrijven in de eerste maanden na werkhervatting en om te evalueren welke persoons- en werkgerelateerde factoren geassocieerd zijn met deze gezondheidsmaten. Met deze informatie zou er meer inzicht kunnen worden verkregen in de ‘timing’ van werkhervatting.

Deze studie toonde duidelijk aan dat werkhervatting, na een significante verbetering in gezondheid tijdens de verzuimperiode, niet synoniem is met het volledig hersteld zijn van een HBA aandoening. Een verdergaande verbetering werd gezien voor pijn, functionele beperkingen en fysieke gezondheid in de eerste maanden na werkhervatting. Werknemers met een terugkerend ziekteverzuim na werkhervatting hadden reeds een slechtere gezondheidsstatus bij werkhervatting en ook een slechtere gezondheidsstatus na 12 maanden follow-up. Eerder verzuim in de 12 maanden voorgaand aan het onderzoek was significant geassocieerd met het niveau van functionele beperkingen en algemene gezondheid op het moment van werkhervatting en ook voorspellend voor terugkerend ziekteverzuim. Daarbij hadden proefpersonen met chronische klachten aan het begin van de studie een risico om opniew te verzuimen na een periode van verzuim ten gevolge van HBA klachten.

Wij veronderstellen dat werknemers met HBA klachten mogelijk additionele medische begeleiding nodig hebben kort na werkhervatting, in het bijzonder die werknemers met een verzuimgeschiedenis voor deze klachten.

Hoofdstuk 8. Productiviteitsverlies na ziekteverzuim ten gevolge van klachten aan het houdings- en bewegingsapparaat en de relatie hiervan met gezondheidsuitkomsten

Het doel van deze prospective cohort studie onder 253 Nederlandse werknemers met een verzuim van 2 tot 6 weken is om het productiviteitsverlies te kwantificeren van werknemers die weer volledig werkzaam zijn na een verzuimperiode ten gevolge van HBA klachten en om te bepalen hoe productiviteitsverlies wordt beïnvloed door gezondheidsparameters zoals ervaren pijn, functionele beperkingen en algemene gezondheid.

Productiviteitsverlies was aanwezig bij 60% van de werknemers kort na werkhervatting en in 40% na 12 maanden follow-up. De initiële HBA aandoening die het voorgaande verzuim had veroorzaakt was de reden voor 75% van de proefpersonen om een reductie in productiviteit te melden na werkhervatting en voor 60% na 12 maanden follow-up. Onder diegene met zelfgerapporteerd productiviteitsverlies bedroeg het mediane productiviteitsverlies op een 8 urige werkdag ten gevolge van HBA klachten 1.6 uur. Een slechtere fysieke gezondheid, meer functionele beperkingen en een slechtere relatie met de leidinggevende werden geassocieerd met het aanwezig zijn van productiviteitsverlies kort na werkhervatting, terwijl terugkerend verzuim de belangrijkste voorspeller was voor productiviteitsverlies na 12 maanden follow-up.

Productiviteitsverlies was sterk prevalent onder werknemers die volledig het werk hadden hervat na een ziekteverzuim episode ten gevolge van HBA klachten. De sterke associaties met functionele beperkingen en fysieke gezondheid geven aan dat werknemers met een voortschrijdende verbetering op deze gezondheidsmaten een risico hebben op productiviteitsverlies kort na werkhervatting. Het optreden van productiviteitsverlies na werkhervatting zou weer kunnen resulteren in terugkerend ziekteverzuim. Dit illustreert het belang van het 'timen' van activiteiten die werkhervatting bevorderen, in het bijzonder voor die werknemers met resterende functionele beperkingen en een slechtere fysieke gezondheid ten gevolge van hun HBA aandoening. De gepresenteerde data benadrukken tevens dat de leidinggevende vroeg in het werkhervattingsproces betrokken moet worden om een vroegtijdige, duurzame en productieve werkhervatting van zijn werknemer te garanderen.

Hoofdstuk 9. Algemene Discussie

De antwoorden op de onderzoeksvragen zoals geformuleerd in de introductie werden geïntegreerd in een algemene interpretatie van de bevindingen vanuit de context van het arbeidsongeschiktheidsmodel.

Methodologische aspecten binnen en tussen de, in dit proefschrift, geïncludeerde studies zijn besproken en er worden aanbevelingen gegeven voor de klinische praktijk alsmede voor toekomstig onderzoek.

De belangrijkste aanbevelingen houden in (1) de noodzaak om niet alleen veranderingen in gezondheid te meten na een interventie maar ook om de effecten van een interventie op de fysieke belasting te bepalen gedurende de interventie, (2) het advies om werknemers die het werk volledig hebben hervat nazorg te bieden, daar het herstel van de HBA aandoening doorgaat na werkhervatting, (3) het beschouwen van de perceptie en het gedrag van de werknemer als belangrijke determinant van effectief ziekteverzuim management.

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About the author

Freek Lötters was born on November 9th, 1964 at Doetinchem, The Netherlands. He completed high school at the Veluws College in Apeldoorn. In 1987 he obtained his BSc degree at the academy for Physical Therapy in Utrecht. Since then he has been working as a Physical Therapist in several private practises, abroad (Israel and Italy), and the Military Rehabilitation Centre in Doorn. In 1993 he graduated at the Faculty of Human Movement Sciences of the Vrije Universiteit, Amsterdam with special focus on health sciences and ergonomics. After 1,5 year of research at the department of Craniomandibular Dysfunction of the Academic Center of Dentistry (ACTA), Amsterdam he started working as a Physical Therapist / Human Movement Scientist at the Medical Center Haaglanden, location Westeinde in The Hague. In 2000 he obtained a full-time employed as a researcher in the section Work & Health of the Department of Public Health, Erasmus MC, Rotterdam, The Netherlands. He attended the international course Work Disability Prevention CIHR Strategic Training Program from 2003 till 2005, at the University of Sherbrooke, Quebec, Canada. Momentarily he is working as coordinator and projectmanager of the Prevention Advisory Center, Department of Occupational Health & Safety Services, Erasmus MC, Rotterdam.

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