CHAPTER 2

The effects of occupational interventions on reduction of musculoskeletal symptoms in the nursing profession; a review

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Abstract

Objective: to present more insight into the effects of occupational interventions for primary prevention of musculoskeletal symptoms in healthcare workers.

Methods: the Cochrane Collaboration methodological guidelines for systematic reviews functioned as a starting point for the present review. Thirteen studies meeting the inclusion criteria were analysed for methodological quality and effects. Eight outcome areas were established and defined as areas whereupon an effect was determined in at least 2 studies. A method based on levels of scientific evidence is used to synthesize the information available.

Results: strong scientific evidence for the beneficial effect of occupational interventions is found for the areas physical discomfort, technical performance of transfers and the frequency of manual lifting. Insufficient evidence is found for the areas absenteeism due to musculoskeletal problems, musculoskeletal symptoms, fatigue, perceived physical load and knowledge. Training and education combined with an ergonomic intervention is found to be effective.

Introduction

Prevalence rates of musculoskeletal symptoms, low back pain in particular, are high in the European working population (Smulders et al., 1998). More than half of the working population reports having had back pain in the past 12 months, and 26 % of the working population reports back pain quite often (Hildebrandt et al., 1995). Musculoskeletal symptoms are an important reason for sickness absence and disability; more than 20 % of the employees on long-term absenteeism and about 25-30% of the employees permanently work disabled are diagnosed as having musculoskeletal symptoms (Fanello et al., 2002, Smulders et al., 1998, Statistics Netherlands, 2002).
As for musculoskeletal symptoms no branch or trade escapes the problem. In general, health care workers also have a high prevalence of musculoskeletal symptoms (Smulders et al., 1998, Statistics Netherlands 2002, Workers Insurance Company 2004). In a hospital setting, particularly for bedside work, physical risk factors for musculoskeletal disorders, like manual handling of patients and flexion and rotation of the trunk are apparent (Hoogendoorn et al., 2000). Besides, high work pressure is considered an additional psychosocial risk factor (Hoogendoorn et al., 2001; 2002).
At present, eight university hospitals in the Netherlands are developing a programme for their workers aimed at preventing musculoskeletal symptoms and sickness absence due to these symptoms. This programme is part of a

covenant for Safety and Health (University Hospitals Associaton, 1999), an agreement between the Dutch government and several branches, in this case university hospitals (50.000 employees), to improve working conditions and reduce sickness absence. The programme combines different approaches since various interrelated factors may cause musculoskeletal symptoms. One part of the programme is the training and education of employees by addressing worker behaviour. Insight into the effect of training and education, alone or in combination with other interventions, on physical load and sickness absence of health care workers in particular is useful for updating the programme. Occupational interventions can be categorised as ergonomic interventions such as redesign of a workplace, interventions to improve health by physical exercise, education and training addressing workers' behaviour and organisational interventions such as changes in work procedures (Zwerling et al., 1997).

Interventions in health care are interesting because health care has, at several levels, specific characteristics due to patient-related work processes. The most significant factor is patient handling, i.e. close contact with another human being in need of help and support. Patient handling is considered rewarding but also demanding for the nurse (Lagerstrom et al.,1998). Second, the hospital organisation is hierarchical and a nurse has to adapt to several supervisory levels, as well as to the demands of the patients (Lagerstrom et al.,1998). The third characteristic of the health care field is the working population as such. Nursing is primarily a female career, and gender differences may be explanatory in the relation between work-related physical and psychosocial risk factors on the one hand and musculoskeletal symptoms on the other (Hooftman et al., 2004).

The aim of the present review is to obtain insight into the effects of occupational interventions for primary prevention of musculoskeletal symptoms in health care workers. Such a review is not yet available and the results may be interesting for professionals and health care managers, ergonomists and other professionals in environmental health dealing with daily practice.

Methods

The guidelines of the Cochrane Collaboration Centre serve as a starting point for this literature study (van Tulder et al., 1997). The purpose of these guidelines is to offer guidance to researchers preparing high-quality reviews. The steps to be followed are a literature search, formulation of in- and exclusion criteria, determination of methodological quality, gathering and analysis of the results, and description of the effect areas. Databases of Medline, Embase, Cinahl, and WebScience are used, as well as the Cochrane Collaboration Library and other scientific peer-reviewed articles. The search covers the period between 1985 and 2005. Because of the rather specialized issue, it was expected to find only a few references. Therefore, we searched over a twenty-year period. During the search a combination of words of 2 columns was used (see Table 1). The search was done with both MeSH and keywords.

Table 1. Sets of keywords and MeSH used in the search strategy

Physical load & factors	Musculoskeletal symptoms	Intervention	Results
lifting physical load	back low back pain musculoskeletal pain back pain injury lumbago disorders spinal disease backache	programme programme prevention evaluation management intervention ergonomic/ergonomics training implementation behaviour occupational vocational education	effect effectiveness effectively reduction behaviour sickness absence

The articles were selected by close reading titles and abstracts. Inclusion criteria were:

- the target group of the intervention are employees working in health care;
- the objective of the intervention is primary prevention of musculoskeletal symptoms;
- the intervention aims to reduce physical load by explicitly described education/training;
- an effect evaluation took place by means of an RCT, CCT or CT design;
- at least one of the following outcome variables is described: musculoskeletal symptoms, sickness absence, exposure to physical load;
- the article is written in the Dutch or English language.

Exclusion criteria were:
- the intervention consisted of physical exercise or introduction of mechanical aid only;
- the interventions focussed on employees on sickness absence only;
- the interventions focussed on individual employees.

A discussion ensued with the third author (AS) in case of doubt about in- or excluding a study (which resulted in the agreement that) when the same outcome variable was described by at least two studies, it was defined as an effect area. A method based on levels of evidence was used to synthesize the available information. The rating system was applied on each effect area and consisted of three levels of scientific evidence:
- strong: consistent findings in multiple high-quality studies;
- moderate: consistent findings in one high quality study and one or more low quality studies or more low-quality studies;
- insufficient: only one study available or inconsistent findings in multiple studies.

A study with a RCT or CCT design was labelled high quality, a study with a CT design low-quality. The findings of the studies were labelled inconsistent when less than 75% of the studies available reported the same conclusion.
Of the studies included the methodological issues were evaluated by using a criteria checklist (van Tulder et al., 1997) specifically developed for systematic reviews. The original checklist was intended for clinical examination, so five adjustments have been made mainly because the criteria involved were not applicable (see Appendix 1). The remaining categories were evaluated: sample size, study design and randomisation, follow-up period and instruments used. Because of structuring the variables, which were described at least two times, a taxonomy was used (Beaton et al., 2001).

Results

The literature search in the various databases resulted in the identification of 250 publications. Thirteen studies met the aforementioned inclusion criteria. Table 2 presents a summary of the studies with the type of intervention and the results evaluated of each intervention.
Nursing home nurses and coordinators are the two groups included in the study of Engels (et al., 1996, 1998). The study population in all thirteen cases are nurses or nursing aides/assistants, in most cases working in a hospital.

Table 2. Summary of studies included with population, kind of intervention, additional interventions and results

Author	Study population	Training intervention	Additional intervention	Results of intervention (region)
Hartvigsen et al., 2005	home care nurses N=345	-educated in body mechanics, patient transfer, and lifting techniques according to the Bobath-principle and use of low-tech ergonomic aids in small groups. -length of training is 2 hours meetings, 4 times during 7 months.	-	- no decrease of musculoskeletal symptoms (low back) - participants thought education was helpfull
Peterson et al., 2004	nursing assistants at state-run veterans' home N=53	-determination of risk-factors. -training package with data, minivideo's, hands-on demonstration and case studies. Length of training is unknown.	–	- no decrease of musculoskeletal symptoms or discomfort - no increase of general health - increased understanding of riskfactors, ergonomic principles and patient-handling techniques (=increased knowledge, p<0.01)
Fanello et al., 2002	hospital nurses, nursing assistants, cleaning staff N=272	- theoretical training in safe posture and patient handling. - 'on-the-job' training. - length of training is 6 days.	–	- no decrease of musculoskeletal symptoms (low back)
Johnsson et al., 2002	hospital and home care nurses N=51	- theoretical training in problem-solving (analysis model to select optimal transfer action) and practical training in patient transfer performance of 7 courses. - focus on patient perception, quality of care and risk factors.	–	- no decrease of musculoskeletal symptoms (neck/shoulder, low back) - less physical discomfort (p<0.05) - no decreased perceived physical exertion - improved technical performance of transfers (p< 0.00) - no decrease of job strain - no difference in effectiveness of learning models
Alexandre et al., 2001	nursing aides N=56	-education of ergonomic aspects in work. -train-the-trainer (physiotherapists).	physical exercise of 6 modules, 2 times a week, four months	- Decrease of musculoskeletal symptoms: cervical pain (last 2 months, p=0.01) and 7 days (p=0.00) and reduction of pain intensity last 2 months, p=0.003) lumbar pain intensity (last 7 days, p=0.01)
Yassi et al., 2000	hospital nurses, nursing assistants N=346	- 3 hours training of both experimental groups; problem based, hands-on educations of back care and handling techniques coupled with practice using equipment available on the wards.	ergonomic intervention: - safe lifting: use small manual equipment (group B) - no-strenuous-lifting group (group C) - use additional mechanical and other aid equipment	- no decrease of sickness absence - decreased musculoskeletal symptoms in B group (shoulder p=0.01, low back p=0.01) - less fatigue (p<0.00) - less physical discomfort (p<0.00) - decreased frequency of manual lifting in C group (p<0.00)
Lynch and Freund, 2000	hospital nurses N=104	- 1 hour training of nurses about risk factors for back injuries and control strategies including engineering controls and the use of proper body mechanics when handling patients, including a hands-on segment. - educate trainers (nurses).	ergonomic intervention: - use additional mechanical and other aid equipment	- lower sickness absence: low back injuries is 30% lower than average of 3 previous years. - decreased musculoskeletal symptoms (low back, p-=0.02) - decreased frequency of manual lifting (p=0.02) - increased knowledge of risk factors (p=0.01) - no increase in use of equipment or mechanical lifts

Author	Study population	Training intervention	Additional intervention	Results of intervention (region)
Engels et al., 1998	nursing home nurses N=225	- ergonomic-educational course for nurses, length course is unknown.	organisational intervention: - implementation of guidelines and protocols- imbedded programme into organisation by activities of a steering committee(appointing a trainer)	- no decrease of sickness absence - no decrease of musculoskeletal symptoms (neck, shoulder, upper back, low back, hip, knee) - no decrease of perceived physical load - no increase of knowledge - no decrease of perceived time pressure
Engels et al., 1998	nursing home nurses trainers N=24	- training reduction physical workload inherent to patient lifting and other nursing activities, length training is unknown. - coaching skills	–	- no increase of perceived exertion - improved technical performance of transfers / harmful postures p<0.01) - decrease of exposure of harmful postures and lifting (p<0.01)
Lagerstrom et al., 1998	female hospital nurses N=348	-1-day training in patient handling - course stress management and – control	physical exercise - fitness	- no decrease of musculoskeletal symptoms (neck/shoulder, elbows, hands, low back, knees, ankles/feet) increase of upper back (p<0.00) and hip symptoms (p<0.00) improved technical performance of transfers, increased motivation using learned transfers
Feldstein et al., 1993	nurses and nursing assistants N=55	-2-hour instruction session about proper body techniques, transfer techniques, use of equipment and a problem identification session on environmental hazards. - practice every two weeks, total 8 hours - problem-solving	–	- no decrease of musculoskeletal symptoms (low back) (pain and fatigue) -improved technical performance of transfers (19%, p=0.00)
Garg and Owen, 1992	nursing home nurses N=57	- determination of patient handling tasks - training nursing assistants in use of devices (2 training sessions of 2 hours) - applying techniques to patient care	ergonomic intervention - modifying toilets and shower rooms	- decrease of musculoskeletal symptoms (back injuries, 43% lower) - decrease of perceived exertion (p<0.01) - decrease of biomechanical stress (p<0.01) - decrease of exposure of patient transfers
Videman et al., 1989	N=255 nursing students	-training on patient-handling skills described by Troup and Rauhala, total 40 hours over 2.5 years.		- no decrease of musculoskeletal symptoms (back pain) - higher skill assessment than control group (p<0.001)
Wood, 1987	Nurses of a geriatric hospital N=3 x 75-bed units	-evaluation of ability to perform safely a transfer -trainer follows nursing staff individually during work for 30 minuters and gives feedback -summarizing, 1- hour classroom demonstration covering body mechanics, lift and transfer techniques and use of equipment	- personnel programme; increasing the effectiveness of the existing procedures used to process wage-loss claims.	-decrease of back injuries (in combination with additional intervention) (p<0.001)

Fanello (et al., 2002) also included cleaning staff. Johnsson et (al., 2002) and Hartvigsen (et al., 2005) included nurses working in a hospital and home care nurses, The nursing aides in the study of Alexandra (et al., 2001) reported having more than 6 months low back pain without sickness absence. In one study, the study population were students at baseline and graduated nurses at follow-up (Videman et al., 1989).

A theoretical and practical training about characteristics of physical load, risk factors, ergonomic rules and patient transfers made part of all interventions. The training-part lasted from one hour (Lynch and Freund 2000) till six days (Alexandre et al., 2001).

In the study of Johnsson (et al., 2002) the participants learned to work with a problem solving model which meant that in transfer situations the carer had to consider his or her own capability, the resources and needs of the patient and the possibilities and limitations of the environment, and accordingly choose the optimal patient handling method. Feldstein (et al., 1993) also uses a kind of problem solving session.

Education and training programmes are often used to improve the competence of employees, also in health care. The current tendency is to combine different approaches in a single programme since various interrelated factors may cause musculoskeletal problems. In the selected studies seven interventions combine training and education with an additional intervention. Yassi (et al., 2000), Lynch and Freund (2000) and Garg and Owen (1992) combine training with the introduction of mechanical equipment to assist in patient transfers. Training, physical exercise and fitness is combined by Alexandra (et al., 2001) and Lagerstrom (et al., 1997). By means of installing a steering-committee in a nursing home Engels (et al. 1998) paid attention to organisational aspects such as commitment and co-operation of the manager. The responsibilities of this committee include finding solutions to reduce the physical workload, attending meetings with coordinators and stimulating activities which contribute to the continuity of the programme. In the study of Wood (1987) a Personnel Programme was followed by a Back Programme.

Fifteen different outcome variables are described in the thirteen studies. Of these perceived physical exertion, job strain, effectiveness of the learning model, postural load, perceived time pressure, the motivation of using the transfers learned and biomechanical stress are described only once. The eight variables described at least two times are classified in a taxonomy, existing of economic, health and ergonomic outcomes. In this taxonomy we assumed musculoskeletal health and wellbeing will influence sickness absence (economic outcome) (Hignett, 2001). Ergonomic interventions can be used tackling problems due to physical load and manual handling, which, in turn, can influence musculoskeletal health (Kemmlert, 1996). In the category economic outcomes absenteeism due to musculoskeletal problems is mentioned 4 times. The category health outcomes contains musculoskeletal symptoms (13), fatigue (2), physical discomfort (2) and perceived physical load (4). The category ergonomic contains technical performance of transfers (5) frequency of manual lifting and working in a harmful postural load (4) and knowledge of risk factors at work and ergonomic principles (3).

Methodological issues
Table 3 summarizes the methodological issues of the studies included.
Three of thirteen studies have a RCT design (Alexandre et al., 2001, Fanello et al., 2002, Yassi et al., 2000). A control group is present in eight studies in which a pre- and post-test was performed (Engels et al., 1996, Feldstein et al., 1993, Hartvigsen et al., 2005, Johnsson et al., 2002, Lynch and Freund 2000, Peterson et al., 2004, Videman et al., 2005, Wood et al., 1987). For reasons of the study design these eleven studies are rated as high quality. Two studies do neither include a control group nor a RCT design and are therefore rated as low quality studies (Garg and Owen 1992, Lagerstrom et al., 1997). The smallest sample size consists of 51 respondents (Johnsson et al., 2002) and Yassi's (et al., 2000) sample size of 348 respondents is the largest.
The follow-up period ranges from directly after the intervention (Garg and Owen, 1992, Lynch and Freud 2000) to four years (Lagerstrom et al., 1997) after the intervention. All studies use self-report instruments such as questionnaires and visual analogue scales. Johnsson (et al. 2002), Lynch and Freund (2000), Engels (et al. 1998), Feldstein (et al. 1993), Garg and Owen, (1992) and Videman (et al. 1989) make use of observational techniques for measuring outcome variables. Knowledge of risk factors in work is measured with a self constructed test (Lynch and Freund 2000, Peterson et al., 2004). Other techniques used in the studies are interviews (Garg and Owen, 1992, Lagerstrom et al., 1997), specific motorial tests (Feldstein et al., 1993), and biomechanical stress-measurement (Garg and Owen 1992). Wood (1987) counts the number of wage loss claims as a result of back incidents. At baseline the intervention and control group in the study of Engels (et al., 1998) differ in characteristics: the control group has more managerial tasks and a larger percentage is performing exercise in spare time. The intervention group

Table 3. Methodological issues of included studies

Author	Study design	Intervention group	Follow-up length	Instruments
Hartvigsen et al., 2005	CCT baseline and follow-up with control group -control group N=115	N=140	2 years after baseline	- Nordic questionnaire* supplemented with information on number of episodes of LBP and care seeking due to LBP during the past year.
Peterson et al., 2004	baseline and follow-up with 3 groups -control group N=14 -training and reinforcement by research assistant -training and reinforcement by registered nurses	nursing assistants N=17 registered nurses N=8	1 month after intervention	- questionnaires to asses top 20 risk factors and obstacles† - videotape to evaluate work environment - knowledge test
Fanello et al., 2002	RCT with matching (sex, age and function) Control group N=136	N=136	24 months	- EIFEL Scale*
Johnsson et al., 2002	CT baseline and follow-up with 2 intervention groups	N= 51, divided into 7 groups	6 months	- observation from video with 7- item checklist - Nordic scale* - Borg scale*
Alexandre et al., 2001	RCT Control group N= 29	N=27	Immedialety after intervention	- VAS scale*
Yassi et al., 2000	RCT with 3 groups A = control group N=103; B = safe lifting; C = no strenuous lifting	N=116 (B) N=127 (C)	6 months and 12 months	- interview - VAS scale*, SF 36*, DASH*, Owestry LBP Disability* - absenteeism database
Lynch and Freund, 2000	CT baseline and follow-up measuring with control group N=45	N=59	1 month and 2 months	- knowledge test† - observation in work situation with checklist† - questionnaire
Engels et al., 1998	coordinators: baseline and follow-up measuring with control group (N=12) in a laboratory setting	N=12	3 months and 15 months	- observation (OWAS)* from video - Borg scale* - Checklist†
	nurses: baseline and follow-up measuring with control group (N=126)	N=75	12 months	- knowledge examination† - Nordic-scale*
Lagerstrom et al., 1998	CT baseline and follow-up measuring	N=348	every 12 months during a 4 year period	- Nordic-scale*, physical exposures, patient handling, Borg CR-scale* - evaluation of training - interviews with management and nurses

Author	Study design	Intervention group	Follow-up length	Instruments
Feldstein et al., 1993	Baseline and follow-up measuring with control group (N=25)	N=30	1 month	- questionnaires (pain, general information) - flexibility test - proprioception test - observation
Garg and Owen, 1992	CT baseline and follow-up measuring	N=57	immedialety after intervention	- Borg RPE- scale* - observation - biomechanical model
Videman et al., 1989	CCT baseline and follow-up measuring, control group (N=113)	N=87	every 3 months during school and 1 year after graduation	- assessment of skills on video with checklist† - assessment of anthropometric aspects - questionnaires MHQ*, MPI*, LES* (cognitive, emotional and motivational aspects, health locus of control, satisfaction and strain)
Wood, 1987	CCT measuring of a 1 year period before and after the intervention with 1 control 75-bed unit.	N= 2 x 75-bed units	1 year after the intervention	- count number of wage-loss claims caused by interaction with patients

*psychometric properties satisfactory
†Instrument is not described

appears to have more symptoms of the shoulder and upper arm. Lynch and Freund (2000) and Yassi (et al., 2000) do not address the issue of the inclusion of groups with equal characteristics.

Each study explicitly specifies criteria for the selection of the target groups; the intervention and the outcome variables are described properly as well. Information about other simultaneous interventions affecting the target group is not mentioned by any of the studies, neither are the opposite effects of the intervention under study. Drop-outs within each study with the exception of the study of Yassi et al. (2000) in which information about this issue is not available, is known (0-30%) and seems acceptable.

Level of effect

The effect areas, listed in table 4, are indicated + when positive differences were found and - when no differences were found.

The aim of all thirteen studies has been to establish a decrease in (the frequency of) musculoskeletal symptoms. Four of them (Alexandre et al., 2001, Garg and Owen, 1992, Lynch and Freund, 2000, Yassi et al., 2000, Wood 1987) actually report a significant decrease, an almost fifty percent success rate.

By applying the rating system it is possible to determine the level of evidence of each effect area. As to the effects of preventive occupational interventions aimed at lowering physical load, strong evidence is available that these interventions result in less physical discomfort, improved technical performance of transfers and lowering the frequency of manual lifting. More than 75% of all results point in the same direction. In addition, the evidence that interventions result in a decrease of absenteeism due to musculoskeletal problems, a decrease in musculoskeletal symptoms, less fatigue, lower perceived physical load and increased knowledge of risk factors in work is insufficient. Findings on these areas were inconsistent in multiple studies.

With regard to the ergonomic effect-area the results obtained are more positive as compared to the health and economic effect-area. In the ergonomic area 11 out of the 12 results mentioned are positive. In the health area 50% (10 out of 21) are positive. One positive result is found among the four results described in the economic area.

One type of intervention, education and training, has been evaluated by six studies (Fanello et al., 2002, Feldstein et al., 1993, Johnsson et al., 2002, Peterson et al., 2004). Not one of them found a decrease of musculoskeletal symptoms. Six studies (Alexandre et al., 2001, Engels et al., 1996, Garg and

Table 4. Results on the economic, health and ergonomic level and eight effect areas

		Taxonomy	Economic	Health				Ergonomic		
Author	Design	Effect areas:	Lower absenteeism due to musculo skeletal symptoms	Decreased musculo skeletal symptoms	Less fatigue	Less physical discomfort	Lower perceived physical load / exertion	Improved technical performance of transfers	Lower frequency of manual lifting or harmful postures	Increased knowledge
		Additional intervention:								
Yassi et al., 2000	RCT	Ergonomic intervention	-	+	+	+			+	
Alexandre et al., 2001	RCT	Physical exercise		+						
Fanello et al., 2002	RCT	-		-						
Hartvigsen et al., 2005	CCT			-						
Peterson et al., 2004	CCT	-		-						+
Johnsson et al., 2002	CCT	-		-		+	+	+		
Lynch and Freund, 2000	CCT	Ergonomic intervention	+	+					+	+
Engels et al., 1998 -coordinators -nurses	CCT	Organizational intervention	 - -	 -			 - -	 +	 +	 -
Feldstein et al., 1993	CCT	-		-	-			+		
Videman et al., 1989	CCT			-				+		
Wood, 1987	CCT	Organizational intervention		+						
Lagerstrom et al., 1998	CT	Physical exercise		-				+		
Garg and Owen, 1993	CT	Ergonomic intervention		+			+		+	
(+/total effect area)			1/4	5/13	1/2	2/2	2/4	5/5	4/4	2/3
(+/total of kind of outcome)			1/4	10/21				11/12		

\- = no effects are found
\+ = proof for effects

Owen, 1992, Hartvigsen et al., 2005, Lagerstrom et al., 1997, Lynch and Freund 2000, Videman et al., 1989, Yassi et al., 2000) evaluated two types of interventions simultaneously, three of them (Garg and Owen, 1992, Lynch and Freund, 2000, Yassi et al., 2000) combined education with ergonomic interventions, two (Alexandre et al., 2001, Lagerstrom et al., 1997) combined education with physical exercise and two (Engels et al., 1996, Wood 1987) combined education with organisational interventions. The two studies that combined education and ergonomic interventions both found a decrease of musculoskeletal symptoms and lower exposure of manual lifting. Which part of the intervention is responsible for which part of the results remains unclear. Improved technical performance of transfers was found in five studies (Engels et al., 1996, Feldstein et al., 1993, Lagerstrom et al., 1997, Lynch and Freund, 2000, Videman et al., 1989) whereas musculoskeletal symptoms were unchanged. This information indicates that training and education alone is not sufficient for a decrease in musculoskeletal symptoms. Training and education combined with an ergonomic intervention, i.e. use of additional mechanical or other aid seems to be effective and can partly be explained by a decrease in frequency of manual lifting.

Discussion

The aim of this review is to obtain more insight in the effects of occupational interventions for primary prevention of musculoskeletal symptoms in health care workers. Knowledge of the effects is useful for decision-making about development and implementation of prevention programme. Interventions directed towards a decrease in musculoskeletal symptoms in health care workers are interesting because of the specific demands of patient-related work processes and the working population as such. Thirteen studies met the inclusion criteria and eight result areas were determined. About these effect areas, we found that ergonomic effect-areas have more positive effects than health and economic effect-areas. A possible explanation may be that the relation between the intervention and the ergonomic effect area is direct; the relation between practical training in performing patient-transfers and improved technical performance is obvious. The relation between an intervention and sickness absence is much more complicated. Many individual and organisational factors influence the decision of the employee to report sick.

The results of this review bring us to the conclusion that training and education alone is not sufficient for a decrease in musculoskeletal symptoms. However, in combination with an ergonomic intervention i.e. the use of additional mechanical or other aid equipment, a decrease of musculoskeletal symptoms can be achieved. The use of multifactorial interventions in daily practise seems to be preferable. This conclusion is in line with the findings of Johnston (et al. 1994), who indicated in a review that training alone is insufficient.

In the present review five out of thirteen studies found a significant decrease of musculoskeletal symptoms, which is less than half of the studies. Musculoskeletal symptoms are often stable in time. It has been stated that once musculoskeletal symptoms have developed, they may not necessarily be cured, even if a new well-developed work technique has been introduced among the employees (Kemmert et al., 1993). Therefore it is questionable whether it is possible to measure a decrease in musculoskeletal symptoms after one year or earlier. Another issue is the definition of the outcome variable i.e. musculoskeletal symptoms. In this review, all studies evaluated low back pain as a complaint area. Some studies also involve symptoms of neck and shoulders and two studies involve other regions of the body. A complaint is broadly defined, the type of complaint is not circumscribed and ranges from acute traumatic injury to work-related musculoskeletal disorder. Ideally, one uses complaint rates as the outcome variable in an evaluation of interventions, since the ultimate goal of the intervention is to prevent injuries. In case a reduction of the targeted injuries is obtained, it is likely that the intervention is effective. So far however, it is not known how an intervention directed towards occupational injury is working exactly. Further research is needed to understand which type or characteristic of symptoms or injury the intervention is trying to prevent (Zwerling et al., 1997). More specific outcome variables are necessary in order to understand the underlying mechanisms.

Further explanation of the contradictory results may be that different work-related factors are relevant for new episodes and/or for the maintenance of musculoskeletal symptoms. Evidence is available that in the nursing profession low-back pain and its consequences are affected by physical and psychosocial factors (Hoogendoorn et al., 2001).

Two of the studies included (Engels et al., 1996, Johnsson et al., 2002) evaluate psychosocial factors in relation to musculoskeletal symptoms, in both studies no significant differences were established.

Most of the studies included in this review have some limitations concerning study design, definition of samples, power or outcome variables. Retrospective self-report questionnaires generate uncertainties as a result of recall bias and may influence the registered data as to frequency as well as the start and intensity of a period of musculoskeletal symptoms.

Although beyond the scope of the present paper we realise that the quality of the training and the organisational factors are influencing the effects of intervention-programmes (Bongers et al., 1993). A variety of individual factors, such as motivation, attitude, usefulness and relevance of the newly learned knowledge or behaviour all contribute to the transfer from training to job.

One specific methodological shortcoming within this study should be mentioned. Due to the inclusion criteria, the number of articles included is relatively low. However, the aim of the present review was to obtain information about the effects of interventions including training and education; the information obtained is useful for us in order to execute additional research into prevention programmes.

Appendix 1 - Criterion checklist of methodological quality

Criterion	
Eligibility criteria are specified	
Randomisation is performed	
Treatment allocation is concealed	NA[1]
Similar groups at baseline regarding the most important prognostic indicators	
Care provider is blinded to the intervention	NA[1]
Explicitly described intervention	
Co-interventions are avoided or comparable	
Compliance in groups is acceptable	
Patient is blinded to intervention	NA[1]
Outcome assessor is blinded to the intervention	NA[1]
Adverse effects are described	
Withdrawal/drop-out rate is described and acceptable	
Short-term follow-up measurement is performed	
Long -term follow-up measurement is performed	
Timing of the outcome assessment in both group is comparable	
Sample size for each group is described	
Intention-to-treat analysis is performed	NA[1]
Variability and point measurements are described for the primary outcome measures	

[1]NA not applicable

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