

# iga.Report 13e



## Effectiveness and economic benefits of workplace health promotion and prevention

Summary of the scientific evidence 2000 to 2006  
**Ina Sockoll, Ina Kramer, Wolfgang Bödeker**

### The Initiative Gesundheit und Arbeit (IGA)

The Initiative Gesundheit und Arbeit (Initiative for Health and Work) is a collaborative project between German statutory health and accident insurance institutions. They work together on the prevention of work-related health risks. Prevention approaches are developed across the sectorial boundaries between different social security agencies and the initiative makes existing methods and knowledge available for application.

In IGA work BKK Bundesverband (Federal Association of Company Health Insurance Funds), Deutsche Gesetzliche Unfallversicherung (German Social Accident Insurance), AOK-Bundesverband (Federal Association of Local Health Insurance Funds) and vdek (Association of Substitute Health Funds).



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# 1 Introduction – Evidence-based practice for workplace health promotion and prevention

Health promotion and prevention are attracting increasingly interest in Germany as well. Preventing diseases is not only considered to be an independent objective, it is also pointed out that the individual and social medical costs are considerably reduced by prevention.

The workplace is considered to be an appropriate setting for health promotion and prevention. Understood as a modern company strategy for improving health at work, workplace health promotion includes optimizing the work organization and working environment as well as promoting the active involvement of all persons concerned. It therefore aims both at creating a healthy work environment and giving incentives for employees for a health-conscious behavior, thereby improving job satisfaction, reducing absenteeism and lowering medical costs.

According to a representative survey conducted by the Institut für Arbeitsmarkt- und Berufsforschung (Institute for employment research, IAB) only 20% of all companies report to carry out and to support actions for protecting and promoting employee health beyond the legal provisions (Hollederer 2007), but this percentage strongly varies depending on the company size or the sector: for example, 90% of the companies employing more than 1.000 people or 60% of the vehicle manufacturing companies offer actions of workplace health promotion.

As workplace prevention is gaining in importance and becoming more and more common, the question whether the actions performed actually provide the expected benefits arises increasingly. Already in 2003, the Initiative Gesundheit und Arbeit (IGA – Initiative Health and Work) published a systematic synopsis of the scientific evidence base for health-related and economic benefits of workplace health promotion and prevention (Kreis and Bödeker 2003). The publication was in great demand and represented the starting point of a series of follow-up activities for IGA. The present report aims at updating and extending the previous literature study. In addition to complementary studies in the field of behavioral prevention interventions, in particular studies examining organizational interventions and environmental changes at the workplace should be included.

## 1.1 The claim for evidence-based practice in prevention

The fact that actions of workplace health promotion and prevention should be effective and useful is not a new claim, but already form the basis of action of the reimbursement insti-

tutions which bear the costs of prevention. For example, the so-called § 20 action guideline describes common and uniform fields of action of the statutory health insurance for primary prevention and health promotion and requires: “As a matter of principle, the prerequisite of an individual preventive intervention is the fact that the effectiveness of the intervention has been proven in expert opinions, studies or meta-analyses (evidence-based practice) (effectiveness of the prevention principle)”. This complies with § 12 SGB V (German Social Security Code V) according to which the health insurance funds must not approve services that are unnecessary or uneconomical. The claim of effectiveness also exists for institutions bearing the costs of preventive actions of the accident insurance fund that, according to § 1 SGB VII, are constrained to prevent work accidents and occupational diseases as well as work-related health hazards with all suitable means. Finally, companies consider commitment to workplace health promotion and prevention also as investment that should result in visible monetary or other benefits that can be quantified in money. Today, studies on effectiveness and benefits are often described using the currently popular expression of “evidence-based practice”.

## 1.2 What does evidence-based practice mean?

In the proper sense, evidence-based practice only means assessing whether the intended goals are actually achieved by certain measures. Besides this plain meaning, the expression has been popularized since the approach of evidence-based medicine (EBM) has been developed in the early 1990s. Since then, EBM has become the epitome of modern, knowledge-based medicine based on a rational decision between treatment options. In the meantime, the expression has been applied to other fields, often even if the underlying approach of EBM was not known or meant.

The approach of EBM is understood as the conscientious, explicit and reasonable use of the currently best external evidence for decisions in the medical treatment of patients (Sackett et al. 1996). The external evidence results from the systematic compilation and evaluation of scientific studies. The preparation, updating and spreading of systematic reviews is expected to create a base of scientific information which allows an objective assessment of the current state of research. This approach is followed successfully by the Cochrane Collaboration on an international level and the term of Cochrane Reviews has largely become a synonym for systematic reviews.

## 1.3 What are systematic reviews?

Generally, the multitude of scientific publications is immense for practitioners. Therefore, reviewing the available literature and assessing the state of knowledge comprehensively is a traditional field of work in all scientific disciplines. One possible approach is the so-called narrative review which is undertaken with no defined criteria – i.e. follows no systematic method

either. As a rule, narrative reviews are marked by the special interest of a certain scientist. In these papers often it is also not clear whether actually all available literature on a topic was searched through or which appraisal criteria were used. Therefore, the authors' conclusions cannot clearly be reproduced and consequently its accuracy cannot be verified.

In a systematic review, biases are eliminated to the largest possible extent by using an explicit and standardized methodical approach. This is intended to minimize biases at all stages of the preparation process (identification and selection of relevant studies, data collection and analysis) and to create the largest possible extent of transparency. For these purposes, in advance a clear search strategy is defined which also can be reproduced by other scientists. The inclusion of unpublished studies in addition to publications identified from electronic databases as well as increasingly non-English literature is another objective. Furthermore, the author defines a priori criteria concerning contents and methods which studies to include in the review must fulfill.

Systematic reviews that are conducted within the scope of the international Cochrane Collaboration go even beyond this. For Cochrane Reviews, first of all, it is necessary to prepare a protocol defining the intended approach which is peer reviewed by a Cochrane review group. During the data extraction process, several reviewers usually work together. Moreover, Cochrane reviewers undertake to update the review every two years by including newly published studies (cf. Timmer and Antes 2006). It has to be underlined that meanwhile there are also systematic reviews of other institutions that model themselves on the methodical approach of the Cochrane Collaboration.

### 1.4 How can you assess effectiveness?

A systematic compilation of the scientific literature, however, does not complete an evidence assessment, since the results still have to be synthesized. It has to be decided at this point at the latest e.g. which study should be given preference to in case of contradictory results. To this effect, often so-called hierarchies of evidence are created expressing the epistemological validity of study types.

Randomized controlled trials (RCT) are considered the methodical "gold standard" since they present the lowest probability of systematic biases. Like in all controlled studies, a group of persons receives an intervention (e.g. a course for weight reduction "Mediterranean cuisine for beginners") and is then compared with a control group (employees who did not participate in the course) e.g. regarding to weight changes. In order to avoid that mainly those employees who are slim anyway, but are interested in good food participate in the course, thus a lower average weight would not be a course outcome, in a RCT the persons are randomly assigned to the groups. Thus, it is left to chance whether someone is allowed or not to participate in the course. After randomization, the two groups are expected

to be similar concerning any influencing factor except the intervention. From the epistemological point of view, a RCT is on a higher level than a simply controlled study – according to the rationale mentioned above. On the other hand, both study types are considered to be more significant than case studies or expert opinions (Fig. 1-1). Criticism of an application of the approach of evidence-based medicine to health promotion and prevention has aroused in particular due to this idea of evidence hierarchy and the cognitive value of the study types (Bödeker 2006).

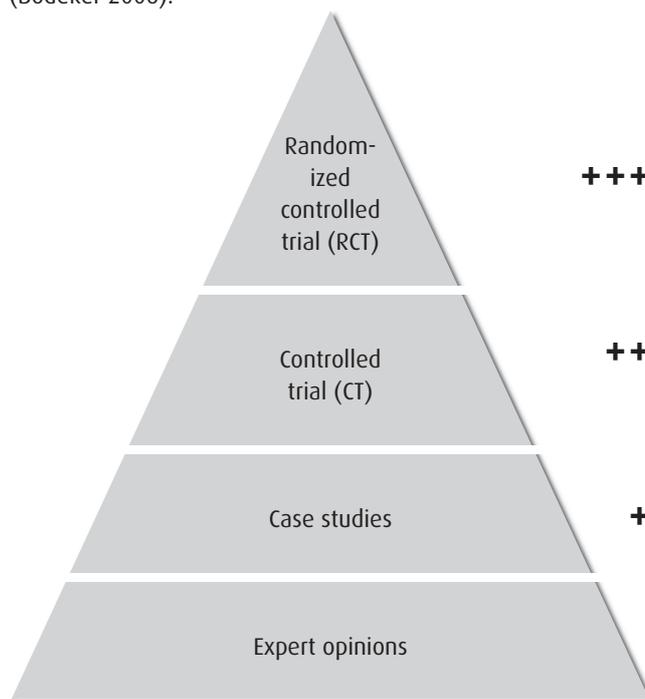


Fig. 1-1: Evidence hierarchy according to the estimated significance of study types

### 1.5 Are health promotion and prevention something special?

According to critics, evidence-based practice in the sense of evidence-based medicine cannot simply be applied to health promotion and prevention. It is underlined that the RCT may be an inadequate study design in health promotion since interventions of health promotion often are more complex than e.g. the administration of drugs. Workplace health promotion should be as comprehensive and "tailor-made" as possible, that is adapted specially to the circumstances prevailing in the company. Since, however, these circumstances could differ largely between companies, the actions themselves often could not be compared either. Furthermore, EBM would require sufficient study data that often does not exist in the fields of health promotion and prevention. On account of the common heterogeneity of studies (e.g. regarding contents, outcomes, study population, study design) evaluation by means of meta-analysis would not be possible and/or reasonable in the field of workplace health promotion and prevention.

The discussion about the adequate approach of evidence-based practice in health promotion and prevention is continued on an international scale inside and outside the Cochrane Collaboration. The analysis of the adequacy of an evidence hierarchy and the question how the approach of evidence-based practice can be developed in a reasonable way in order to take into account the particular requirements in health promotion are in the centre of the debate. At present, there has not been found any consensus on such a reasonable approach (Kreis 2006).

## 1.6 What is the benefit of this report?

The IGA-Report 3 on the benefits of workplace health promotion and prevention published in 2003 has been in very high demand. Translated into English and Italian by users in the meantime, the survey was used for the preparation of prevention approaches in prevention practice, science and politics. The report was the starting point for follow-up activities for IGA as well. These activities deal with the evaluation of the "grey literature" from the German-speaking area (Kramer and Kreis 2007), but also with the issue of methods of evidence-based practice (Bödeker and Kreis 2006) and the estimation of a prospective economic benefit in workplace health promotion (Kramer 2007).

Based on the discovery that the topic has already been treated in a large number of reviews scattered to several disciplines of science, the path of a "review of reviews" has been followed in the IGA-Report 3. Reviews that already had undergone a peer review process by a scientific journal were included in the first place. These reviews were grouped by topics, the results were extracted and any existing different statements on the same topic were underlined. Important original results were the synoptic recommendations on what should be ensured and avoided when implementing actions of workplace prevention.

During the last years a range of new studies on the benefits of workplace health promotion and prevention has been published. On account of the persistent large demand an update of the IGA-Report 3 suggested itself. The present report follows the approach of the previous report, but includes publications between 2000 and summer 2006. In addition, the search strategy was modified to identify and include more safely papers on organizational interventions. Nevertheless, the new report focuses on behavioral interventions as well since the German-language definition of „Verhaltensprävention“ (individual-focused preventive interventions aiming at behavior change) and „Verhältnisprävention“ (organizational-focused preventive interventions involving environmental changes) is not spread internationally from the linguistic or conceptual point of view. The largest part of literature comes from the USA and focuses mainly on actions of behavioral prevention.

Although the reviews included in this report are systematic reviews, they mostly do not comply with the methodical stan-

dards of the Cochrane Collaboration. In contrast to the IGA-Report 3, however, relevant Cochrane reviews could be identified and analyzed for the present report as well. This clearly shows that during the last years the fields of action of the Cochrane Collaboration have been extended effectively and thus corresponding high-quality reviews have already been conducted.

The present report should be understood as a survey of the scientific evidence on the effectiveness and the benefits of workplace health promotion and prevention. In the first place, it is intended as a decision-making aid for prevention practice and policy. The ultimate aim is to increase the quality of actions as well as to spread workplace health promotion and prevention.

## 1.7 References

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## 2 Search strategy and inclusion criteria

The project aimed to include as complete as possible all relevant scientific reviews published between 2000 and August 2006. Research was carried out using literature databases and Internet search engines as well as searching Internet pages of relevant organizations and various journals by hand. Included were papers published in German or in English language which assess interventions of workplace health promotion and prevention, both individual- and organizational-focused.

### 2.1 Literature databases and search engines

We accessed the following databases and search engines:

- MEDLINE via PubMed,
- EMBASE,
- Cochrane Library (Issue 1 & 2, 2006),
- NeLH (National electronic Library for Health),
- HighWire Press,
- Google as well as
- Google Scholar.

Literature search in databases as well as research using Internet search engines was done in several steps. The search strategy was heavily based on the strategy used for the precursor project. Furthermore, we followed the recommendations of the Occupational Health Field of the Cochrane Collaboration for searching publications on effects of occupational health interventions (Verbeek et al. 2005).

First of all, a simply search was carried out using single key words and word combinations such as Evaluation – evaluation, Gesundheitsförderung – health promotion, Gesundheitswesen – public health, Metaanalyse – meta-analysis, Prävention – prevention, Kosten-Nutzen-Analyse – cost-benefit analysis, Wirksamkeit – effectiveness. Then, more specific terms and their combinations were used. Table 2-1 shows an example of a combined search.

Tab. 2-1: Example of a search request in MEDLINE via PubMed

|                                                                      |
|----------------------------------------------------------------------|
| Presetting review/meta-analysis:                                     |
| • (occupational health)                                              |
| • (worksite health promotion)                                        |
| • (organizational health promotion)                                  |
| • (occupational health promotion)                                    |
| • (industrial health promotion)                                      |
| • (comprehensive worksite health promotion)                          |
| • (behavioural health promotion) AND (work OR worksite OR workplace) |

|                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------------------------------|
| • (occupational health) AND (prevention OR promotion)                                                                                          |
| • (worksite health promotion) AND (environmental intervention OR organizational intervention OR environmental change OR organizational change) |
| • (effect*) AND (intervention) AND (prevent*) AND (work* health promotion OR workplace wellness program* OR occupational health)               |
| • (work* health promotion OR work* prevention) AND (cost OR cost-benefit OR cost-benefit-analysis OR economic* OR return on investment)        |

### 2.2 Internet pages of relevant organizations and manual search

In addition to database search, the Internet pages of the following institutions conducting systematic reviews in the field of health promotion/public health have been examined:

- Cochrane Collaboration including different Cochrane Centres,
- Centre for Reviews and Dissemination (University of York),
- The Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre),
- Campbell Collaboration,
- Centers for Disease Control and Prevention (CDC) with the Guide to Community Preventive Services.

Other organizations and/or institutions that seemed to be relevant to the present report were on an international scale the Institute for Work and Health (IWH, Canada), the European Agency for Safety and Health at Work, the National Institute for Occupational Safety and Health (NIOSH) and the British Occupational Health Research Foundation (BOHRF). On a national scale, in particular the Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA, Federal Institute for Occupational Safety and Health) and the Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (BGIA, Institute for Occupational Safety and Health of the German Berufsgenossenschaften (BG), the institutions for statutory accident insurance and prevention) were examined.

Furthermore, we used University libraries and the internal library of the BKK Bundesverband (Federal Association of Company Health Insurance Funds) for complementary manual search. Already existing archives such as an internal literature database were used additionally for research. Identified papers were also screened for further publications. References mentioned in the examined literature often give an additional overview of materials published on the topic. In addition to various limits and filters that can be set for a search, some databases also offer the possibility of listing related articles. Examining these articles may give additional results.

## 2.3 Inclusion criteria

The abstracts of the identified publications were read and the full text of articles that seemed to be relevant was procured. In individual cases – in particular for monographs published by the authors themselves – it was not possible to procure the entire texts. The decision on the final inclusion was made using the following predefined inclusion criteria:

- publication during the period from 2000 to August 2006,
- only systematic reviews (peer reviewed),
- publication language German or English,
- workplace interventions,
- investigation of general health outcomes or risk factors as well as
- investigation of disease-specific outcomes of musculoskeletal disorders, mental ill-health and cardiovascular diseases.

Thus, particular importance was attached to the inclusion of publications reporting general health outcomes of preventive interventions, such as satisfaction with overall health or prevalence of risk factors. For reasons of capacity, reviews on disease-specific outcomes, however, were included for the three groups of diseases mentioned above only. Publications such as for example on the evidence of workplace interventions to prevent bronchial asthma were not taken into account. Moreover, when reading the publications indicated to be specifically aimed at cardiovascular diseases, we found out that no “hard” outcomes such as the incidence of myocardial infarctions were examined in these publications, but the prevalence of known risk factors such as smoking or stress. This is why this evidence is presented in the following chapter on interventions for promoting health and well-being. The number of the identified systematic reviews using this search strategy and the number of studies comprised are shown in the following table.

Tab. 2-2: Number of included studies on workplace-related health promotion and prevention

| Field of intervention                        | Number of included reviews | Number of comprised studies |
|----------------------------------------------|----------------------------|-----------------------------|
| Measures for promoting health and well-being | 17                         | > 350                       |
| Prevention of mental ill-health              | 9                          | ≈ 300                       |
| Prevention of musculoskeletal disorders      | 19                         | > 400                       |

## 2.4 References

Verbeek J, Salmi J, Pasternack I, Jauhiainen M, Laamanen I, Schaafsma F, Hulshof C, Dijk van F: A search strategy for occupational health intervention studies. *Occupational and Environmental Medicine*. 62(10):682-7. 2005

## 3 Effectiveness of workplace interventions for promoting health and well-being

Do exercise programs increase employees’ fitness? Does a smoking cessation program contribute to an increase in the number of employees stopping smoking? Can employees’ eating habits be influenced decisively by means of healthy food offered in canteens? What actually is the effect of workplace programs for weight control? Do health circles improve the working conditions? Has the effectiveness of participation been proven? The list of questions could be continued easily, since it reflects nothing but the range of activities of workplace health promotion and prevention on the level of behavior as well as of the workplace conditions. But what is the general effectiveness of the measures used? Can the targets aimed at – minimizing health-related risk factors, activating health potentials, improving well-being at work as well as enabling and empowering employees – actually be achieved?

For the selected publication period, in addition to two reviews that have already been included in the IGA-Report 3 and have been taken over for the present work (Janer et al. 2002, Pelletier 2001), 15 systematic reviews were found that are dealing with the general effectiveness of workplace strategies. Each of these reviews addresses one or several of the following fields of intervention: programs for increasing physical activity, strategies for smoking cessation, approaches for promoting healthy nutrition, programs for weight control, employee assistance programs for alcohol prevention, multi-component programs, participatory ergonomic interventions and health circles.

Most of the studies analyzed used changes in known health-related risk factors (e.g. tobacco use, overweight, increased cholesterol levels, high blood pressure) and/or changes in health-related behavior patterns (e.g. nutrition, exercise) as outcome measures; furthermore, important outcomes such as prevalence, absenteeism or changes in working conditions are found.

The results of the reviews are presented on the following pages – structured according to the fields of intervention found. When more than one systematic review could be assigned to a field of intervention, the results of all reviews on this topic were first summarized in a separate section. When only one review was available, its key results precede the actual individual presentation. The findings of reviews comprising more than one field of intervention (Janer et al. 2002, Matson-Koffman et al. 2005) are not reported in succession for reasons of clarity. Instead, they are presented separately under the corresponding field of intervention. If possible, the reviews were also sorted according to the particular level of intervention they are dealing with (individual or organizational level). Findings of papers which could not clearly be allocated in this context (e.g. Janer et al. 2002) can be found at the beginning of a section.

Further information on the individual reviews are given in table A-1 in the annex, the structure of which follows the present chapter.

### 3.1 Programs for promoting physical activity

According to the four available reviews (Janer et al. 2002, Marshall 2004, Proper et al. 2003, Matson-Koffman et al. 2005), the state of evidence for measures for increasing the employees' physical activity currently is as follows:

In the field of preventive interventions aiming at the individual, there is strong evidence that exercise programs may increase the physical activity of employees and prevent musculoskeletal disorders (for the latter also see chapter 5). Individual exercise programs at the workplace seem to have a positive influence on fatigue and exhaustion. There is no or only insufficient evidence for their effectiveness regarding outcomes such as muscle flexibility, body weight, body composition, blood lipids, blood pressure as well as general health. The same applies to brief information in the context of health checkups at work. Moreover, it turned out that intensive, theory-guided educational interventions tailored to the employees' individual physical activity behavior are clearly superior to generic health education. The offer of sport facilities or sport classes seems to be superior to those unspecific interventions focusing on educative information provision only as well.

When the entire staff should be addressed, workplace interventions focusing on environmental changes have a great potential. For example Matson-Koffmann et al. (2005) find moderate to good evidence that already low-cost interventions such as e.g. motivational prompts can achieve a success. The creation of fitness facilities on-site can promote the employees' activity as well. At the same time, tailor-made individual counseling or training of behavioral skills should be offered.

In addition, there are findings allowing the conclusion that multifactor programs in which promising individual interventions are combined are more effective than each of the interventions alone.

#### **Janer et al. (2002)**

Janer et al. analyze 13 quasi-experimental and 32 experimental studies to determine the effectiveness of workplace programs for the reduction of cancer risk factors. They include both individual measures and multi-component programs comprising physical activity programs and interventions for smoking cessation, nutrition, weight control, alcohol and other risk factors (results see sections on the corresponding fields of intervention).

14 studies evaluated measures that aimed at increasing physical activity. Eleven times they were part of a more comprehensive approach which, in addition to physical activity, also

focused on other health aspects. According to the authors, all studies reported positive results, whereas more consistent results have been achieved by programs explicitly focusing on physical activity. Statistical significance was reached in half of the studies, including four of nine studies that evaluated education and information materials, as well as in three of four studies in which sport facilities were offered. According to this, interventions of the latter field seem to have a greater potential than educative information strategies. A large-scale study comparing three different interventions plus control group, however, showed that providing fitness facilities alone was inferior to a more complex program involving additional counseling and employee support.

Seven studies provided information on the maintenance of the programs. Except for one study where the participation in activities after seven years was still as high as at the end of the intervention, the effect decreased over the years.

#### **Marshall (2004)**

With this systematic review, Marshall gives an overview of literature on the effectiveness of workplace physical activity interventions from 1997 on. 32 studies – eleven randomized studies, seven controlled studies as well as 14 cohort studies without control group, conducted in public service agencies, hospitals, universities, and manufacturing sites were evaluated. Marshall calculates average effect sizes for physical activity outcomes including the findings of six randomized studies of good quality.

In most cases, the intervention strategies address several risk factors. Health checks, education, motivational prompts for being physically more active, exercise programs and incentive-based programs or some combination of these interventions are evaluated. Some programs also involved professional counseling, others focused on self-directed behavior change only. Generally, positive results were achieved, but mainly in samples of motivated volunteers with good compliance rates. The retention rates themselves ranged between 51% and 63%.

The observations from four studies suggest that fitness facilities at the workplace are often only used by already active persons. On the contrary, however, other evaluations show that the use of fitness facilities can be increased through supplementary programs of behavioral skills training or individual counseling.

Educational interventions should be modeled on theories of behavior change and take into account individual needs. As the literature shows, they are more effective than generic workshops on various health-related topics. Self-help print material (e.g. brochures) seems to be more effective when it is motivationally-tailored. However, the effect was found in studies with volunteer program participants only. According to Marshall, the actual reach of the programs can only be estimated reliably when results of selective measurements of effectiveness in non-volunteer participants are available as well.

The lowest participation was recorded for annual health checks. Moreover, referring individuals, who were screened and found to be at risk by their physician, to on-site fitness facilities or educational programs commonly turned out to be ineffective regarding desired changes in behavior. Even additional financial incentives or benefits could not influence the participation in the health check and the change in behavior essentially either.

Interventions involving environmental changes most likely have the potential to reach unmotivated persons as well. This is shown by studies that attempted to promote the physical activity behavior of the employees rather along the way, e.g. in the form of signs encouraging stair use or active traveling to and from work (e.g. by bike). Each of the five studies in this context was accompanied by positive short-term effects. At the same time, however, the studies showed that innovative, creative methods are required in order to achieve long-term behavior changes.

Taking the results of randomized studies at a starting point and after performing a meta-analysis, Marshall arrives at the conclusion that motivating signs, exercise programs, individualized counseling, programs for the control of individual risk factors as well as programs addressing multiple risk factors can bring about a small to medium effect regarding physical activity. According to Marshall, all results have to be interpreted with caution on account of the small number of underlying studies.

The long-term benefit of workplace physical activity programs has not yet been proved sufficiently according to the author. Studies on relevant outcomes, in particular absenteeism, stress, turnover, productivity and job satisfaction are lacking. Nevertheless, Marshall describes the working environment as an ideal setting for the implementation and further development of successful approaches.

### **Individual approaches**

#### **Proper et al. (2003)**

In this review 15 randomized and eleven non-randomized controlled studies on the effectiveness of workplace physical activity programs have undergone a critical analysis regarding the outcomes of physical activity, physical fitness and general health. The evidence rating was performed depending on study quality. When two high-quality RCT were available, they formed the evaluation basis, irrespective of the results of other evaluation studies of poorer methodological quality. The categories used were strong, moderate, limited, inconclusive and no evidence, at least two randomized studies of good quality with consistent results having to be available for reaching the highest level of evidence.

According to the authors, there is strong evidence that the programs increase physical activity. Two high RCT reported positive effects, the first one found clearly improved exercise and physical activity behavior, the second one showed a significantly

increased energy expenditure in the intervention group compared to controls who did not receive a dietary program and/or no intervention. Strong evidence of effectiveness are found in the studies by Proper et al. for significantly reduced prevalence of musculoskeletal disorders as well (see also chapter 5). Exercise programs also seem to influence positively mental and physical fatigue. Two randomized controlled studies have proven relevant effects in this context. Since, however, shortcomings regarding the methods were found for both studies, Proper et al. state there is limited evidence.

Regarding cardiorespiratory fitness, the results of three high-quality RCT, seven low-quality RCT as well as six controlled studies do not allow any clear conclusion (inconclusive evidence). In two of the high quality RCT, the exercise programs were accompanied by important changes in maximum oxygen consumption, the third, however, remained unsuccessful as to this parameter. For the outcomes of muscle flexibility, muscle strength, weight and/or body composition as well as general health, the study results were conflicting as well (inconclusive evidence). There is no evidence for an effect of workplace physical activity programs on blood pressure and blood lipids. Neither randomized nor non-randomized controlled studies reported important differences between intervention and comparison groups.

To sum up, according to the authors, the primary goal of exercise programs at the workplace is achieved – they increase the physical activity. Furthermore, they represent a promising component in the context of the prevention of musculoskeletal disorders. Except for fatigue, however, no convincing evidence for an improvement in health-related outcomes was found.

### **Organizational approaches**

#### **Matson-Koffman et al. (2005)**

The review by Matson-Koffman et al. deals with the effectiveness of environmental interventions which promote physical activity and nutrition for cardiovascular health. The authors compare the state of research until 1990 with studies published in the subsequent period until 2003. Due to the assumption that the interventions examined are relatively new and have been used in practice only for a short time, studies were taken into account even if they did not meet the formal evaluation criteria. As environmental interventions the authors define strategies that involve a modification of the physical surroundings or social, economic or organizational systems and aim at an individual change in behavior. Examples of such interventions for promoting physical activity are posting signs suggesting stair use, providing sport facilities at the workplace or the initiation of jogging groups.

In their paper, Matson-Koffman et al. analyze several intervention settings. In addition to the working environment, studies are included as well that have been conducted in public facilities such as schools or other environments such as e.g. med-

ical practices, supermarkets and the like. In contrast to their detailed presentation of the individual studies which will only be roughly outlined hereinafter, the authors do not make any clear delimitation of the different evaluation contexts. On the contrary, the recommendations derived from the studies are formulated in a general way and therefore have to be understood as applicable both to worksites and other settings.

In all, with two papers before 1990, only a small number of studies on environmental interventions of promoting physical activity were identified. Both the use of financial incentives, the placing of environmental prompts to increase stair use, instructions and other behavioral strategies as well as providing facilities for physical exercise on-site and on-site shower facilities and lockers turned out to be effective interventions for encouraging employees to significantly increase their activity. The authors found ten studies of interventions at worksites for the period of publication from 1990 to 2003. In these studies, mainly those interventions that combined health education classes with screening, counseling and sports and/or exercise facilities on-site reached positive effects. By means of a controlled study, the authors were able to prove that the commitment by executives and their willingness to implement health promotion measures increased when they first attended a training course on establishing a wellness committee. This had a positive effect on the number of workplace health promotion offers and also on the cardiovascular risk of the employees, who achieved an improvement in heart check scores by approx. 75% compared to the time before the intervention.

In their summary, Matson-Koffman et al. state that there is moderate to strong evidence that physical activity can be increased already by low-cost interventions such as e.g. signs for promoting stair use. The same applies to the access to fitness facilities on-site. In addition, the empirical findings indicate that a comprehensive program including individual counseling, health promotion training and the access to fitness facilities on-site is more effective than each intervention alone. The results of this review on the effectiveness of environmental changes to promote healthy nutrition can be found in the following section (3.2).

### 3.2 Programs for promoting healthy nutrition

According to the review made by Janer et al. (2002), workplace programs for improving eating habits are generally accompanied by positive effects, even though they are rather moderate. Nevertheless, they can influence the employees' consumption of fruit, vegetables and fat as well as their intake of dietary fibers significantly as shown in controlled studies.

The two papers identified on environmental interventions to improve nutrition (Matson-Koffman et al. 2005, Seymour et al. 2004) arrive at a similar conclusion: Creating a healthy work environment in the form of more healthy meal offers in canteens and vending machines, corresponding labeling of

products and other informational strategies can encourage the sale and consumption of healthier food and thus a healthier food selection of the employees during working hours. Matson-Koffman et al. (2005) even state that there is strong evidence in this context. However, the studies analyzed by Janer et al. (2002) do not show any relevant effects going beyond those of behavioral interventions.

On the other hand, the study results on the effectiveness of incentives for improving eating behavior disperse. If they are implemented in addition to informational strategies, they might be more effective.

Hardly any intervention was tested for its effect on physiological outcomes, which would be much more convincing. Therefore, the authors of the two latter reviews see an urgent need for conducting better evaluation studies as well as developing innovative prevention methods for modifying the work environment beyond the simple strategies used up to now.

#### **Janer et al. (2002)**

Janer et al. assign 16 studies to the field of nutrition promotion reporting moderate, but entirely positive results. At least for some of the outcomes assessed, each of them showed changes to the desired direction, 11 studies reached statistically significant effects. Interventions for promoting vegetable intake document an increase by 0.9 to 0.19 servings consumed per day, regarding fruit intake, observed changes amount to 0.11 to 0.24 daily servings. Studies that examine both fruit and vegetable intake found changes by 0.18 to 0.5 servings per day. Significant effects on fat consumption were shown in six of ten studies reporting reductions by up to 3% per 1,000 kilocalories from fat, only one study assessed an increase by 1,3%. An increased consumption of dietary fibers up to 1.3 g per 1.000 calories was proved in three of five studies.

Studies that evaluated modifications in the workplace environment (for example healthier canteen food) showed effects similar to those studies that did not include any environmental or organizational changes. No remarkable effects were reached by involving the employees in intervention planning and implementation in corresponding studies. The percentage of changes that were maintained for six to twelve months was between 30% and 65% in the studies reviewed by Janer et al.

#### **Organizational approaches**

##### **Seymour et al. (2004)**

The systematic review by Seymour et al. deals with the benefits of environmental prevention interventions for the promotion of a healthy diet. The authors appraise 38 studies from the years 1970 to 2003 carried out in universities, worksites, grocery stores or restaurants. Ten of the studies used a workplace setting for the evaluation. Their results are summarized in the following. Sales figures, key figures of nutrition (e.g. fruit consumption) or biological markers (e.g. blood pressure) were

considered to be indicators for successful behavior change. Studies that assessed exclusively psychosocial outcomes (e.g. attitude towards healthy diet) were excluded.

The majority of the ten studies obtained results in the desired direction. However, the effectiveness of the interventions was not examined in any of the papers assessing physiological outcomes – seven studies used sales figures and four studies used key figures of nutrition as measure of effect. Six studies had a good to very good design. Eight studies evaluated interventions in cafeterias; two studies examined the effect of a healthier food offer in vending machines. Program duration varied from a week to a year.

Three programs used simple information strategies. In all cases, sales figures were significantly influenced. For example, the listing of low-fat entrées on a sign in front of the cafeteria and a heart symbol next to the corresponding products resulted in an increased sale of the entrées; information on healthier alternatives (e.g. apple instead of apple cake for dessert) brought about a lower calorie and sodium intake.

Combined measures consisting of healthier food offers and information and/or price-oriented strategies in cafeterias were tested in four studies. Two of them showed significantly positive changes in sales figures, the result of the third study did not reach statistical significance, and the fourth study remained unsuccessful.

Three interventions included incentives and/or bonus systems for promoting the sale of the “target products”. Two of them turned out to be not effective. The third strategy for which playing cards with recommendations on healthy diet were distributed was associated with a decrease in the sale of high-calorie desserts and bread as well as increased sale of skim milk and a lower calorie intake per day.

To sum up, eating habits of employees can absolutely be already improved by minimum interventions. As the authors see it, this is not enough in order to influence the population’s nutrition and lifestyle sustainably – also outside the work environment. According to Seymour et al., for being successful, interventions must be applied which go beyond the simple information strategies described. The authors also consider the outcomes used up to now for evaluating intervention success to be rather inappropriate as they are difficult to interpret and have hardly been collected using valid measuring instruments. There is also a clear lack of information on important issues such as e.g. sustainability or cost effectiveness. Therefore, first of all, an improved methodology should be aimed at. In principle, Seymour et al. consider the workplace to be a suitable setting for nutrition environmental interventions with the potential of influencing point-of-purchase behavior positively.

#### **Matson-Koffman et al. (2005)**

Matson-Koffman et al. identified 31 evaluation studies on environmental interventions that promote a healthy diet; 18

thereof were published before 1990, 13 thereof after 1990. Ten of the studies published before 1990 evaluated interventions with environmental changes where, in addition to healthier foods offered in canteens or vending machines, point of purchase strategies (POP-strategies) were used.

In all, four of the interventions resulted in an increased sale of selected items, including an informative poster in a cafeteria, the increased offer of low-fat meals, colored signs and offering of low-calorie snacks in vending machines as well as information addressing not only aspects of health, but also of taste. The authors described a study in a big American company as being successful where in addition to weight control and nutrition programs, offering healthier food in the cafeteria and in vending machines, information where the food was sold and the provision of scales in break rooms were the components of intervention. After one year, a significant effect was found in the intervention group – the prevalence of overweight decreased by 1%, in contrast to the control group which only received a screening.

Two of the studies examined the effect of incentives on a healthier diet. The results are inconsistent; the same applies to the findings for interventions using competitions (e.g. raffles).

Five of the 13 studies published after 1990 showed that the dietary behavior of employees was already affected by the access to healthier food (in cafeterias and/or vending machines). Findings were, for example, a significantly reduced fat consumption, an increased consumption of fruit and vegetables or an increased intake of dietary fibers. Four studies proved an increased sale of “healthy” meals when they were labeled and had a reduced price. Two interventions that combined nutrition and physical activity components were successful as well. They showed significant reductions in cholesterol levels and/or weight of the employees. Three studies involving increased access to health-conscious food plus labeling, however, remained unsuccessful.

In all, due to the findings of more than ten controlled and/or randomized studies found, the authors state that there is strong evidence for the effectiveness of environmental interventions at the workplace which use POP-strategies, changes in food offer, price reductions as well as increased offering and labeling of healthier food. According to Matson-Koffman et al., each of these interventions contributes to an increased sale and consumption of healthy food in cafeterias and at vending machines.

Like it is the case for environmental programs to promote physical activity (results see 3.1), the authors discover that, despite the promising results, only a very small number of the analyzed studies meet methodologically strict criteria. Control groups and valid outcomes are included too rarely in the studies and the often too short evaluation periods do not allow any statements on the sustainability of the effects.

Therefore, researchers should realize methodologically stricter studies, focus in particular on long-term effects and examine the differences between how effective environmental and organizational interventions are alone and in combination with other traditional approaches for increasing physical activity and improving nutrition.

### 3.3 Programs for smoking cessation and tobacco control

The six relevant reviews found provide a relatively comprehensive overview of the findings on this important field of workplace health promotion. But the known situation is prevailing in this field as well: there is a certain number of reliable papers on individual interventions, but methodologically weaker data for the effectiveness of organizational approaches (see e.g. Moher et al. 2005). However, the findings on the field last mentioned offer clear indications.

If we choose a general perspective and assess the effectiveness for all interventions globally such as e.g. Smedslund et al. (2004) we will arrive at a rather disappointing conclusion, namely: workplace smoking cessation programs have positive effects which, however, disappear after more than a year. On the contrary, when examining individual interventions separately it becomes clear that it is important to differentiate – since some interventions have very well proven to be useful on the long run as well.

Moher et al. (2005), for example, find strong evidence for a supporting effect of group cessation programs, individual, professional and intensive counseling offers as well as pharmacological treatment. Thanks to these measures, smoking prevalence can be reduced and abstinence rates can be improved sustainably.

In the same way, in the field of organizational interventions, (total) smoking bans in companies reduce considerably cigarette consumption at the workplace and improve clearly air quality (Fichtenberg and Glantz 2002, Levy and Friend 2003, Moher et al. 2005). It has been and continues to be a contentious issue whether and to which extent workplace smoking policies influence prevalence and cessation rates in the company – there is a trend suggesting that they remain mainly uninfluenced by the bans (e.g. Moher et al. 2005). Population studies on the topic, however, also showed that the smoking prevalence among employees in smoke-free companies is clearly under that of employees in companies without ban (see Fichtenberg and Glantz 2002).

Furthermore, scientific literature suggests that self-help materials and incentives do not contribute essentially to reduced smoking prevalence and increased abstinence rates. The results also do not indicate that social support (e.g. by colleagues) makes quitting easier and sustainably promotes abstinence.

The findings for the effectiveness of multiple approaches (multi-component programs) where smoking cessation is a component are not convincing either. In most cases, however, the positive cessation rates that are achieved by using individual interventions represent a small absolute number of persons stopping smoking only. Although smokers can be reached easier by health promotion at the workplace, the participation rates in smoking cessation programs are relatively low. As it turned out, this, however, can be increased by means of incentives and bonuses. Even if they do not increase the cessation rate, they have the potential of gaining more participants for a program.

#### **Janer et al. (2002)**

In the studies reviewed by Janer et al. the percentage of persons in the intervention groups who stopped smoking successfully was between 10% and 15%. When taking the control groups into account, a net difference of approx. 5% to 6% in favor of the intervention groups was found. In most of the studies, the effects observed at the end of the intervention diminished over time. Six months after the end of the program, the effect was reduced by approx. 40%, partially even by up to 80%, which may be attributed to longer latency periods in the control groups that often were provided with self-help material. The reduction present in the intervention groups after six months seems to remain stable over time. There also are findings indicating that smoking cessation programs are more effective among managers, in moderate smokers smoking less than one packet and/or less than ten cigarettes per day and in smokers who have already tried to stop smoking before.

According to Janer et al., the effectiveness of the programs increases with a prolonged duration of the intervention up to six months; it seems that there are no further effects after this period. The association between the intensity of the interventions (number of contacts) and quit rates is weak: although the highest quit rates were observed in intensive programs, a high intensity did not always result in a higher number of abstainers.

Four of five studies comparing interventions with and without incentives reported that the abstinence rates in the incentive groups were higher by 0.9% to 3.5% than in the groups without incentives. The effect of the incentives, however, was considerably reduced in the long run in one of the studies; another study even showed a negative effect on the long-term abstinence rate. In another study the incentives were effective only in a subgroup of employees with lower education.

One study showed that social support, for example encouragement by colleagues, was associated with a higher abstinence rate. Additional changes in the working environment, e.g. creating non-smoking areas, reached additional effects in part only.

#### **Smedslund et al. (2004)**

The objective of the meta-analysis by Smedslund et al. is to determine the general effectiveness of workplace smoking ces-

sation programs by means of evaluation literature from 1989 to 2000. Quit rates from 19 controlled studies including nine studies with a randomized design are analyzed.

The authors find a multitude of interventions. In addition to self-help material, group cessation and incentives, steering committees, smoking bans and restrictions, physician advice, pharmacological treatment as well as measures categorized as “other interventions” are evaluated. The intervention constituted a component of a more complex health program for the employees in four studies. The evaluation studies were carried out mainly in companies with high smoking prevalence and white, heavy smokers.

Smedslund et al. find considerable variations between studies in abstinence rates both for the intervention and for the control groups. Although in part up to three independent treatment conditions were examined per study, the authors exclusively use results from simple comparisons between groups with and without intervention for evaluating the effectiveness. They enter the meta-analysis in the form of odds ratios.

Across all studies, abstinence rates of nearly 17% were found in the intervention groups compared to 8.5% in the control groups after six months, 21% compared to 12% after one year and 17% compared to approx. 14% after more than a year. This corresponds to statistically significant weighted odds ratios of 2.03 for the period of six months and 1.56 for twelve months, as well as an only just not significant odds ratio of 1.33 for follow-ups after more than twelve months.

There is a high probability of publication bias for the follow-ups both after six and after twelve months. This is a systematic distortion resulting from a biased publication practice where studies with positive and statistically significant results are preferred to “unsuccessful” research. Therefore, Smedslund et al. cannot rule out that the effect is overestimated for both periods. In case of the studies with follow-up after more than twelve months, the probability of publication bias is low according to the authors. This is why it seems to be relatively certain in their opinion that the effects found – irrespective of which size – are of a limited duration only.

The meta-analysis updates a paper that was published in the early 1990s and obtained similar results. Thus, a decisive improvement in achievable program results has not been accomplished yet. According to Smedslund et al., this proves that, in the future, smoking cessation programs must have a broader effect and focus also on factors such as the organizational context in addition to smoking cessation alone.

### **Individual approaches**

#### **Moher et al. (2005)**

The aim of this very detailed review published by the Cochrane Tobacco Addiction Group is to give a comprehensive overview of interventions for smoking cessation at the workplace as well

as to determine their effectiveness. In the field of preventive interventions aiming at the individual exclusively randomized controlled studies were evaluated in which outcomes such as quit rates, smoking prevalence or productivity measures such as e.g. sickness absence were recorded. The follow-up periods comprised a period of at least half a year to 24 months.

In all, Moher et al. identified 61 studies that – according to the evaluated program – were assigned to one or several intervention categories, differentiated according to individual and organizational level and/or multi-component programs. The following presentation of results follows this system. Since, unlike other programs such as e.g. education on ergonomics, the examined measures are no setting-specific approaches, the authors include the findings of previous reviews on the topic in their final assessment.

#### *Group cessation*

Ten RCT evaluated a form of group intervention or examined its effect as an additional component of a program. A higher success rate was mainly found in the group condition than in the corresponding comparison group, even if the effects did not always reach statistical significance due to partially too small samples. The highest abstinence rate of 43% in the 12 months follow-up was achieved in a relapse prevention group supported by a psychologist the members of which had already participated in a cessation course before. Two of the three large-scale RCT also proved a benefit by additional group meetings. After twelve months, with 11% and 31%, the abstinence rates in the two studies were significantly higher in the group than in the non-group condition, but the point prevalence for smoking of 26% was clearly higher than for the comparison group of 16% in one RCT. There was a tendency that the group intervention was also superior to control groups that received self-help material, as well as in combination with gradual reduction of the tobacco consumption compared with an abrupt stop. On the contrary, competing groups and the use of hypnosis combined with behavioral therapy group sessions turned out to be strategies not having a greater effect in the long run.

#### *Individual counseling*

Seven studies were assigned to this field. Overall, professional supervision and instruction – either by a physician or trained nursing staff – turned out to be an absolutely effective measure for making it easier to stop smoking. For example, the quit rate of 18% in intervention groups with individual counseling after twelve months was significantly higher than the rate of 13.5% in the control group without this component. A large-scale RCT found 21.4% of abstainers after two years in the counseling group, whereas there were only 13.4% in the control group. In another study, a reduced smoking prevalence by approx. 19% was found after two years in the counseling condition for participants with high cardiovascular risk compared to 12% in a high-risk control group. Even a four-armed study that evaluated a program consisting of several components and at first did not find any differences in quit rates, detected a significant effect when testing for the influence of the counseling component.

### *Self-help*

None of the nine randomized controlled studies assigned to this category has proven convincingly that self-help materials can contribute significantly to an increase in abstinence rates and a reduction of smoking prevalence. Computerized self-help programs, individually designed magazines, motivational videos as well as written instructions for self-help turned out to be not more effective compared to control groups without intervention and/or in part even less effective compared to other measures (e.g. group cessation). Furthermore, no changes in outcomes of interest were found between different types of an intervention either (e.g. structure of contents or action guide for self-help).

### *Pharmacological treatment*

Five RCT examined the effectiveness of nicotine replacement products. In all studies positive effects were reached, albeit they were not always statistically significant. After 12 months, abstinence rates of 12% to 32% compared to rates of approx. 2% in control groups were observed. A study showed that the likelihood of successfully stopping smoking was two and a half time higher when the attempt to stop smoking was realized after counseling by means of a nicotine replacement product. In this case, the comparison group only was given a brief advice to stop smoking at the annual routine health check. A placebo study in which both nicotine gums and patches and corresponding placebos were examined in three different combinations (group 1: gum and patch, group 2: placebo gum and patch, group 3: placebo gum and placebo patch) reached abstinence rates of approx. 13% in the two placebo conditions and 18% in the group with two active products after one year. The differences found, however, turned out to be not statistically significant.

### *Conclusions*

After having examined the results of far-reaching reviews, Moher et al. conclude that there is strong evidence that group interventions, individual counseling and pharmacological treatment for smoking cessation have a positive effect. Since, however, the participation rates in the identified studies are very low, the quit rates represent only a very small number of abstainers. In accordance with other previous reviews, there is no evidence for the effectiveness of self-help materials.

For further findings of this review, see the sections on the effectiveness of organizational and environmental interventions for tobacco control and smoking cessation (directly below) as well as on cost effectiveness of workplace health promotion and prevention (chapter 6).

## **Organizational approaches**

### **Fichtenberg and Glantz (2002)**

In their systematic review, Fichtenberg and Glantz analyze in all 26 studies conducted in the USA, Australia, Canada and Germany. The aim is to quantify the effect of smoking bans at the

workplace for subsequently comparing it with effects that can be reached by measures of tax policy. 21 studies were realized in worksites using either retrospective or prospective methods or a sequential cross-sectional design. Four of them are population studies that compared smokers in companies with smoking bans and smokers in companies without restrictions by means of cross-sectional surveys.

Outcomes of interest were differences in smoking prevalence before and after the introduction of the ban as well as changes in the number of cigarettes smoked per day, smoker and employee. If they could not be taken directly from the study, they were at first calculated by the authors. Subsequent tests showed that there were no important differences in the effects between worksite studies and population studies. The same applied to the different study designs so that they could enter a meta-analysis.

As a result it turned out that the introduction of a workplace smoking ban reduces the absolute smoking prevalence by 3.8% as well as the tobacco consumption to 3.1 cigarettes per day and (continued) smoker. In all, this corresponds to a reduction by 1.3 cigarettes per day and capita and/or a relative reduction by 29%. Total smoking bans turned out to be nearly twice as effective compared to policies that still allowed smoking in defined areas. The period between implementation and follow-up in the studies ranged from one to 24 months. However, since no significant association was found between the extent of the effect and the duration of the follow-up, the authors assume an effect relatively stable over time. For reaching a similar effect by means of tax policy, the average tax in the USA would have to rise from US\$ 0.76 to US\$ 3.05, in Great Britain from £3.44 to £6.59 per pack of cigarettes. If all workplaces were smoke-free, tobacco consumption in adult population per capita would decrease by 4.5% in the USA and by 7.6% in Great Britain.

Fichtenberg and Glantz arrive at the conclusion that smoke-free workplaces do not only make a contribution to nonsmoker protection, but also encourage smokers to quit smoking or at least to reduce their cigarette consumption.

### **Levy and Friend (2003)**

In their paper, Levy and Friend explore the question of the effectiveness of clean indoor air laws. They include, among other studies, worksite studies and cross-sectional population studies on workplace environments that report at least one relevant outcome on smoking behavior (e.g. number of cigarettes, prevalence, quit rates).

19 workplace intervention studies were found in which – to the extent they did not have a controlled design – at least pre-post measurements were carried out. After six to 13 months, the studies showed reductions in cigarette consumption by 10% to 20%. Furthermore, prospective cohort studies documented also a reduction of smoking prevalence with relative differences of similar percentages a year or more after the introduction of the

ban. On the contrary, the results for abstinence rates were less consistent.

The number of smoked cigarettes tends to show its strongest decrease within the first six months. On the contrary, more long-term than immediate effects were observed for prevalence and quit rates. For the latter there is, however, far less clear evidence.

The population-based studies most of which were carried out in a US federal state compared employees in smoke-free work-sites with employees in companies without a smoking ban. In contrast to worksite studies, bias through systematic differences between individual companies can largely be ruled out in representative studies. In order to achieve reliable results, however, other possible influencing factors should always be taken into account, which was not the case in each of the nine population studies included. Nevertheless, the results for cigarette consumption showing a difference ranging from 10% to 15% correspond to those observed in intervention studies. Regarding prevalence rates, the number of smokers among employees at smoke-free workplaces was 15% to 20% lower than in companies without ban. Furthermore, employees in companies with smoking bans reported a higher number of quit attempts and successful attempts lasting for at least three months, which was reflected in higher abstinence rates – in part with differences by 10% to 15% – as well. However, a certain number of studies remained unsuccessful regarding this outcome.

In their summary, Levy and Friend conclude that, despite considerable variations in the observed effect sizes, smoking bans are generally associated with lower cigarette consumption, reduced prevalence rates as well as higher quit rates. Even if some worksite intervention studies only show inconsistent effects on prevalence rates, the consistent findings of the cross-sectional population studies were convincing in this context according to the authors.

#### **Hey and Perera (2005)**

This Cochrane Review deals with the question of the effectiveness of competitions and incentives for smoking cessation, focusing in particular on long-term abstinence and participation rates. Nine randomized as well as six non-randomized controlled studies from the USA, the UK, Australia and Canada entered the review. Ten evaluations were carried out at worksites, the other five ones in medical facilities. Outcomes of primary interest included quit rates, point prevalence and abstinence periods which were recorded at least six months after the intervention and, as the case may be, additionally validated using biological markers (e.g. carbon monoxide in respiratory air).

The incentives used varied strongly between the studies – while, in some programs, only the successful quit was rewarded with money or a non-cash prize, other approaches examined the effect of bonuses for the participation in the program and/or the compliance or a combination of both. In addition to

cash payment, various vouchers for goods or services, national lottery tickets, tickets combined with cash prizes, raffles or also a menu including service are used as incentives. The amounts paid to individual participants in the programs ranged from US\$20 for each successful abstinence test plus the chance of winning US\$500 to possible US\$240 over a period of six months; for groups, the amounts ranged from approx. US\$15 per member to a team prize worth US\$ 1.830.

Nine studies entered a meta-analysis carried out by the authors for the different follow-up points (six to 24 months) in order to avoid bias by studies with several follow-up waves. For the first follow-up point at six months after the end of the intervention Hey and Perera did not find a significant effect, but they do not exclude a clinical relevance on account of the small confidence interval. This is mainly caused by the results of two studies that observed a significant influence of monetary incentives after half a year. In this context, the authors point out that these findings are inconclusive since in both studies the last cash payment took place immediately before data collection. No significant results suggesting a higher abstinence rate in the intervention groups were found for periods of twelve months or more either. Thus, there is no clear evidence for the sustainable effectiveness of incentives and competitions for smoking cessation – any possible short-term effects disappear relatively quickly when the incentive no longer is present and program participants relapse into their old smoking pattern.

Although long-term abstinence rates do not seem to be influenced by incentives, the interventions have a rather large potential to increase the number of quitters. As it was shown in several studies found, the participation rate in the intervention groups was in part nearly twice as high as in the reference groups without incentive. Moreover, the presumption that mainly smokers who are more interested in the bonuses than in quitting smoking would be targeted by the interventions – which would result in an unacceptable number of false claims of abstinence – turned out to be wrong in most of the studies. Nearly in all included studies breath or saliva samples were taken or the so-called “bogus pipeline” method (in which a test is announced but not carried out) was used to validate self reports. Good to very good correspondence between claims and tests was reported, namely 95% to 100%. The observations made in two studies that reported considerable discrepancies of approx. 30% suggest that the participants should be informed of the test and questioned face-to-face about their smoker status.

Although the authors point out in their summary that the methods used in some of the reviewed studies were insufficient, they consider that more research is not necessary in this field of intervention. In their opinion further studies are not required.

#### **Moher et al. (2005)**

The organizational-level interventions evaluated in the studies reviewed by Moher et al. include tobacco control policies such

as restrictions or total smoking bans, social support or other favorable environmental conditions, as well as incentives and competitions. Unlike for the studies on measures focusing on the individual (see individual approaches for smoking cessation), also non-randomized controlled studies and uncontrolled studies with pre-post design were taken into account.

#### *Workplace smoking bans*

14 studies examined the effectiveness of total or less restrictive smoking bans at worksites. In two cases, a control group of companies without restrictions was available, twelve studies used an uncontrolled design with one or two cross-sectional post-test surveys. In eight studies, the smoking bans were associated with a clear reduction of tobacco consumption during working hours. For example, in a study, the percentage of smokers smoking 15 cigarettes or more of nearly 17% decreased by more than 50% to reach 7.5% already after a month, after half a year, the percentage amounted to approx. 5%. Improvements were reported for the subjectively perceived smoke pollution, air quality and smoke exposure as well.

On the contrary, the overall consumption of cigarettes per day (i.e. not only during working hours) seems to be far less influenced by tobacco control policies – eight studies only find a very small effect, three studies found no change at all. The findings regarding the effect of smoking bans on prevalence and quit rates are of similar inconsistency. Five studies report no changes in prevalence, four find a non-significant, two a significant reduction by 8% and 5%, respectively. The implementation of a smoking ban as additional intervention for a smoking cessation program turned out to be effective for increasing the quit rate in one study. In a second study, the rate after the introduction of the ban was lower than in the comparison company.

#### *Social support*

Two studies investigated, among other things, the influence of social support as a component of smoking cessation. None of them suggests an additional benefit since no important differences between groups with and without support were found regarding outcomes of interest such as abstinence or relapse rate.

#### *Environmental support*

The creation of favorable environmental conditions such as educational health promotion classes and workplace health promotion measures for volunteers or companywide anti-smoking actions seems to have a limited effect on smoking cessation only. Whereas, in a study, the abstinence rate in the group with enriched environment and smoking cessation program was as twice as high as in the control group in which only the cessation program was offered, the two other studies only showed insignificant or no effects.

#### *Incentives*

None of the five randomized controlled studies proved an effect of monetary incentives on abstinence rates or relapse

rates. The findings, however, suggest a favorable effect on participation rates that were higher in intervention groups than in control groups without incentives.

#### *Conclusions*

Despite the in part poor study quality, the findings allow the conclusion that measures for clean indoor air laws and/or smoking bans considerably reduce cigarette consumption of smokers during working hours as well as passive smoke exposure at the workplace. Moreover, literature shows that such measures are also well accepted by smokers in most cases.

There is inconclusive evidence, however, for the effectiveness of smoking bans whether they reduce smoking prevalence, overall consumption and relapse rates and/or clearly increase the number of quitters. For an enriched work environment supporting quit attempts, findings are similar. An effect of social support was not proven up to date either. There is also a lack of proof for the effectiveness of incentives on relevant outcomes, but there is limited evidence for the fact that they can increase the number of participants taking part in smoking cessation programs.

#### ***Combined approaches (multi-component programs)***

##### **Moher et al. (2005)**

Despite good theoretical foundation, no convincing proof has been existing up to now for the fact that multi-component programs integrating smoking cessation and following a complex health promotion approach can clearly reduce smoking prevalence in companies. Eight studies were assigned to this category; only approx. half of them detected any noteworthy changes in smoking prevalence or abstinence rates and the effects mainly did not reach statistical significance.

This applied for example to a multiple program for reducing cardiovascular risk that, in addition to smoking cessation, included individual counseling and 16 annual group meetings with videos, discussions and activities. In this study, smoking prevalence in the intervention group decreased from 65% to 37% after twelve months, whereas a reduction by only 2% from 65% to 63% was found in the control group. A multi-armed RCT where the intervention (depending on the group) consisted of health risk appraisals, newsletters, self-help books, workshops on behavioral change and social support through teams reported significant reductions of smoking prevalence after two years, except for one group. On the contrary, another program for lowering the cardiovascular risk was not successful, although it was tailored individually to each of the companies involved; the same applies to a comprehensive physical activity program that included a smoking ban.

According to the authors, nevertheless, there is limited evidence for the fact that smoking cessation programs aiming at the individual are more effective when they are extended by an institutional approach.

### 3.4 Programs for alcohol prevention

According to the two reviews identified during literature search (Janer et al. 2002, Rey-Riek et al. 2003), first findings suggest that workplace programs on alcohol-related problems represent a worthwhile approach. However, there is a considerable lack of evaluation studies, in particular in German-speaking countries. Therefore, the evidence has to be considered to be weak.

#### **Janer et al. (2002)**

Janer et al. identify only three relevant intervention studies that examine worksite alcohol prevention programs. Although significant reductions of the weekly alcohol consumption and/or an increase in the percentage of moderate drinkers compared to the control group were found in these studies, no information is available whether the observed effects also occurred in high-risk groups (employees with uncontrolled alcohol consumption). The interventions are not described in detail by Janer et al.

#### **Rey-Riek et al. (2003)**

This review aims at determining the benefit of workplace interventions for alcohol prevention, both regarding effectiveness and efficiency (cost effectiveness, see chapter 6). Analyzed were qualitative and quantitative papers published between 1965 and 2003, including evaluation studies and theoretical essays, bibliographies and monographs.

The most common workplace interventions for managing alcohol-related problems are Employee Assistance Programs (EAP). EAP do not follow an uniform approach, the issues for which EAP provide support vary as well as the resources used. The most important element of an EAP is the so-called constructive confrontation, a strategy where the problem is addressed by a supervisor in order to provide offers of help. Thus, it is a secondary preventive instrument which is used when problems or symptoms have already cropped up.

Due to a lack of published studies, the initial aim, a meta-analysis of German-language studies, could not be realized. Instead, the authors carried out a qualitative analysis for which they additionally included the findings of two reviews from Northern America.

Both reviews arrive at the conclusion that establishing the evidence of clear cost savings through workplace alcohol prevention programs is still difficult mainly due to poor study designs. At the same time, the two papers, however, confirm the correlation between constructive confrontation strategy and work performance as well as the provision of treatment offers.

The research for Germany and Switzerland shows that, workplace addiction programs are mostly not evaluated here. On the contrary, pilot studies and descriptions mainly limited to the analysis of costs due to absenteeism were found. Nevertheless, the programs resulted in reduced sickness absence due to alcohol showing economic benefit of the intervention as well.

Rey-Riek et al. criticize that the existing programs rather aim at identifying problems and their treatment instead of avoiding the onset of a disease. Moreover, since the programs have proven successful exclusively in large companies, the development and testing of strategies suitable for small and medium-sized companies as well is required in addition to further systematic evaluations.

In this context, they suggest applying brief interventions which have already been successfully tested in medical practice to the workplace context and evaluating it systematically.

### 3.5 Programs for weight control

According to the reviews by Janer et al. (2002) and Katz et al. (2005) available for this field, the evidence base for interventions for preventing and controlling obesity is relatively weak. Therefore, only combined programs taking into account several fields of action – mainly nutrition and physical activity – can be recommended. On the contrary, individual-focused preventive programs seem to be not sustainable according to controlled studies.

#### **Janer et al. (2002)**

For weight reduction, the results of the studies that were assigned to this category by Janer et al. vary between an increase in weight by 0.25 kg to a weight loss of 3.5 kg. The short-term effects of the evaluated programs were larger than those observed after follow-up periods of two to three years.

#### **Katz et al. (2005)**

This review on behalf of the US Task Force on Community Preventive Services aims at compiling interventions for weight control and obesity prevention as well as assessing their evidence, practicability and – if possible – cost effectiveness. Weight-related outcomes (such as BMI or body weight) as well as medium-term figures e.g. changes in eating or exercise habits are of primary interest. For a workplace program, the authors consider a loss of weight of at least 2 kg after six months or more as the criterion of success. 20 relevant evaluation studies are found for the period from 1966 to 2001.

Based on the findings of seven papers sufficient according to the authors, the Task Force recommends that, for being successful, dietary and exercise-related approaches for weight control should be combined. Components include for example dietary prescription, aerobics or strength training as well as dietary education, the provision of self-directed material, group exercise or supervised exercise programs. On account of a too small number of studies, only insufficient evidence could be found for the effectiveness of individual interventions in the fields of nutrition and exercise. Studies on the primary prevention of overweight are lacking completely in the literature found.

Although first successful workplace interventions for controlling the risk factor of overweight have already been identified, efforts regarding programs, strategies and science are still required according to the analysis by Katz et al. Moreover, there is still a lack of findings as to which weight loss over which period of time provides the largest health-related benefit. The question how an initial success can be maintained also needs to be researched.

### 3.6 Multi-component programs

In the field of multiple programs taking effect at several levels, the findings differ in part. Whereas Pelletier, whose reviews also include studies of poor methodical quality (2001, 2005), comes to a positive judgment (in particular concerning comprehensive approaches with high-risk interventions), the findings of the systematic review by Engbers et al. (2005) have to be interpreted with caution according to the authors.

In general, this review points out that multi-component programs involving environmental changes potentially can improve the eating habits of employees. In particular an expanded offer of healthy food, labeling the food and placing it easy visible as well as corresponding information material such as brochures and posters probably are effective. For physical activity, available data on the effectiveness of multifactorial programs is disappointing for lack of studies reporting on this outcome. Therefore, future research should increasingly turn to this field.

#### **Pelletier (2001, 2005)**

These two papers are the fifth and sixth publication of a series of reviews started in 1991 for investigating the health-related and economic benefit of comprehensive workplace programs (for latter see chapter 6).

As already summarized in the IGA-Report 3, in his 2001 review as well as in the previous reviews, Pelletier finds that the scientific evaluation literature available reports mainly on positive health effects. Moreover, recent studies of better design support the results of poor quality studies. Therefore, comprehensive health promotion programs addressing multiple risk factors reduce employee risks for chronic disease.

For the 2005 review eight other studies for the period from 2000 to 2004 could be identified including only one study using a strictly experimental design. This shows a downward trend towards lower quantity and quality of published studies which, according to Pelletier, is critical given the existing need for convincing arguments for the use of comprehensive workplace health promotion. According to Pelletier, in the USA this may possibly be due to the difficulty in gaining government or private foundation. Founded research, however, is needed to permit evaluation studies and provide insight which program components are successful in detail.

The recent literature shows that there is a growing interest in mental health issues that have rather been absent in evaluation studies up to now. The interventions found are geared primarily to high-risk employees and often combine public health strategies with individualized measures of behavioral risk management as well as the use of telemedicine delivery technologies (use of information and telecommunication technologies in diagnostics and therapy).

Overall, evaluating all 107 studies analyzed up to now, Pelletier finds in his 2005 review that workplace multi-component programs contribute to the employees' health. Programs that combine comprehensive approaches with high-risk interventions and follow a dose-response model of increasing levels of intensity seem to be particularly promising.

#### **Engbers et al. (2005)**

Engbers et al. provide a systematic overview of the effectiveness of comprehensive programs of health promotion with environmental modifications. According to the authors, these interventions include changes that support the employees in making healthier choices by reducing barriers, such as making healthier food more accessible in canteens or establishing fitness facilities on-site.

Outcomes associated with physical activity and the eating behavior of employees as well as general risk factors are observed. Eleven randomized and two non-randomized controlled trials published in the period until January 2004 form the evaluation basis. Many of these studies are multi-center studies. For the evidence assessment, the categories strong, moderate, limited, inconclusive and no evidence are used. At least two high-quality RCT reporting consistently positive results are needed for reaching the highest level of evidence.

Eight programs focused on lifestyle factors for reducing cancer risk, three on reducing cardiovascular risks. A multi-component program aimed at lowering serum cholesterol levels, another one aimed at the promotion of a healthy lifestyle in general. The interventions often consisted of a combination of educational measures (e.g. group training and capacity exercise), counseling, incentives and information to increase problem awareness (e.g. flyers, brochures, kick-off events, presentations, newsletters).

Two studies also implemented a policy change (on smoking). In the context of another study, family counseling was offered in addition in order to achieve the employees' life outside the workplace.

The interventions included structural modifications of the environment for encouraging physical activity in three studies only. As a result of the inconsistent results and the poor study quality, Engbers et al. do not find clear evidence for the effectiveness of the programs on exercise behavior (inconclusive evidence).

All 13 studies used organizational and environmental interventions to promote a healthy diet. Measured outcomes were consumption of fruit, vegetables, fat and dietary fibers. Six studies involved food labeling, eight studies expanded the food offer by healthier products or improved the visibility of healthy food already offered in the canteen. In most cases, leaflets or posters were distributed additionally. Six studies filled vending machines with healthier food as well.

Six studies, including three studies of relatively good quality, found a significant increase in the reported consumption of fruit and vegetables compared to the control groups. The same applies for the reported fat consumption that decreased significantly in the intervention groups in five of six studies. Since the findings were consistent, the authors conclude there is strong evidence that these outcomes can be affected positively by multi-component programs with environmental changes. Since, however, all programs are multi-modal interventions, the effects cannot clearly be attributed to the environmental component. RCT of high quality are required for revealing the connections.

The intake of dietary fibers was examined in one study only that did not find any effect. The same applies to health-related risk factors; here, no evidence for the programs was found either. In addition to four studies measuring cholesterol levels, three studies on body mass index (BMI) and another study on blood pressure reached no significant result.

### 3.7 Health circles

According to the systematic review by Aust and Ducki published in 2004, the scientific evidence for health circles is weak at present. This is not due to a lack of experienced effects, but to a lack of selective intervention studies of high quality. According to the authors, available data suggest that health circles contribute considerably to ergonomic, technical and organizational improvements in the company and thus reduce sickness absenteeism, increase job satisfaction as well as support the reduction of psychosocial stress.

#### **Aust and Ducki (2004)**

This systematic literature review includes 15 papers reporting on eleven studies published between 1980 and 2001 that summarize 81 health circles in Germany. More than half of the circles have been implemented in companies of the steel sector, twelve have been carried out in companies of the chemical industry, five in hospitals. The other circles have been conducted in various companies of the production, telecommunication or services sector. The majority of the circles conformed to the Düsseldorf model in which representatives of the management level participate in the circles as well. Five circles followed the

alternative Berlin approach that does not include the participation of executive staff.

In all studies, the participants report great satisfaction with the composition of the circles, the number of sessions as well as the overall process for identifying problems and developing possible solutions. Two studies showed that the information flow within the company and/or the support by the employees for whose field the circle has been initiated was not ideal.

The reported results regarding successfully implemented suggestions for improvement paint a positive picture. 45% to 86% of all suggestions were realized within the first six to twelve months after the final circle session. A comprehensive study on 41 health circles reports that, after half a year, the highest implementation rate was found for suggestions to improve the psychosocial environment (67%), followed by organizational interventions (60%) and suggestions for reducing physical strain (54%). A few of the suggestions were implemented by the steering committee in one study only; this, however, was one of the early pilot studies of the Berlin model.

Except for one study where the intervention aimed primarily at coping strategies, all studies found at least some improvements in working conditions, including e.g. stress reduction as a result of an optimized work organization or reduced physical strains due to ergonomic improvements. According to the study on 41 circles, approximately half of the employees reported improvements in experienced social support, reward as well as better technical equipment and improved decision authority.

Five studies evaluated the effectiveness by means of self-rated health, including two studies that had a controlled design. Statistical analyses were used in three cases; one study also included objective measurements. Four studies reported positive results, for example, statistically significant changes in three stress indicators compared to the control group or improvements in psychological well-being, work satisfaction as well as in cholesterol levels were proven for circle participants.

No statistical analyses were performed to prove the effect on sickness absenteeism, although seven studies were able to access company or health insurance data. Considerable differences were observed in five cases, e.g. sickness absenteeism decreased from 10% to 5% in a company. An increase in sickness absence in both groups was found in the only controlled study, the remaining study did not show any change.

Aust and Ducki conclude that health circles have proven to be an useful instrument which seems to be acceptable both to employees and employers in practice. Because of the positive experiences, better studies should absolutely be conducted in future.

### 3.8 Participatory ergonomic measures

Cole et al. (2005) investigated the participatory approach, one of the core principles of workplace health promotion and prevention. Except for one paper, all studies reported a positive effect of the interventions on relevant health outcomes (e.g. musculoskeletal complaints, sickness absence). On account of the heterogeneity of methods found, the authors state there is limited evidence for the effectiveness of the interventions. Nevertheless, the continuous implementation of participatory ergonomic interventions in practice is recommended since, according to the authors, the data available provide sufficient indications.

#### **Cole et al. (2005)**

The systematic literature review on behalf of the Institute for Work & Health of Toronto aims at providing answers to the question of evidence of participatory ergonomics. In addition to the active involvement of the employees in problem-solving processes, these interventions are characterized by the formation of an “ergonomics team” consisting of employees, managers and/or representatives of company management, health and safety experts and ergonomists as well as research experts.

Ten studies met the criteria as to methods and contents and were evaluated using “best evidence synthesis”. Six studies had a controlled design with one or several comparison groups; these comparison groups generally did not receive any intervention. Health outcomes of interest included for example reported pains or general health, musculoskeletal complaints or indicators such as injury rates, accident rates, absenteeism, sick leave as well as the employees’ work function and performance.

Changes in the design of equipment and workplaces were a main component of the interventions in most of the studies. The interventions less commonly include also changes in job tasks, in existing work teams, in work organization or the introduction of policies and specific trainings. Six studies additionally implemented interventions such as e.g. the development of a stretching and exercise program, the development for improved maintenance strategies for existing equipment or the implementation of new break rooms.

According to Cole et al., there is limited evidence that participatory ergonomics have a small, but positive effect on musculoskeletal complaints and physical discomfort.

There is also limited evidence for an effect on injury rates and worker’s compensation claims, in particular in the field of musculoskeletal disorders. Since effect sizes strongly varied in the analyses, the extent of the effect cannot be determined reliably up to now.

The authors also find limited evidence that participatory ergonomic interventions can reduce sick leave and the number of lost work days, although the extent of the effect is not known here either.

In all, nine of ten studies of medium to high quality demonstrate an effect on the health outcomes assessed. Although participatory ergonomics still have to be considered to be of limited evidence, they should nevertheless be implemented in practice. According to the authors, any preventive intervention proven to have at least a small effect should be made use of. This applies in particular to widespread diseases such as musculoskeletal disorders, even when hard evidence is still lacking (i.e. positive results in several high-quality RCT). The authors suggest to apply less strict criteria when assessing the effectiveness of preventive interventions.

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## 4 Effectiveness of workplace interventions to prevent mental ill-health

Based on the currently available evidence, this chapter shows which strategies have been proven to be effective for the prevention of mental disorders and the promotion of mental health at the workplace. Nine reviews and meta-analyses identified in the systematic literature research, including 294 studies some of which have been taken into account in several

reviews, form the basis of evaluation. Table A-2 in the annex gives an overview of the included studies.

In recent years, a number of partially very detailed reviews on the effectiveness of different interventions for the promotion of mental health and the reduction of mental disorders have been published. Most of the studies comprise individual interventions and only a few studies examine the effectiveness of measures at the organizational level. No review dealing exclusively with organizational interventions was found for the given period (2000 to August 2006). Most of the studies in literature refer to stress interventions with the focus on the individual level. Effectiveness often is judged by means of the reduction of work-related stress in general or of individual stress components and not by means of direct characteristics such as prevalence reduction or a lower duration of illnesses.

The reviews and/or meta-analyses include studies on various types of intervention measures. Heterogeneity is found also regarding duration, number of included participants, groups of persons and/or professions, outcomes and measuring instruments. This results in some difficulties in evaluation regarding effectiveness since a comparison is hardly possible. On account of the relatively small number of studies on measures of the organizational level, no equivalent comparison with those of the individual level can be made. Further qualified studies have to be striven for and realized in this context. Nevertheless, at the end of this chapter, following from the results found, recommendations and information for prevention and health promotion are given for the individual and organizational level. First of all, however, we would like to deal with the reviews and meta-analyses identified.

### 4.1 Programs for the prevention of mental disorders

Different designations and/or classifications for stress interventions can be found in literature. A classification according to DeFrank and Cooper (1987, quoted according to Giga et al. 2003) was adopted for structuring the studies included in this report. A distinction is made between three levels: individual (I), organizational (O) and individual-organizational (I/O) interventions. They are also used in the tabular overview on the reviews in the annex (Tab. A-2).

#### Individual stress interventions (I):

Stress interventions on an individual level aim at an increased awareness of stress and the dealing with it. The health-related impacts and the possibilities of prevention should be demonstrated to the employees. Stress interventions are techniques intended to help judging and/or assessing stressful situations and/or to make effective coping with the symptoms easier. Examples of individual interventions include relaxation techniques, time management and exercise programs.

**Organizational interventions (0):**

Organizational interventions aim at minimizing the stress load of employees by changing the organizational, social and technical conditions. Examples include modifications of the working process (job rotation) and the responsibilities as well as modification of the job tasks.

**Individual-organizational interventions (1/0):**

These interventions represent the interface between individual and organizational level. They concern questions on role allocation (lack of clarity regarding responsibilities, role conflicts) and the involvement of employees in decisions. Methods include e.g. conversations for solving role conflicts and participation in decision-making processes.

The results of the reviews and meta-analyses found will be presented in more detail below. Table A-2 in the annex gives additional information on the individual papers.

**Van der Klink et al. (2001)**

The meta-analysis deals with the question of effectiveness of stress interventions and attempts to shed light on the most effective forms of intervention. 48 studies were included in the meta-analysis. Five studies assess interventions on the organizational level, the rest addresses individuals. 18 thereof assess cognitive-behavioral approaches and 17 studies deal with the effect of relaxation techniques. The other eight studies comprise a multimodal approach.

The meta-analysis arrives at the conclusion that there is "reliable" evidence regarding the positive benefit of stress-reducing interventions. The comparison of measures of the individual level shows that cognitive-behavioral approaches have a greater effect than relaxation techniques and multimodal programs (comprehensive programs). Some individual measures of cognitive-behavioral approaches are more effective than others; it is, however, not shown which ones are concerned by this. Cognitive-behavioral approaches have a positive impact on the examined outcome variables. They include the following components: psychological responses and resources, complaints, physiology and the quality of working life.

Multimodal programs seem to be ineffective regarding the positive influence on psychological resources. Individual stress interventions have a stronger effect on employees with great self-determination at work than on those with little self-determination. No effect was found for interventions focusing on the organizational level, although cases of corresponding success have already been reported in (uncontrolled) evaluations. Among other things, a too short follow-up period to produce measurable effects of organizational interventions is stated as a possible explanation.

**Proper et al. (2002)**

The systematic review by Proper et al. examines the effectiveness of physical activity programs at the workplace with respect to work-related outcomes. They include work satisfac-

tion and job stress, productivity, absenteeism and employee turnover. The review comprises controlled studies only (randomized controlled or controlled). Studies dealing with comprehensive workplace health programs in which physical activity only is a component are excluded. Physical activity programs at workplaces aimed at secondary prevention of specific health problems have not been included either.

Eight studies have been identified (four randomized controlled trials and four controlled trials) and assessed by means of defined criteria with respect to methodical quality. The study period of the randomized controlled trials varied from six to twelve months, whereas the controlled studies cover a study period from eight weeks to a year. Conclusions regarding evidence result from the five-level assessment system using the following levels: "strong evidence", "moderate evidence", "limited evidence", "inconclusive evidence" and "no evidence".

The literature sifted examining the impact of workplace physical activity programs on absenteeism (absence from work) results in an assessment of limited evidence for the effectiveness. According to Proper et al., companies can quite benefit from such programs. Regarding the effectiveness for work satisfaction, the results are summed up as inconclusive. The same applies to the results for work-related stress. No evidence is found for the effectiveness of physical activity programs on productivity. Since only one controlled study was found, the authors arrive at the conclusion of "inconclusive evidence" for the outcome of employee turnover as well.

**Mimura and Griffiths (2003)**

Mimura and Griffiths conducted a systematic review on the effectiveness of stress management at the workplace. Individual and organizational programs for employees in the nursing sector are analyzed. The review includes six randomized controlled studies, a prospective cohort study as well as three auxiliary studies. The interventions comprise highly different methods and measures such as education, role playing, relaxation, music, exercise, humor and cognitive techniques.

Interventions at the individual level involving physical exercise, music and relaxation are potentially effective. Weak evidence comes from a study of a cognitive technique at the individual level. One approach of social support education is questioned but possibly effective.

The authors qualify the methodological quality of the identified studies as "poor/modest". This is why no conclusions are allowed and/or possible in several cases. This applies to the studies at the organizational level as well.

According to the authors, on the basis of the results, there is more evidence for the effectiveness of personal support for reducing work-related stress than for environmental management. However, they cannot make any statement on the fact which approach is more effective since the number of studies is too small. In their opinion, further research in this field is required.

**Michie and Williams (2003)**

This systematic review examines the effectiveness of interventions for the reduction of work-related psychological ill-health and sickness absence. At the same time, key work factors associated with psychological ill-health are emphasized. The population mainly comprises employees in the health care system, but is completed by other professional groups. Three groups are created for a comparison: employees in the health care system in England, health care workers in other developed countries and employees in other sectors. The review includes a total of 49 studies thereof six studies examine the effectiveness of interventions.

The following factors turned out to be key factors associated with psychological ill-health: work overload, work pressure/time pressure, much overtime, too high job demands, lack of control over work, lack of participation in decision making, poor social support, interpersonal conflicts, unclear management as well as conflicts between work and family requirements. According to Michie and Williams, the relations between the key factors and the impact on mental health are similar for the different professional groups, with employees of the health care system being affected more frequently by psychological disorders.

According to the authors, interventions using individual training and organizational modifications are of benefit and result in an increase of mental well-being and a reduction of absenteeism. The interventions aim at an increase in the participation in decision making and problem solving, the increase of social support and feedback as well as an improved communication. Michie and Williams consider the combination of stress interventions at the individual and organizational level to be most effective. Further research on the reduction of stress causes and the economic evaluation is required in their opinion.

**Giga et al. (2003)**

The review by Giga et al. examines 16 studies on stress management interventions (SMI) carried out in the United Kingdom. Most of the studies comprise interventions on the individual level. The review focuses on interventions aiming at a) the prevention of the occurrence of potentially stressful situations, b) the reduction of the intensity of these stress factors and/or the strain due to these stress factors and c) to the dealing with and management of stressful situations (through knowledge transfer and enhancing competence).

13 of 16 studies focus on the individual behavior of the employees. They include measures such as relaxation, meditation and cognitive-behavioral interventions. Three studies focus on organizational interventions e.g. continuing education and restructuring of the work process. Seven studies include more than one intervention level, in most cases the individual and the individual-organizational level being connected. No study combining all three intervention levels was found.

In general, the studies show a positive result, a decrease in anxiety and depression on the individual level being reached. The increase in productivity and the reduction of sickness absence can be recorded on the organizational level. In all, the individual measures are stated to have a certain positive effect, but it is established that interventions of the individual level more rarely result in a long-term effect. Giga et al. think that this also is a reason for the fact that the number of studies on organizational interventions tends to increase.

In addition to the general positive effects, the authors point out that interventions on the individual level less probably have effects on the organizational level such as e.g. productivity. They are mainly associated with an increase in the individual mental well-being. Improvements regarding the employees' health and the company environment can be achieved more probably by interventions of the organizational and individual-organizational level.

Giga et al. point out that the studies found for this review do not allow any clear conclusion about the effectiveness of interventions at the individual level. The small number of studies that compare different intervention levels leads to this result. Moreover, not all studies are randomized and controlled.

**Caulfield et al. (2004)**

The authors summarize the empirical research on work-related stress of the past ten years in Australia and emphasize the effectiveness of the interventions. To this effect, only empirical studies with participants in Australia were chosen and assigned according to defined criteria. This review focuses on interventions at the individual level as well. Only one of the six studies included refers to the organizational level.

Based on the studies, the authors do not associate any clear reduction of work-related stress with studies focused on interventions of the individual level. In their opinion, the effectiveness for the entire company depends on the number of employees taking part in the interventions. The study representing interventions on the organizational level shows a positive effect. Here the larger relation between work-related stress and work factors and work environment becomes clear. Changes in the work conditions, such as work redesign, promote positive results concerning stress reduction. At the same time, more employees can benefit from the measure than in case of a voluntary participation in programs of the individual level. It has to be qualified that, however, by saying that the results are based on a single study focusing on organizational measures only.

**Jordan et al. (2003)**

The systematic review by Jordan et al. deals with measures for stress prevention and management. In all 74 studies were identified. The duration of the programs evaluated in the studies varies between a few hours and ten years. Most of the

included studies are measures on the individual level. They are completed by studies combining the individual and organizational level. Studies focusing exclusively on the organizational level were also found for this review.

In their evaluation, the authors state that there is no evidence for a superiority of certain individual interventions over others. They point out that it is less a question of using certain individual interventions, but rather of analyzing the need and necessity. Conversations with employees and the identification of risks should be used to find out where and which changes are required. The studies show evidence for the fact that the use of stress management interventions and of programs of prevention only has a small and/or no long-term benefit when the necessity and the field of application are not analyzed before. Companies have to develop a comprehensive strategy for recognizing their specific needs and adapt the interventions accordingly.

Evidence for short-time effectiveness was found for individual interventions. This short-term effect can turn into a long-term effect for continual offers of exercise measures only. According to the authors, strong evidence is found for the necessity of the development of supporting structures and the involvement of the organizational level. No evidence-based conclusions can be drawn about the question which individual measures are more effective since the studies involve different target groups, study designs and prevention methods.

Jordan et al. arrive at the conclusion that the combination of measures of the individual and organizational level is the most effective form. Important preconditions for the success of the programs include the participation of the employees in the planning, the implementation and the evaluation of changes on the organizational level and changes in the work structure. Another important factor is the role of supervisors and of the management in the development, identification of risks and support of employees through appropriate communication.

#### **LaMontagne et al. (2006)**

The comprehensive review by LaMontagne et al. constitutes an update, a completion and extension of the paper conducted by Jordan et al. (2003). The question of the effectiveness of stress interventions both on the individual level and on the organizational level is in the center of interest. The comprehensive review refers to in all 95 systematically evaluated studies.

On the one hand, the interventions of the studies included are grouped and assessed according to the following categories and/or system approaches a) "high" – means studies with mainly primary prevention, completed by secondary and/or tertiary prevention, b) "moderate" – means studies with primary prevention only and c) "low" includes little or no primary prevention in the studies. At the same time, the intervention level and, if possible, the duration of the intervention are recorded. In this paper, the intervention levels include the follow-

ing four levels: physical work environment (e.g. noise level), organizational level (e.g. restructuring of the work process), individual level (e.g. coping skills training) and the combination of organizational and individual level (e.g. co-worker support groups).

The three resulting system approaches are defined as follows: "high systems approaches" are related to the organization and to the individual. "Moderate systems approaches" comprise interventions exclusively aiming at the organization. "Low systems approaches" comprise measures focusing purely on the individual person. This paper examines the hypothesis that "systems approaches" (i.e. interventions with mainly primary prevention, completed by secondary and/or tertiary prevention) offer the best results for the individual and organizational level.

Studies on interventions focused on the individual person show that measures with little or no primary prevention are effective for the individual person only. There is a good evidence base for these interventions on account of comprehensive literature and convincing study designs. Examples of interventions for this approach include progressive muscle relaxation, meditation and cognitive-behavioral interventions. Outcomes in the studies include for example physical symptoms, physiological changes, coping strategies and mental variables (general mental condition). These measures tend not to have a positive effect on the organizational level.

Studies with interventions mainly focused on the organization on the level of primary prevention completed by secondary and/or tertiary prevention and those exclusively on the level of primary prevention have a positive influence on both levels.

Finally, LaMontagne et al. arrive at the conclusion that „high systems approaches“ most effectively influence the consequences of work-related stress, both in the individual person and in the company. As already shown in other reviews, the authors came to the conclusion that both levels, the individual and the organizational level, have to be involved, unless the measures cannot be effective.

Regarding an evaluation of the economic aspect, the authors found that studies on "high systems approaches" obtained positive results. An economical evaluation was found only rarely in "moderate systems approaches" and "low systems approaches" (also see chapter 6).

In general, it turned out that more and more studies on interventions of primary prevention, completed by secondary and/or tertiary prevention, are available in international literature.

#### **Seymour and Grove (2005)**

This comprehensive review focuses on the question of evidence of interventions for the prevention of mental health problems at the workplace. All three levels – primary, secondary and tertiary prevention – are explored. Conclusions regarding evidence

result from the grading system used, the three star system, comprising the following grades: \*\*\* “strong evidence”, \*\* “moderate evidence” and \* “limited or contradictory evidence” as well as “no scientific evidence”. Studies on interventions for persons with severe mental disorders were excluded from the literature study. The review includes in all 31 studies.

A large number of different interventions and approaches were identified in the included studies for the field of primary prevention. A combination of skills acquisition, partially completed by exercise, relaxation and self help was found most commonly. The improvement of problem-solving skills and of skills for an improved communication was identified as common components. The use of measures on the individual level was predominant.

The authors sum up the results in their evaluation as follows: employees without manifest mental health problems and those not belonging to the high-risk groups can benefit from a large number of stress management interventions. This is supported by “moderate evidence” in literature. These interventions impart skills to the employees from which both they personally and the organization and/or company can benefit. The extent to which the individual interventions contribute to prevention cannot be determined.

For the field of secondary prevention as well, the focus of the included measures is on interventions for stress management. The authors found a “moderate to limited evidence” for the effectiveness of a large number of such interventions. Measures for individual support, educational approaches, consultation and the imparting of specific skills are used in the first line. Only limited evidence was found in this review for the effectiveness of interventions for physical activity in this context. Regarding the outcome measure of sickness absence, the authors refer to strong evidence of cognitive-behavioral interventions.

Moderate evidence was also found for the use of a multi-modal approach implying more than one technique or method. The authors consider this technique to be more effective than the use of individual measures.

Regarding the focusing on interventions of the individual level, the authors refer to limited evidence only. Limited evidence was determined for the use of measures on the organizational level regarding the reduction of present mental health problems (“common mental health problems”) as well.

Strong evidence is stated for the use of interventions focused on the individual level for employees having a high risk of mental health problems. According to the authors, this form of measures is more effective than interventions on the organizational level. Programs including support, the learning of individual, social skills and skills for coping with stress are most effective. According to studies, multi-modal programs are associated with longer-lasting effects.

This review emphasizes as well that it is particular important to identify the persons and needs in a company. Selective interventions are possible only in this case.

The authors found a strong evidence regarding the use of short, individual measures (up to eight weeks) for the field of tertiary prevention. Those measures focusing on the cognitive-behavioral approach are particularly effective. The effect is stronger in employees whose job is marked by high control.

## 4.2 Summary

Based on the currently available and researched evidence, a summary of the measures that have proven to be effective for the prevention of mental health problems and the promotion of mental health at the workplace follows. It deals with the intervention levels and the outcomes as well as emphasizes the divergences of the studies (concerning their methods etc.) and their possible influence on the results, before drawing up a conclusion in the form of recommendations.

The analysis of the nine reviews and/or meta-analyses included that cover in all nearly 300 individual papers illustrate the heterogeneity of the studies. There is a continual, albeit slow increase in evaluations in literature. The studies found show that various aspects influence the results for the effectiveness of interventions. The quality of the evidence often is affected by a large number of methodical and conceptual problems.

For example, Proper et al. refer to an oftentimes poor methodical quality of RCT and CT. An insufficient description of the inclusion criteria and the randomization procedures are considered to be shortcomings. Furthermore, an often too short duration of the interventions and limited follow-ups are mentioned. Many studies do not make any detailed statement on the extent to which the program was complied with (compliance). It is therefore not possible to infer which extent the intervention must have for generating a positive effect. Moreover, it is partly unclear on which exact mechanisms the intervention has to be based for being effective. Various variables exert an influence on the fact whether an intervention generates positive, negative or no changes. The effects and the results can vary in different companies for the same intervention since it is still unclear under which circumstances and/or conditions the intervention is effective in which form.

This also makes clear that there is a problem of transferability of study results. Specific organizational characteristics of a company can cause a different effect of equally or similarly structured interventions. Some authors (among others, Seymour and Grove 2005) put a generally valid transferability into question also as to the fact that, in their opinion, cultural, professional and profession-related conditions influence the results and/or the effect of the interventions. Therefore, according to them, a modification of the interventions results in a reduction of the comparability of the interventions performed. The limits

of evidence-based practice of complex organizational-related interventions of workplace health promotion become clear in this context.

On account of the complexity as to type, extent etc. of the interventions already described above, it turns out to be difficult to make an exact statement on the effectiveness of the individual interventions and techniques. It can in part no longer be gathered clearly from the reviews included to what extent several or only individual interventions were used in the initial study. At present, it can be determined in part only which interventions create which effects and which interventions are particularly effective and recommendable. Rather indications and/or general statements can be derived.

Stress interventions focus on the individual level. They are also carried out more frequently in practice than measures on the organizational level. The increased presence of stress interventions in science and practice can be explained by the following reasons, among others: on the one hand, these measures can be integrated more easily into existing company structures without influencing them. Moreover, they are considered to be more cost-effective. Furthermore, these interventions are more easily examined and evaluated than those of the organizational level. Individual-related interventions have been more widespread in practice so far since, in most cases, the reasons of existing problems are still assumed to be caused by the individual person and thus have to be addressed on this level.

The reviews of individual measures reflect a large variety of interventions. According to the evidence found, they can absolutely be effective. However, it also becomes clear that they cannot effectively counteract all sources of stress. Organization-related causes of stress such as management style, working atmosphere or company culture can hardly be influenced by these interventions. Stress management interventions that exclusively focus on the individual person – without reducing the sources causing the stress – will have a limited effect. There are references in literature pointing out that primary preventive measures on the organizational level are important. These interventions could be used to address the causes of stress and thus of a negative affection of mental health. Individual stress interventions reduce the symptoms, but, in most cases, they do not have any effect on the causes.

According to the studies included, in particular cognitive-behavioral interventions have proven to be effective on the individual level. Regarding sickness absence, Seymour and Grove (2005) found “strong evidence” for these interventions. The same paper qualified exercise programs as of “limited evidence”. Proper et al. (2002) arrive at a similar conclusion. According to them, there is limited evidence and/or no conclusive evidence for these investigated outcome measures. Mimura and Griffiths (2003) assess physical activity as potentially effective. Van der Klink et al. (2001) carried out a comparison of cognitive-behavioral measures and relaxation techniques as

well as a multi-modal approach. According to that comparison, cognitive-behavioral interventions are more effective than relaxation techniques and multi-modal programs. LaMontagne et al. (2006) point out a good evidence base as well for individually focused interventions regarding the effectiveness for the individual person. Caulfield et al. (2004) associate no clear reduction of work-related stress with measures on the individual level. In their paper, Seymour and Grove (2005) arrive at the conclusion that individual interventions are less effective than comprehensive measures (limited evidence). However, this review notes there is strong evidence for the effectiveness of individually focused interventions for high-risk employees.

The evaluation of interventions on the organizational level is based on the findings of a clearly smaller number of studies. On account of the results, the evidence for the effectiveness on this level can now be assessed to some extent only. All in all, the reviews show that interventions on the organizational level of workplace absolutely have the potential to create positive effects. However, there are also differences in the results of the reviews and/or meta-analyses found. For example, in their review, van der Klink et al. (2001) arrive at the conclusion that measures of the organizational level do not have any effect. At the same time they refer to the small number of the included studies and too a short period for the follow-up of the effects of organizational interventions. Mimura and Griffiths (2003) come to the following result in their overall assessment: There is more evidence for the effectiveness on the individual level than for measures on the organizational level. However, they also think that this conclusion is due to the small number of studies.

Michie and Williams (2003) assess both individual interventions (e.g. trainings) and organizational modification as successful for the promotion of mental well-being and for the reduction of absenteeism. Caulfield et al. (2004) point out that more employees benefit from the use of interventions on the organizational level. Seymour and Grove (2005) ascribe limited evidence to organizationally focused interventions regarding their effectiveness for the individual person. In contrast, the comprehensive review by LaMontagne et al. (2006) points out that organizationally focused interventions have a positive influence both on the individual person and on the company.

Up to present, the combination of measures on the individual and on the organizational level was rather rarely object of scientific research, but a large number of scientists have supported their use in the last years already. In their report, Jordan et al. (2003) now point out that there is strong evidence for the necessity of involving the organizational level. According to the authors, the combination of interventions of the individual and the organizational level improves the effectiveness of the measures. In their overall assessment, LaMontagne et al. (2006) also come to the conclusion that the combination of measures on the individual and on the organizational level is more effective both for the employer and for the employee.

Their use would also lead to positive results of economic evaluations. Giga et al. (2003) also state that the combination of both levels tends to be most effective. They point out in particular that interventions of the individual level often only have a short-term effect on the individual person.

In addition to the conclusions presented above, other indications can be taken from the reviews and/or meta-analyses included. For example, Jordan et al. (2003) point out that measures provide only a small and/or short-term benefit if the necessity and the field of application are not analyzed before. The authors also recommend the use of continual offers for achieving a long-term effect.

The evaluation of the reviews included shows that individuals and organizations benefit from stress intervention measures. According to Seymour and Grove (2005), there is moderate evidence for it. The following recommendations for practice can be derived from the results found:

- use of a combination of interventions of the individual and the organizational level,
- use of a comprehensive approach,
- analysis of the necessity and of the field of application before the implementation of the intervention as well as
- use of continual offers.

In addition to recommendations and information for practice, there can be derived such recommendations and information for scientific research as well. Reviews carried out up to now have mainly focused on the analysis of the outcomes. By doing so, variables contributing to the explanation of the connection between the use of the intervention and the result achieved are not taken into account. This is a part of the process evaluation that has been given only little attention in the scientific studies up to now. Future evaluations should identify the causal variable for the effect of the treatment and the circumstances under which interventions have the greatest effect. It is also important to study the sustainability of the measures. Information on different risk groups, on the participation and on gender-specific differences should be an element of future studies. More scientific studies should be carried out in this field so that the evidence base of organizational interventions can be assessed better. Further knowledge is required regarding the combination of measures of the individual and the organizational level as well. At present, the studies on organizational interventions and their combination with individual measures are often associated with methodical shortcomings. Moreover, they are still too rare. This should change in future.

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## 5 Effectiveness of workplace interventions to prevent musculoskeletal disorders

The literature search revealed 19 reviews published between 2000 and 2006 which deal with the effectiveness of workplace interventions to reduce musculoskeletal disorders (MSD). Without a doubt, this field of action deserves great attention both in research and in practice. Since this report aims to summarize the scientific evidence on the effectiveness of workplace health promotion and prevention, in the field of musculoskeletal disorders several difficulties already occurred when sifting through the literature.

First, on an international scale different concepts are used for describing musculoskeletal clinical pictures and symptoms – for example back pain or diseases of the neck and upper limbs due to repeated strain (also called cumulative trauma disorders). As a consequence of this the comparability of papers is not always ensured.

Moreover, from the scientific point of view, no standard definition is established that clarifies the designation ‘work-related musculoskeletal disorders’. In the reviewed literature, several authors use this designation, in some papers it is even part of the title (e.g. Silverstein a. Clark 2004), but it is not always clear whether the term covers exactly the same clinical pictures or not. According to a definition of the European Agency for Safety and Health at Work, work-related musculoskeletal disorders are impairments that affect body structures such as muscles, joints, tendons, ligaments, nerves or the local blood circulation. The disorders are caused and/or intensified primarily by performing the work itself and/or the impact of the work environment. Other sectors of research (e.g. occupational medicine) deal with the question to what extent musculoskeletal disorders have to be considered as caused by work definitely, so even there is still need for clarification.

A third problem, that also is addressed by several review authors (e.g. Linton a. van Tulder 2001, van Eerd et al. 2006), is the difficulty to distinguish clearly between primary prevention (aiming at avoiding the onset of a disease) and secondary prevention (aiming at avoiding the recurrence of complaints or the progress of a disease) regarding MSD. This applies in particular to papers dealing with studies which examine measures for the prevention of global musculoskeletal complaints (e.g. pain in the upper or lower limbs) and/or back or low back pain since their onset often already occurs in childhood or adolescence (cf. Lühmann et al. 2006).

As a result, for such clinical pictures a traditional primary prevention is no longer possible in the context of workplace health promotion. Hence, the preventive aim may rather be to prevent a progress of musculoskeletal disorders or to reduce the severity of the symptoms. This is why the study selection in many reviews is not only restricted to studies using samples of healthy, pain-free employees. Alternatively, the review authors define a less strict criterion by including studies of employees who are not on sick leave due to MSD or not seeking treatment when the baseline assessment is done.

The present chapter aims at reviewing the evidence-base on the effectiveness of preventive interventions for MSD as comprehensive as possible. Due to the imprecise definition, the term of ‘work-related musculoskeletal disorder’ is used in literature for a very broad range of musculoskeletal ailments, disorders as well as injuries, affecting several or all of the components of the musculoskeletal system. There are various differentiations for classifying the individual clinical pictures:

On the one hand, a distinction is made by cumulative affections that are the result of repeated strain over a long time period of high or low intensity (e.g. inflammation of a tendon) and acute traumas resulting from an extreme, short strain (e.g. rupture of a muscle fiber as a result of lifting heavy weights, sciatica after abrupt movement).

Furthermore, there is a classification by specific disorders that have an initial somatic cause (e.g. carpal tunnel syndrome) and unspecific diseases that cannot be clearly ascribed to a specific trigger (e.g. unspecific back pain).

Both distinctions are intended to provide rather an orientation and summary than a clear and rigid categorization. For example, specific musculoskeletal disorders can be the result of repeated physical strain, but they can also be caused by acute traumas. The carpal tunnel syndrome is a good example for illustrating this: in most cases, it is caused by repeated strain of the wrist joint (e.g. working with the wrists flexed or frequent, repetitive wrist movements). However, the disorder can also be triggered by an acute trauma leading to a mechanical irritation of the nerve in the carpal tunnel, for instance a carpal bone dislocation.

In addition, because of their high prevalence, work-related musculoskeletal disorders of the neck and the upper extremities often are examined separately. Among the most serious risk factors are repetitive hand and arm movements as well as vibration at work to which nearly two thirds and a quarter of the European employees are exposed, respectively (European Agency for Safety and Health at Work 2007).

Although some of the neck and upper extremity disorders – as illustrated by the example of the carpal tunnel syndrome – can result from extreme strain, the ailments are usually caused by repeated, albeit only moderate strain of the affected components. This is why work-related neck and upper limb disorders (WRULD) in literature are also known as cumulative trauma disorders (CTD), repetitive strain injuries (RSI) or overuse syndrome. Besides the carpal tunnel syndrome, the cumulative trauma disorders also include diseases like tenosynovitis, hand-arm vibration syndrome, shoulder arm syndrome or unspecific neck pain.

In order to cope with the variety outlined above, we followed a pragmatic approach when selecting the reviews on the prevention of musculoskeletal disorders. A review was taken into account if it dealt with one of the aspects described above, this means that no restrictions to specific musculoskeletal disorders were made. The same applied to the problem of the distinction of interventions by primary and secondary preventive – reviews were excluded only when they exclusively focused on rehabilitation interventions, i. e. tertiary prevention interventions for the rehabilitation of (long-term) disabled employees suffering from musculoskeletal disorders.

There are a large number of interventions for the prevention of work-related musculoskeletal disorders. Regarding the frequency of implementation, as in the field of mental health, interventions aiming primarily at individual behavior changes outweigh organizational and environmental interventions, since they can be integrated into the work process much more easily than interventions requiring structural changes. Individual-focused approaches include in particular educational interventions of various contents (e.g. back or neck schools, training on ergonomics) as well as physical activity programs to improve flexibility and increase fitness of the employees.

Furthermore, there are a large number of measures following the approach of environmental changes. They aim to reduce known risk factors of musculoskeletal disorders such as awkward postures or high physical demands by modifying working conditions. In addition to traditional ergonomic interventions such as the provision of technical or other auxiliary devices (e.g. lifting aids, lumbar supports) and workplace redesign, administrative interventions are used that comprise job task modification, reorganization of the work process or policy interventions (e.g. the establishment of a steering committee on ergonomics).

In some cases it is difficult to assign interventions clearly to one of the two categories. For example, the provision of lifting aids for employees working in physical demanding jobs can be understood as traditionally ergonomic and therefore as an organizational intervention. At the same time, however, it is also necessary that the employees actually use these devices and thus change their mode of working – and so their behavior. Further examples represent individual-focused educational interventions whose main aim is to transfer knowledge and provoke changes in employee behavior. However, if these programs are a regularly, mandatory part of the job and integrated in the work process (for a defined time period), the classification becomes vague here as well.

Nevertheless, we will try to summarize the findings of the identified reviews, which are presented in detail in the following sections, in order to make recommendations for individual-focused as well as organizational-focused interventions. The 19 papers report on the results of more than 400 studies. In some reviews there are overlaps regarding the analyzed studies, in particular when they are of comparable publication date and purpose (e.g. van Poppel et al. 2004 & Tveito et al. 2004). In these cases, it is interesting whether the authors independently draw consistent conclusions on the effectiveness of an intervention or if there are differences between the assessments.

First, we will elaborate on reviews dealing with work-related musculoskeletal disorders in general. Then systematic reviews are presented which examine the effectiveness of MSD interventions offered to certain professional groups (e.g. health care workers). Finally, we will discuss papers that focus on specific clinical pictures (e.g. carpal tunnel syndrome). In section 5.5

we kept the terms used by the respective authors to describe the examined clinical pictures (e.g., findings on back pain and low back pain are presented separately). The same applied to the interventions. In each section the reviews are arranged according to their publication date. Table A-3 in the Annex provides an overview of the results.

## 5.1 Work-related musculoskeletal disorders in general

### **Karsh et al. (2001)**

Including 101 articles, the review by Karsh et al. is the most extensive review identified on the effectiveness of worksite interventions for MSD prevention. It deals with ergonomic measures which are assigned to technical interventions (e.g. height-adjustable work tables), administrative interventions (e.g. job task modification) and personal interventions (e.g. training on body mechanics). Karsh et al. do not make any restrictions regarding study design and include studies with a strictly experimental or quasi-experimental design as well as observational studies with or without pre-post design, non-equivalent control groups or with an pre-experimental design.

Nearly half of all studies (47) evaluated multi-component programs. Eight papers dealt with the benefit of lumbar supports/back belts, 21 with educational interventions and ergonomic trainings. Ten of the studies examined tools and/or technical interventions, 14 assessed physical activity programs. Only one study documented the effect of job redesign. The review reports on the state of the science until early in 1999.

### *Lumbar supports*

50% of the eight studies on lumbar supports used a randomized, controlled design with adjustment of potential confounders. The others were longitudinal, case control or cohort studies where confounders were not taken into account. Four of the papers, including three RCT, reported no effects on relevant outcomes such as e.g. the frequency of self-reported back injuries, experienced pain, sick leave, days with complaints or trunk muscle strength.

In two of the studies the results were mixed: in a pre-post study, wearing the belt was associated with a strengthening of the trunk flexor muscle, but not of the trunk extensor muscle. The second study, which used an experimental design, showed a positive effect of the back belt as an additional intervention to education compared to the training alone, but no differences regarding the musculature were found here.

A prospective cohort study and a study with pre-post design showed positive results. Reduced physician diagnosed back injuries as well as a smaller number of injuries and cumulative trauma disorders in new employees were observed. The results of the pre-post study, however, were not subject to a statistical significance test.

*Tools/Technologies*

None of the ten studies found used an experimental design, in particular longitudinal studies and a study in which data collection took only place after the intervention were found in addition to a quasi-experimental study. The interventions evaluated included for example new technical equipment for street paving employees (e.g. wheelbarrows, shovels), new sorting tables for parcel sorters, new crane seats, lifting devices for health care workers or mobile offshore drilling units.

Four studies found positive results, including improved well-being, increase in the strength of the hand, reduced incidence of back pain, reduced absenteeism and a decrease in the frequency of cumulative trauma disorders as well as reduced severity of symptoms.

Five papers reported inconsistent results. One study showed that technical auxiliary devices reduced physical workload, but were associated with new strains like noise or vibration. A similar situation was found in a study involving a new work table which improved some awkward postures, but worsened others.

*Education/Training*

Educational interventions were evaluated in 21 studies and included trainings on body mechanics, body posture, lifting techniques, anatomy or pain management as well as work technique. Seven RCT, seven quasi-experimental studies, five longitudinal studies, an uncontrolled study using a post-test design and a study analyzing data, which were recorded prior to the program implementation, entered the review by Karsh et al.

Five studies showed no effect of the training regarding improved body mechanics during lifting, lowering or transferring. The frequency of lifting on the job remained unchanged as well and no effect regarding posture on the job was found either. Injuries of the lower back, back injuries due to lifting and handling and other relevant outcomes were not influenced, too.

14 studies reported mixed results, a positive effect was found for two of seven outcomes. For example, the work technique of nursing staff during patient transfers was improved, but no reduction of the incidence of back injuries could be observed.

*Physical activity/exercise programs*

The preventive effectiveness of physical activity was investigated in seven randomized controlled studies, a quasi-experimental study, five longitudinal studies and a study with a prospective cross-over design. Four papers reported positive results regarding lost work days, days with complaints, pain intensity, strength of back muscles, musculoskeletal symptoms and incidence of cumulative trauma disorders. In six cases, the results were partly positive, partly no effect was found (e.g. reduction of the cases of disorders but no changes in sick leave), in two of the studies the intervention proved completely ineffective.

*Job redesign*

A study with a pre-post design tested whether a work reorganization program reduces risk factors of upper limb musculoskeletal disorders. A change was observed for one outcome, three others remained unchanged. Comparison between groups was not possible since this study used a pre-experimental design without control group.

*Multi-component programs*

The 47 publications that Karsh et al. assigned to this category include two randomized controlled studies, three quasi-experimental studies, 29 studies with longitudinal design, four case studies as well as studies using pre-experimental designs. In most cases, the programs consisted of training, technical devices, workstation redesign as well as changes in work organization.

19 studies found positive results, including reduced musculoskeletal symptoms in the upper limbs, improved work technique as well as a reduced incidence of back injuries, musculoskeletal disorders and cumulative trauma disorders. Positive effects were also shown for outcomes like the number of visits to the medical department due to cumulative trauma disorders, sick leave and restricted days. In addition, cost savings through reduced compensation payments, reduced turnover rates and improved general health were reported.

In 27 studies the results were inconsistent, for instance regarding muscular strain, absence rates, pain intensity, incidence of work-related musculoskeletal disorders, injury rates or awkward body postures. The two randomized controlled studies also reported mixed results – whereas, on the one hand, the prevalence of back pain and medical costs were reduced, other relevant outcomes such as incidence of diseases due to repeated strain or severity of experienced pain did not change.

In the overall assessment, positive results for at least one of the examined outcomes were found in 84% of all studies. Therefore, according to the authors, the question whether workplace ergonomic interventions to control work-related MSD are effective can partly be answered “yes”.

Multi-component programs seem to be the most successful interventions. 97% of the studies found by Karsh et al. reported a positive result for at least one outcome. The implementation of technical devices comes second, with desired effects in 90% of the studies, followed by physical activity programs (86%) and educational interventions (67%). For lumbar supports only 50% of the studies reported at least one positive outcome.

In their conclusion Karsh et al. point out that only a third of the studies use an experimental or quasi-experimental design. This is why the results have to be interpreted with caution. According to the authors, if only high-quality studies were taken into account for the assessment, in particular the preventive effectiveness of educational interventions and lumbar supports would have to be doubted.

**Hess and Hecker (2003)***Stretching programs*

Regular stretching aims at increasing flexibility to prevent work-related musculoskeletal injuries and complaints. Hess and Hecker found only three studies which evaluated stretching programs offered to firefighters and employees in the manufacturing industry with physical demanding jobs. Even though only cautious conclusions can be drawn due to the small number of studies, the results indicate that stretching at the workplace can improve the flexibility of the employees.

One of the studies reported reduced incidence of musculoskeletal disorders in the intervention group at the follow-up after two years, the result, however, did not reach statistical significance. Furthermore, the studies found increases in dynamic and static strength in the intervention groups (when stretching was combined with progressive resistance strength training), a significant cost reduction due to reduced sick leave (no difference was found regarding the medical treatment costs) as well as improved well-being due to increased self-worth.

However, one of the studies used a pre-experimental design without control group and two studies did not record any relevant outcomes such as incidence of musculoskeletal complaints or severity of symptoms. The authors point out that further studies of higher methodical quality are required to prove the effective relation.

**Silverstein and Clark (2004)**

The review by Silverstein and Clark is based on the findings of 17 earlier systematic reviews, 20 RCT and 17 quasi-experimental studies. Each study is described in detail by the authors (for further information, please see the original review). Both individual-focused interventions and interventions aimed at the working environment were examined in various professional contexts (health care, VDU work, industry).

In their summary, Silverstein and Clark arrive at the conclusion that participative multi-component programs are the most promising approach in the field of MSD prevention. Moreover, they seem to be clearly more effective than single interventions. Measures aiming at the individual are found to be of limited effectiveness only. According to the authors, however, exercise programs could reduce the consequences of work-related musculoskeletal disorders.

Silverstein and Clark clearly state the necessity of conducting quasi-experimental field studies. They are needed for identifying effective intervention strategies which could subsequently be tested in randomized controlled trials. However, it is important to control potential confounders and to measure compliance for obtaining valid findings.

**Van der Molen et al. (2005)**

Van der Molen et al. analyzed 46 publications, both laboratory and field studies with experimental, quasi-experimental, pre-post and only post design. They evaluate the effectiveness

of ergonomic measures and various implementation strategies to reduce physical work demands and related musculoskeletal disorders. Interventions are categorized into technical (e.g. new technical equipment), organizational (e.g. changes in the work organization) and individual (e.g. workplace-specific ergonomic training), implementation strategies into "informational", "compulsory", "educational", "persuasive" and "facilitating".

*Ergonomic interventions*

Nearly all studies reported reduced physical demands after the introduction of new technical equipment. The same applies both to the combination of technical and organizational measures, technical and individual measures as well as for a study that only evaluated an individual ergonomic intervention. The evidence for musculoskeletal disorders is much less clear. Only four of ten studies, including three studies of high methodological quality, were successful in reducing incidence rates for musculoskeletal symptoms or perceived complaints.

According to the authors, no clear evidence exists that reduced physical demands subsequently lead to less musculoskeletal disorders, although an association of both factors is often found in epidemiologic studies. On one hand this could be attributed to the study duration which might be too short for identifying existing effects. On the other hand, in addition to physical work demands, factors outside the working environment or risk factors that have not been detected yet might play a rather large role.

*Implementation strategies*

The authors point out that most intervention studies do not deliberately distinguish between the effectiveness of an (ergonomic) intervention and different implementation strategies. The results of the review, however, suggest that the success of a workplace ergonomic measure does not only depend on its effectiveness per se, but also on the approach chosen for its implementation. The analyzed studies in which in addition to outcome data (effectiveness of the intervention) process data were assessed (e.g. change in risk awareness, willingness to change their behavior) show that the different actor groups have to go through several cognitive phases.

First, the actors have to become aware of the problem ("awareness"), second, they have to change their attitude towards supporting the changes ("attitude"), before finally the target "ultimately" aimed at, a short-term and long-term change in behavior, can be reached. During this process, it has to be ensured that the target group is sufficiently enabled to change its behavior ("ability"). For example, this is always put at risk when the availability of technical devices is not given and specific exercises are not carried out etc. A supporting, participative policy of the company is essential during the entire process. All studies that showed positive process data examined participative ergonomic interventions, training or exercise measures or a combination of both, thus with direct involvement of the employees.

Studies in which changes in the attitude or willingness to change the behavior were measured comprised practicing the interventions before implementing them, the participation of the target group and/or an involvement of labor inspectors (to increase compliance). The employees' risk awareness improved partly through informational strategies. Controlled studies show, however, that informational strategies alone do not result in a change in behavior in order to reduce physical work demands. Two experimental studies combined technical equipment with two implementation strategies ("educating" and "facilitating") where both reduced physical demands and decreased musculoskeletal symptoms could be observed.

To sum up, a combination of technical interventions and facilitating implementation strategies, e.g. participative-educational approaches, seems to be the most successful ergonomic measure to reduce physical work demands and associated musculoskeletal disorders. Furthermore, participative and educational strategies are suitable to influence process outcomes positively, but above all it is important to involve the employees actively and directly.

## 5.2 Musculoskeletal disorders in health care workers

### Haiduven (2003)

#### *Lifting Teams*

Haiduven analyzed nine studies published between 1991 and 2001 to evaluate the benefit of lifting teams in health care. The author defines the lifting team as a multifactorial ergonomic approach combining technical, administrative and individual components. A lifting team consists of two to four selectively trained, physically healthy persons who cooperate to accomplish (possibly) all patient transfers in a ward or in the entire hospital. The aim is to reduce musculoskeletal disorders related to lifting activities by relieving the nursing staff from physically demanding, high-risk lifting and transport activities.

The study results are assigned to three categories – disease- and cost-related outcomes, staff and patient satisfaction and capacity of the lifting team. All studies report a decrease by 50% to 100% in lost time work injuries and injuries related to lifting. Six programs were associated with medical cost savings. A back injury of a lifting team member was reported only once. Both staff and patients showed great satisfaction with the lifting team in all analyzed studies. The team achieved to absorb 88% to 95% of the staff's exposure to lifting per shift and to keep the time from call to lift as short as possible (approx. five minutes).

Since none of the included studies used a controlled evaluation design, Haiduven's recommendations are limited to preliminary guidelines that should be considered when implementing lift-

ing teams. Particular importance should be given to a thorough and careful selection of the intended lifting team members, their intensive training for back-friendly principles of body mechanics for patient transfer as well as a consistent hospital policy. Specific administrative guidelines that clearly define the situations in which the team has to be used, schedules for the lifting team as well as a prohibition of the regular nursing staff to perform lifts (except for emergency cases) are required.

Furthermore, an easy availability and the operability of transfer devices has to be ensured (for example, the devices should not be located in a room at the end of a corridor). In addition, Haiduven points out that the lifting team is not feasible for every health care facility. The author advises against using the teams in departments with a high number of unscheduled transfer activities.

### Hignett (2003)

This review looks at the effectiveness of intervention strategies to reduce musculoskeletal disorders and risk factors due to patient handling activities. 63 studies published between 1960 and 2001 are examined. Hignett divides the interventions into three categories – single factor interventions, multifactor interventions and interventions based on technique training. The methodical quality of each study is appraised using predefined criteria. Applied evidence levels include strong, moderate, limited and poor/no evidence.

#### *Technique trainings*

The author qualifies interventions focusing primarily on technique trainings as ineffective since no improvement in work techniques and no reduction of injury rates was reported. Four high-quality studies as well as a large number of low-quality studies showed no effect on these outcomes so that strong evidence is stated. Moreover, there is moderate evidence for a possibly positive short-term effect on other variables (e.g. the use of auxiliary devices).

#### *Single factor interventions*

The single factor interventions examined in the papers reviewed by Hignett include either hoisting equipment or the introduction of lifting teams (in contrast to the review by Haiduven 2003: here they were understood as a multimodal ergonomic intervention). The results of the studies which were of moderate to poor methodical quality suggest moderate evidence for the effectiveness of both interventions.

As the author explains, it is unusual to provide only hoisting equipment without any other components. This variation, however, might prove to be more cost-effective than complex multi-component programs in future high quality research. According to Hignett, the lifting team approach is promising. However, studies conducted outside the USA are required to generate more convincing evidence for the effectiveness of lifting teams which allows for generalization.

### *Multifactor programs*

Hignett found moderate evidence for the statement that multifactor interventions based on an individual risk assessment are successful. The same applies to multifactor approaches without risk assessment, but their effectiveness has been proven in fewer studies than the effectiveness of programs with risk assessment. In addition, one high quality study involving no risk assessment found mixed results, which also supports the superiority of the combination first mentioned.

Hignett suggests forming a generic multifactor intervention program for health care workers based on the seven interventions most commonly applied in the successful studies. It can be adapted depending on the context, the results of the risk assessment and the employee's needs.

The seven most commonly used interventions are (sorted according to their number of occurrences): provision of technical equipment, education and technical trainings, risk assessment, policies, patient assessment systems, work environment design and changes in work organization or practices (e.g. by introducing lifting teams).

The review makes a very simple general recommendation: wherever in health care technique trainings are primarily used to prevent musculoskeletal disorders, the current strategy should be reviewed and replaced by alternative programs.

### **Bos et al. (2006)**

The systematic review conducted by Bos et al. has a similar purpose as the paper by Hignett (2003). When selecting the original papers, methodical criteria based on those of the Cochrane Collaboration were applied. Bos et al. include randomized controlled studies (RCT), controlled studies as well as clinical studies in which workplace interventions for the prevention of musculoskeletal symptoms in health care are examined. Explicitly described education or training had to be part of each intervention. Studies not involving education and explicitly focusing on physical activity or mechanical aids were excluded. For the selected publication period from 1985 to 2005 13 studies could be identified. Nearly all studies used a random sample of nurses and nursing aides, in part, the studies included also home-care nurses, nursing students or cleaning staff.

### *Education/Training*

The interventions in the analyzed studies included both theoretical and practical training about the characteristics of physical workload, risk factors, ergonomic principles and safe patient transfer. The duration of the trainings (both individual and as part of a program) ranged from one hour to six days, follow-up periods ranged from immediately after the intervention to four years.

In two of the included studies the participants were instructed to perform patient transfers according to a problem-solving

model. Using a systematic approach the best patient-handling method should be chosen by the nurse after she or he considered her or his own capacity, the needs and resources of the patient and the existing possibilities and/or limits of the environment.

In seven studies, training and education were combined with additional interventions – in three studies, they were lifting devices, in two studies physical exercise, a program included the establishment of a steering committee and focused on commitment and cooperation by the nursing home manager, in the seventh study, a personnel program preceded the training.

In the 13 studies, Bos et al. counted 15 different outcomes which were used to assess the effectiveness of the interventions. The authors assigned outcomes described at least twice to one of three categories: economic outcomes (sickness absence), health-related outcomes (musculoskeletal symptoms, fatigue, physical discomfort, perceived physical workload) and ergonomic outcomes (technical performance of transfers, frequency of patient transfer activities and/or of activities in harmful body postures, knowledge of risk factors and ergonomic principles). For each outcome category the evidence was determined using one of the following levels: strong evidence, moderate evidence or insufficient evidence.

In general, the results for the ergonomic outcome were more positive than for health-related and economic outcomes. Whereas, for instance, only in one of four studies which recorded economic outcomes reduced sickness absence was found, more than 90% of the results for ergonomic outcomes were positive. Up to 50% of the health-related outcomes were positive.

According to the authors, there is strong evidence that education and trainings go along with less physical discomfort, improved technical performance of patient transfers and a reduction of the number of transfers performed. More than 75% of the results suggest this classification.

On the contrary, insufficient evidence was found for an effect on knowledge of risk factors, sickness absence due to musculoskeletal disorders, musculoskeletal symptoms, perceived physical load or fatigue. However, a significant lower exposure to lifting activities and a decrease of musculoskeletal symptoms was achieved in two studies combining educational and technical interventions. Although none of the two studies allows a statement on the fact which part of the intervention is responsible for the effect, the authors consider the combination of education and technical devices as effective.

Bos et al. draw the conclusion that training and education alone is not sufficient for preventing musculoskeletal disorders. When combined with ergonomic equipment, the chances of success increase considerably. This is why the authors recommend preferring the use of multifactor programs in daily practice.

### 5.3 Musculoskeletal disorders in computer users

#### Van Eerd et al. (2006)

The systematic review by van Eerd et al. aims at reviewing workplace ergonomic interventions for the prevention of visual and musculoskeletal symptoms in computer users. The authors do not define any further restricting criteria; besides traditional technical measures (e.g. workstation redesign, new office chairs), administrative (e.g. rest breaks) and individual interventions (e.g. neck school) are included as well. The evaluation is based on 28 studies published from 1980 on.

The methodical quality of the papers is mainly qualified as moderate, nine studies correspond to high quality. Van Eerd et al. use strong, moderate, mixed, partial and insufficient evidence as categories for data synthesis. The findings for measures to reduce musculoskeletal disorders are summed up below.

#### *Ergonomics trainings/education*

Four studies deal with ergonomic trainings ranging from a one-hour lecture on ergonomics to a participatory approach involving six weekly two-hour group sessions. The results were mixed. A high quality study that evaluated a program consisting of two two-hour sessions showed no effects, three studies of medium quality found positive and/or no effects. Therefore, van Eerd et al. conclude that there is mixed evidence for the benefit of such trainings.

#### *Neck school*

One of the studies evaluated a traditional neck school as an additional intervention. This was a randomized controlled study which found no differences in neck, shoulder or low back pain compared to the non-intervention control group. However, there is insufficient evidence since there was just this single study.

#### *Stress management training*

The effectiveness of a stress management training was investigated as well in a study with randomized design. Musculoskeletal symptoms were not influenced by the intervention. This is why there is insufficient evidence as well for stress management training for computer users.

#### *Rest breaks*

Based on four studies, including one of high quality, van Eerd et al. find mixed evidence for a preventive benefit of rest breaks. Patterns providing a break of five minutes every hour and/or a micro-break of thirty seconds every 20 minutes reached partly positive results. On the contrary, break patterns providing a five-minute break every 35 minutes and a three-minute break every 60 minutes plus micro-breaks were ineffective.

#### *New offices*

Since only one non-randomized study dealt with this intervention, it is not possible to make any statements on the effect

of moving into a new office on musculoskeletal complaints. Therefore, the evidence has to be qualified as insufficient.

#### *Workstation adjustment*

None of the four studies in which workstation redesign was examined found considerable effects on musculoskeletal disorders. Since these studies also included two studies of high methodical quality, van Eerd et al. conclude that there is moderate evidence that these interventions have no effect on MSD outcomes.

#### *New office chairs*

A high quality study showed a positive effect on MSD outcomes when, in addition to a training on ergonomics, the conventional office chair was replaced by a height-adjustable, ergonomic office chair. To assess the preventive benefit, however, further studies are required. Therefore, the evidence is still considered to be insufficient.

#### *Arm supports*

In a high quality study, the implementation of arm supports was associated with positive effects on MSD outcomes. On the contrary, a second study of lower methodical quality yielded no positive results. Therefore, the evidence for the effectiveness is mixed here as well.

#### *Alternative pointing devices*

In a study of high methodical quality a trackball proved more effective than a conventional mouse for some relevant outcomes. In this case, positive effects were reported only for the left side of the body. Another study of medium quality showed positive effects as well; here, the conventional mouse was compared with an alternative mouse model. Thus, there is moderate evidence for a preventive benefit of alternative pointing devices.

#### *Alternative keyboards*

Alternative keyboard models were evaluated in two studies of high quality. The studies showed positive results, both for a model with keyswitch force displacement and for a split keyboard. The latter, however, was part of a placebo study in which two other models were compared with a placebo (standard keyboard). Since no effect was found for these ergonomic models, van Eerd et al. state mixed evidence.

#### *Screen filters*

Two of the studies estimated the effect of special screen filters on musculoskeletal problems. Both of them were of moderate methodical quality, one showed positive results, the second no effect at all. There is mixed evidence regarding the effectiveness of screen filters.

#### *VDT glasses for computer users*

No effects regarding musculoskeletal disorders were found in studies comparing VDT glasses with no intervention or in studies comparing different models. Therefore, there is insufficient evidence for the effectiveness of the visual aids.

#### *Ergonomics training and workstation adjustment*

A study of medium methodical quality combined workstation adjustment with an educational intervention on ergonomics. Positive results were found here, but due to just one study a statement on the effectiveness is not permissible (insufficient evidence).

#### *Lighting and workstation adjustment and VDT glasses*

This multimodal intervention was associated with positive effects in a study as well. However, the effectiveness of the measure cannot be determined here either (insufficient evidence).

#### *Rest breaks and stretching exercises*

The combination of a break pattern and stretching exercises during the break showed no result in two studies. Since one of the studies was considered to be of high methodical quality, there is moderate evidence that such programs do not prevent musculoskeletal disorders in computer users.

Altogether, according to van Eerd et al. the evidence for technical, administrative and individual measures is mixed. Due to the large heterogeneity of the interventions and outcomes used, they point out that no conclusions can be drawn. This is why they abstain from formulating recommendations. However, the authors suggest that already two additional high quality studies with positive results could shift the evidence level from insufficient to moderate or even strong. This applies in particular to ergonomics training, arm supports, alternative keyboards and rest breaks.

Moderate evidence was found for the effectiveness of alternative pointing devices. Van Eerd et al., however, recommend cautious interpretation since various results from studies evaluating very different mouse models were aggregated. A similar situation is found for interventions involving workstation redesign as well as combinations of break patterns and physical exercises. In studies examining workstation interventions, the measures were usually compared to ergonomic trainings, that is, intervention studies comparing other strategies are still lacking. Neither researchers nor practitioners should therefore be discouraged to develop new programs that use these interventions.

## 5.4 Cumulative trauma disorders

### **Leonard-Dolack (2000)**

#### *Education/training*

Leonard-Dolack reviews six studies dealing with educational interventions for the prevention of cumulative trauma disorders. The studies were conducted both in clinical and workplace settings. None of the studies meets the formal quality criteria applied to scientific evaluations. A summary of the workplace intervention studies which investigated the effectiveness of educational interventions is given below.

Up to now, evidence is considerably lacking for educational interventions that are intended to sensitize employees to risk factors of cumulative trauma disorders and safe work techniques. An individual tailored employee education program including intensive feedback, the demonstration of the (work) behavior to be learnt as well as a repeated practice of the correct postures and movements tend to be beneficial. Perhaps practice is not always absolutely necessary, for instance, when it is about changing the hand used for repetitive work at an assembly line. Thus, the effect might depend on the type of job task as well. For computer users intensive practice seems to have a positive effect on correctly performed hand-wrist postures, but not on general sitting posture. Further research is absolutely required in this field.

## 5.5 Neck pain, back pain and low back pain

### BACK AND NECK PAIN

#### **Linton and van Tulder (2001)**

The review by Linton and van Tulder on the success of interventions against back and neck pain analyzes 27 studies published between 1967 and 1998. 19 of these studies use a controlled, randomized design, the others are non-randomized controlled studies.

Lumbar supports, back schools and education, exercises and ergonomics are evaluated with the exception of exercise programs, lumbar supports and education assessed separately. Possible levels of evidence are: strong, moderate, limited and no evidence.

#### *Lumbar supports*

Six (four RCT and two CT) of the studies examined lumbar supports. Three studies with randomized, controlled design did not show positive results, an effect of the auxiliary device was found neither compared to no intervention, nor compared to other measures. The fourth RCT did not find a difference between the back belts in combination with training on back prevention and the training alone either, but the number of days lost from work seems to be reduced by wearing the supports when compared with no intervention.

In contrast to the randomized controlled studies, the two controlled studies found positive effects for incidence of back pain and injuries. Although Linton and van Tulder emphasize that several studies reported problems concerning the compliance of the employees, they refer in their judgment to the more demanding and conclusive methodology of the RCT. According to them, there is strong and consistent evidence for the fact that lumbar supports do not have a protective effect on neck or back complaints in the work context.

#### *Back schools and education*

Only one of nine RCT showed a positive effect on sick leave and duration of the symptoms. Six RCT did not find a significant

effect of back schools, neither compared to usual care, nor to a non-intervention control group or in a comparison of various forms of back schools. Moreover, the back school was inferior to an intervention involving the McKenzie method in another randomized controlled study.

One of the RCT examined a training in which information was imparted to the employees aiming at preventing fear-avoidance and providing knowledge of coping strategies. The intervention turned out to be effective when compared with the control group. The results of five other CT are in contrast with the nearly consistent results of the randomized studies. Three of them report positive changes for at least one of the outcomes recorded. Despite these results, however, taking into account the design and the thus stronger validity of the RCT, Linton and van Tulder arrive at the conclusion that back schools are ineffective in preventing neck and back pain (strong evidence).

#### *Physical activity/exercise programs*

Linton and van Tulder identified six RCT in this field. Four of the studies using no-intervention control groups found a significant reduction in absenteeism and experienced back pain in the intervention groups. Therefore, the authors state strong evidence for the effectiveness of exercise programs.

#### *Ergonomic interventions*

Linton and van Tulder did not find any controlled studies that evaluate ergonomic interventions. Therefore, there is no good quality evidence on the effectiveness of ergonomic measures (without lumbar supports, exercise programs and education).

Summing-up the evidence, among the interventions used to prevent work-related back and neck pain, only exercise programs turned out to be effective. All in all the results are disappointing, since neither controlled studies on technical or administrative measures nor on multi-component programs were found. Thus, future high-quality studies are needed.

## BACK PAIN

### **German Advisory Council for Concerted Action in Health Care: Report 2000/2001**

#### *Back schools*

Within its report on appropriateness and efficiency of care, the Advisory Council focuses on back pain and approaches of workplace health promotion. Based on a health technology assessment report and current literature reviews the Council concludes that "there is sufficient evidence that "back school" education programs as isolated measures are ineffective as a means of primary prevention, regardless of whether they are workplace-oriented" (p. 122). On the other hand, according to the report, there is sufficient evidence suggesting that back schools for secondary and tertiary prevention may be effective and cost-reducing if access to and alignment of the interventions are tailored to the target group and the participants are highly selected.

In all, the evidence base on the primary preventive effectiveness of back schools is relatively vague. In addition, the Council points out that individual-focused interventions at the workplace such as lift training or back schools only play a complementary role in addition to environmental changes. Therefore, they remain largely ineffective when implemented as the only measure.

#### **Gatty et al. (2003)**

The interventions for the prevention of back pain that were evaluated in the nine papers found by Gatty et al. were lumbar supports as well as combined (multifactor) programs involving education and task modification – with or without workplace redesign. The interventions were carried out in various settings (industry, health care etc.) and comprised periods of six months, except for one intervention.

#### *Lumbar supports*

Three of four analyzed studies did not find a preventive effect of the supports. No differences between intervention and control groups were found for 75% of the outcomes recorded in the two highest rated studies. According to the authors, this is why the auxiliary devices have to be considered as ineffective.

#### *Education and job task modification*

Two studies of high methodical quality investigated programs in which individually focused educational interventions were combined with job task modification. Positive changes in outcomes were observed in 70% of the statistical analyses performed. Only 10% of the outcomes suggested an ineffectiveness of the intervention, 20% of the results were neutral. Both studies reported high compliance, which, according to the authors, additionally supports the effectiveness of the multifactor intervention.

#### *Education, job task modification and workstation redesign*

Two studies, including one RCT, dealt with this approach consisting of three components. The results are inconsistent – whereas the quasi-experimental study showed a significant decrease in the number of lost workdays per back injury, the RCT found significantly improved knowledge on safe work behavior in the intervention group, but more cases of injuries than in the control group were observed here – albeit without statistical significance. Since this RCT does not report on compliance, the authors interpret the findings cautiously.

In their summary, Gatty et al. strongly advise against using back belts as a "blanket" preventive means. They neither address specific job requirements, nor individual physiques or other risk factors. Instead of that, they recommend tailor-made programs using job-site analysis and the implementation of individually customized, job-specific interventions.

Educational trainings should be intensive, continual and above all job-specific and require both the involvement of the employee and other actors (by giving feedback). According to the authors, ergonomic solutions, workstation redesign and an

active role of the employees in the planning and implementation of the interventions can improve compliance which helps to facilitate a behavior change.

#### **Van Poppel et al. (2004)**

The review by van Poppel et al. aims at giving a systematic overview of the scientific evidence on the effectiveness of educational interventions, back belts and physical exercise programs for the prevention of work-related back pain. The paper updates an earlier review published in 1997. Five studies published from 1997 to 2001 were added to the eleven studies examined in the previous paper. The review exclusively takes into account randomized and non-randomized controlled studies. Findings are evaluated using a rating system based on a best evidence synthesis. Possible evidence levels are: strong, moderate, limited and no evidence.

#### *Lumbar supports*

Based on the findings of four randomized and two non-randomized controlled studies van Poppel et al. state that there is no evidence for the primary preventive effectiveness of lumbar supports. Only one RCT reported positive findings, however, only for days lost from work, not for the incidence of back pain.

Van Poppel et al. point out that only three of the studies include information on compliance which is varying considerably between more than 80% and 42%. The subgroup analyses carried out additionally in two studies suggest that lumbar supports may be useful for the treatment of existing back pain or in employees with pre-existing back pain.

#### *Education/training*

None of in all six studies with a randomized design showed a significant effect of educational interventions. The training contents varied highly, one study, for instance, dealt primarily with stress management instead of body mechanics. The findings were similar for the intensity of the trainings, the shortest training had a duration of one hour, the longest one lasted more than two months. According to van Poppel et al., no evidence is available that employee education is effective in preventing back pain.

#### *Physical activity/exercise programs*

The conclusions on the effectiveness of physical activity programs are based on the results of four RCT. Positive findings were achieved in all studies, although they were not significant for all outcomes examined. In most of the cases, a reduced incidence of low back pain and/or a decrease in sick leave due to back pain was observed. Including the findings of three RCT, the authors calculate an effect size of 0.53 for the effect of exercise programs on the incidence of back pain which is assessed as moderate.

Van Poppel et al. use very strict methodical quality criteria of which the four exercise studies met less than 50%. On account of the low quality assessment, the evidence for the effectiveness of exercise programs is rated to be limited only.

In all, van Poppel et al. assess the evidence base as disappointing. Both lumbar supports and educational interventions have turned out to be ineffective in the primary prevention of back pain. Limited evidence was found for the effectiveness of physical activity programs. According to van Poppel et al., a large number of evaluation studies that meet the methodical quality criteria still have to be carried out in order to achieve highly reliable findings.

#### **Lühmann et al. (2006)**

This health technology assessment report is the result of a comprehensive literature search for the assessment of the medical and economic benefit of workplace interventions for the prevention of back pain. As a result of the immense number of original studies, the authors include systematic reviews, added by latest controlled studies. In all, 15 relevant reviews (largely corresponding to those presented in this chapter) as well as 16 controlled studies were identified which report on the effectiveness of interventions on interesting outcomes such as sickness absence or incidence and duration of back pain episodes.

Since – as expected – the available interventions show great heterogeneity, Lühmann et al. distinguish between physical exercise programs, education and informational approaches, multidisciplinary programs (multi-component programs), lumbar supporting belts, lifting teams as well as ergonomic interventions (separated according to individual, administrative and combined approaches).

#### *Physical activity/exercise programs*

According to Lühmann et al., the results of three systematic reviews and six controlled studies suggest a positive effect of activity programs on measured outcomes. It turned out that in particular high-risk groups benefit from the interventions. Currently it is not possible to ascertain to what extent the study design, intensity or duration of the interventions influence the outcomes in detail. In all, however, the findings suggest that the effectiveness depends on the fact whether the exercises are carried out regularly and continuously.

#### *Education and information*

Based on the findings of four reviews as well as three other studies, the authors arrive at the conclusion that trainings in the form of lessons on back-related topics are not suitable for the prevention of back pain at the workplace. Traditional back schools might have a short-term positive effect regarding the incidence of new episodes. Regarding sickness absence, however, the results are inconsistent.

#### *Multidisciplinary programs*

The conclusions drawn by Lühmann et al. on the effectiveness of multi-component programs are based on a systematic review as well as three controlled studies. Thus, programs combining exercises, information and strategies of behavior therapy how to handle back pain may be effective in high-risk groups. Back school programs associated with intensive exer-

cise programs turned out to be effective as well. On account of the results reported on educational interventions, however, the authors suspect that this effect is due to the exercise component.

#### *Lumbar supports*

Five systematic reviews suggest that in a healthy working population back belts do not contribute to reduced incidence of back pain as well as reduced sickness absence. However, the belts might constitute an effective device for employees who report pre-existing episodes of back pain.

#### *Lifting Teams*

Currently there are no convincing controlled studies on lifting teams in health care available in literature. As shown in a review, a certain number of uncontrolled pilot studies, however, report positive experience. In any case, before establishing a lifting team, a thorough context analysis should be undertaken, considering factors such as job tasks and structures, the interaction process between patients and nursing staff as well as infrastructural aspects.

#### *Ergonomic interventions*

Based on the results of three systematic literature reviews, Lühmann et al. conclude that there are no high-quality studies available yet that allow a conclusion on the effectiveness or ineffectiveness of administrative ergonomic measures on back pain (e.g. rearrangement of the physical working environment, changes in work organization). In the field of individual-focused interventions, the results reported in the categories of exercise programs and educational interventions are confirmed for interventions with ergonomic contents as well. According to the authors, the most convincing evidence of effectiveness exists for programs that combine interventions of both individual and organizational levels (multi-component programs) and involve employees actively in the intervention process (participative approach).

In all, according to Lühmann et al., the scientific findings are still too imprecise. They identify a large need for development regarding contents and methods.

### LOW BACK PAIN

#### **Maher (2000)**

Exclusively randomized controlled studies were included in the systematic review by Maher. It assesses the available evidence for workplace interventions to control low back pain. The review is not limited to specific interventions. Maher examines the interventions found in the studies, assigned to lumbar supports, education, physical exercise and interventions combining workplace modification and educational interventions.

13 RCT were found for the selected publication period until January 1999. The methodical quality is assessed to be pre-

dominantly moderate. Maher also takes into account studies that included subjects with existing complaints. Employees working in physical demanding jobs, in particular industrial and health care workers constitute the target group. To determine the strength of evidence, Maher distinguishes between strong, moderate, limited and no evidence, the system used by several authors.

#### *Physical activity/exercise programs*

In three of five RCT exercises managed to reduce the prevalence of low back pain significantly. Due to the only moderate study quality, Maher arrives at the conclusion that there is moderate evidence for a positive effect of physical exercise programs on this outcome. Two of the studies, including a high-quality study, found reductions of pain severity so that there is moderate evidence for this effect as well.

The same applies to sick leave due to low back pain which was reduced significantly in two studies of moderate quality and one high-quality study. Only one of the studies assessed the economic benefit of the intervention. The evidence for cost-related outcomes is considered to be poor (no evidence).

#### *Lumbar supports*

The assessment of the effectiveness of lumbar supports is based on the results of four randomized controlled studies. Only one study in which the belt was used in addition to an educational intervention obtained a positive effect on sick leave, while the prevalence for low back pain remained unchanged. Since this study was of poor methodical quality only and no effects regarding prevalence, pain severity or costs were observed, Maher considers the ineffectiveness of the belts to be proven (strong evidence).

#### *Education/training*

Six of the RCT evaluate interventions aiming at knowledge transfer and information. None of the studies proved a positive effect on one of the essential outcomes associated with low back pain. According to Maher, the results suggest moderate evidence that educational programs cannot prevent back pain in view of moderate to good study quality.

#### *Workplace modification and education*

Two studies combined an educational intervention with workplace modification. In one of the studies no statistical analyses were performed in order to test whether differences between groups were significant; the second one does not report any effects. Based on this single result there is no evidence for the effectiveness of this combined intervention.

Maher summarizes the findings as follows: lumbar supports and educational interventions are likely to be ineffective, only physical exercise programs have turned out to be successful. The effectiveness of the combination of workplace modification and education has not been clarified yet.

**Ammendolia et al. (2002)**

During their literature search involving the time period until June 2002, Ammendolia et al. identified five randomized controlled studies, two non-randomized controlled studies, two cohort studies and one survey which investigated the effectiveness of back belts in employees with high physical strains due to manual load handling (e.g. warehouse employees, nursing staff).

*Lumbar supports*

In four RCT no reduction or only a marginal decrease in the incidence of back pain was found. The fifth study found a positive effect for the supporting belt that only occurred when the device was used in combination with education on lifting and carrying techniques. In two of the RCT which were also included by van Poppel et al. (2004), subgroup analyses showed that employees with pre-existing back pain benefit from the device. No or hardly any positive effects were observed in the other studies.

According to the authors, the great variation in the results is not surprising at all since the overall methodical quality of the studies included is low to moderate only and bias due to confounders cannot be ruled out for any of the studies.

On the other hand, discrepancies occur in laboratory experiments as well. Ammendolia et al. point out that the therapeutic mechanism of back belts is not clarified completely at present. It is assumed that a long-term use of the belts may be associated with negative effects – for example in the form of weakened back muscles. Furthermore, it is discussed that the belts result in an increased risk behavior shown by the employees (e.g. careless lifting). However, these hypotheses have not (yet) been proven in epidemiological studies.

Ammendolia et al. consider the low participation rates as well as the participants' insufficient compliance observed in nearly all studies as being a considerable problem. Further analyses in two of the studies suggest that the belts are associated with annoying "side effects" for the employees, which is why some participants refuse to continue to wear the belts.

For instance, 20% of the participants complained that the belt is chafing or pinching, in 20% of the persons it caused extreme sweating and 15% reported problems when sitting or driving vehicles. In a comparison of high-compliance employees with low-compliance employees, a study showed that the participants with low compliance significantly accounted for more sick days. This might be a reason why no effect was observed in the studies, but caution is warranted since these are the results of just one single study.

Summarizing their assessment, Ammendolia et al. conclude that a recommendation for or against the use of lumbar supports for the prevention of work-related back pains cannot be given. There are trends suggesting that more attention should be paid to employees with a history of back pain, but the

use of the belts should absolutely be preceded by a thorough medical, in particular cardiovascular screening as well as intensive training on lifting techniques.

Moreover, on account of inconsistent laboratory experimental results, the authors recommend short-term use of back belts, in particular when wearing the belts should be prescribed as a mandatory intervention.

**Tveito et al. (2004)**

Tveito et al. want to give an overview of the effectiveness of workplace interventions against low back pain by including – if possible – all interventions that have been evaluated in controlled studies. They identify 31 studies published from 1980 to November 2002 in which 28 different intervention types are tested in different settings. 25 of the publications focus on primary prevention, the rest deals with strategies for the treatment of low back disorders.

The following presentation of results only refers to the effectiveness of primary preventive interventions. Tveito et al. define four relevant outcomes to determine the evidence: sick leave due to complaints, new pain episodes, pain severity and cost effectiveness. Possible levels of evidence are: strong, moderate, limited and no evidence.

*Lumbar supports*

The assessment of the effectiveness of lumbar supporting belts is based on five papers including studies of poor, moderate and high methodical quality. Three studies recorded data on sick leave, only one found a significantly positive effect. According to Tveito et al., there is no evidence that back belts reduce sick leave due to low back pain.

Three studies recorded data on the incidence of new pain episodes, two high-quality studies did not find any difference between the groups; the third study of low methodical quality reported a positive effect. Therefore, the authors conclude that there is limited evidence for the fact that lumbar supports do not prevent new episodes of low back pain.

Only one study examined whether the wearing of the belt influences pain intensity. No effect was found. Therefore, there is no evidence for this outcome as well. The same applies to costs; no effect was found either in a study identified in this field.

*Education/training*

No evidence is found for the effectiveness of educational interventions on sick leave based on 11 studies of generally medium quality. Four of six studies showed no effects, the other two reported quite positive findings, however, without any statistical significance. Two studies showed positive effects on the reoccurrence of complaints; four other studies reported no differences between groups. Therefore, there is limited evidence for the fact that education do not lead to a reduction of new episodes of low back pain.

Three papers additionally investigated the effect of interventions on pain intensity. They are all of poor methodical quality, two did not find any effect, the third study reported a significant reduction. On account of the methodical insufficiency of the studies, the findings are not reliable (no evidence).

Four RCT measured cost outcomes, three of them showed positive results. Only one of the studies which found an effect is of acceptable quality, the same applies to the study in which no effect was observed. According to Tveito et al. the internal validity in the two other studies is not given. The authors understand this as a lack of evidence since the results of the high-quality studies are inconsistent (no evidence).

One of the studies has a special status. It evaluated the preventive benefit of an educational brochure. No important differences regarding interesting outcomes were found. Therefore, there is no evidence for the effectiveness of this intervention.

#### *Physical activity/exercise programs*

Six controlled studies were assigned to this category, including four studies with randomized design. Two of the studies used sick leave due to low back pain as an outcome, both showed significant positive results. Since bias due to confounders cannot be ruled out in any of the studies, Tveito et al. conclude that there is limited evidence for the effectiveness of the exercise programs.

The same applies to the effectiveness for new episodes of low back pain and costs (limited evidence). Only pain severity does not seem to be influenced by physical exercises. Data taken from two studies suggest that there is no evidence.

#### *Multi-component programs*

Two papers dealt with interventions that focus on multiple factors. One of the studies was assessed to be of high methodical quality by Tveito et al. It did not find any significant differences between groups regarding sick leave, but reported significantly reduced pain intensity. The second study, that has considerable methodical shortcomings, observed positive cost effects and a reduction of new episodes of back pain.

Tveito et al. understand this as limited evidence for the ineffectiveness of the programs on sick leave and for the effectiveness of the interventions regarding pain severity. No evidence is found for an effect on costs and the incidence of new pain episodes.

According to Tveito et al., only physical exercise programs as well as multimodal programs are suitable for the prevention of non-specific low back pain. However, no effect is documented for educational measures and back belts. Tveito et al. see an urgent need for future high-quality studies in order to strengthen the evidence base.

#### **Van Tulder et al. (2006)**

This Cochrane review reflects the scientific knowledge on the

effectiveness of lumbar supports until 1999. The version used for the present report is a revision of a review published in 2000 on the effectiveness of back belts for the prevention and therapy of low back pain. Therefore the review by Ammendolia et al. (2005), for instance, is more recent despite the earlier publication date.

Five randomized as well as two non-randomized controlled studies were found. Only two meet more than 50% of the methodological criteria for quality assessment. Three of the studies included employees with previous episodes of low back pain, two also took into account persons who were currently experiencing pain. All studies included an instruction by the company management prescribing the wearing of the belts. Three publications provide information on the percentage of persons who were regularly wearing the supports. It varied between 43% who were wearing the device for at least half of the intervention period and 80% who stated to have been wearing the belt „most of the time“.

According to the Cochrane Collaboration guidelines, study results were summarized conducting a best evidence synthesis using the evidence levels strong, moderate, limited/conflicting and no evidence. Interesting outcomes were incidence of low back pain, pain duration, associated sickness absence and functional status of the employees.

#### *Lumbar supports*

The effectiveness of the belts compared to no intervention is analyzed in four RCT. No change in the incidence of non-specific low back pain is found after three, six, eight or twelve months and no effect on sickness absence can be seen. One of the studies is of high methodical quality. Van Tulder et al. appraise these results as moderate evidence for the fact that back belts are not suitable for the prevention of lumbar pain.

Two papers including a high quality study compare lumbar supports with other preventive interventions (trainings, instructions). No effects on the incidence of low back pain or sickness absence are found. Therefore, there is moderate evidence for the fact that lumbar supports cannot contribute more or less to the prevention of low back pain than other interventions.

In a methodically reliable, randomized controlled study as well as a CT, the supports are used as complementary intervention in addition to a back school. The comparison of the groups with and without belt remains without result, no difference regarding the incidence of low back pain is found. The results suggest limited evidence for the fact that supporting belts as an additional intervention to back schools are not more effective than back schools alone.

According to van Tulder et al., the preventive benefit of back belts is not completely clear since there is a lack of sound evidence in studies of methodically reliable design. Up to present, it seems that back belts are not suitable for the prevention of low back pain and are not more effective than other interven-

tions. Van Tulder et al. point out that in particular the problem of low compliance has to be addressed.

## 5.6 Carpal tunnel syndrome

### **Lincoln et al. (2000)**

This review on the effectiveness of ergonomic interventions to prevent the carpal tunnel syndrome (CTS) includes 24 studies that were carried out either at the workplace or at simulated workplaces in the laboratory. The target group is adult employees and/or persons of working age free of CTS symptoms. Lincoln et al. classify the interventions according to engineering interventions (e.g. ergonomic keyboards), administrative interventions (e.g. job modification) and personal approaches (e.g. ergonomic trainings) using the control implementation hierarchy recommended by the US National Institute for Occupational Safety and Health (NIOSH). In addition, the effectiveness of multifactor programs is examined. In the literature search, Lincoln et al. cannot find a study on the carpal tunnel syndrome in which administrative interventions are used.

CTS incidence, symptoms and risk factors are considered to be important outcomes indicating the success of an intervention. Results were also taken into account when they referred generally to disorders of the upper extremities – to the extent they included the carpal tunnel syndrome.

#### *Engineering (ergonomic) interventions*

In all, twelve of the studies evaluated engineering interventions. In most cases, the intervention consisted of an adjustable split keyboard or a keyboard with modified key fields that were compared with traditional models. Despite the fact that nearly all studies were of high quality (ten of the studies are laboratory experiments), they only had small sample sizes and also very short follow-up periods. Outcome data were often collected directly after the end of the intervention. Since the incidence or comparable outcomes were measured in none of the studies on engineering interventions, no statements on long-term effectiveness can be made. Recorded outcomes refer to short- and medium-term effects instead, for example wrist posture, muscle tension or experienced fatigue.

The findings are conflicting and suggest that neither alternative keyboards nor modified key fields significantly influence clinical outcomes such as pain or fatigue. No study clearly demonstrated an effect, even if the alternative keyboards have been extra developed for the prevention of upper limb risk factors. In part, the employees even preferred traditional models. Some researchers therefore assume that other factors are more important for the etiology of the carpal tunnel syndrome such as e.g. the mechanical characteristics of the key stroke or the duration of typing.

Some positive, but only medium-term results were found for other technical interventions to promote neutral wrist postures.

The interventions included a negative slope keyboard support, a mouse pad with wrist support and an alternative, ergonomic mouse model. The demonstration of long-term effects is still pending.

#### *Personal (ergonomic) interventions*

The four studies which involved individual interventions also used very small sample sizes. A study examined the effectiveness of a wrist splint; in a second study, a electromyographic biofeedback was realized to sensitize workers to awkward hand postures. Moreover, two studies were found in which an on-the-job flexibility exercise program and an education program including risk assessment for decreasing the incidence of cumulative trauma disorders were tested.

None of the studies showed a positive effect. The splint had no impact on wrist posture, the biofeedback did not show any differences between groups regarding discomfort and motor nerve conduction velocity. In the third study, the employees receiving exercise program did not differ from the control group regarding CTS symptoms, the fourth did not show any change in relevant outcomes either. Therefore, Lincoln et al. ascertain that there is currently no sufficient evidence for the effectiveness of personal ergonomic interventions.

#### *Multi-component programs*

Eight of the studies dealt with multifactor interventions. In most cases, they combined engineering (e.g. workstation redesign) with administrative interventions (e.g. the establishment of an ergonomics task force) and behavioral interventions (e.g. education on ergonomics) and were implemented in large industrial companies.

In one study, the rate of musculoskeletal disorders was considerably reduced, another study showed a reduction of the rate of upper limb disorders (20% of which were CTS cases) from 2.1 cases per 200.000 work hours to 0.1 cases within 3 years. A third study documented a decrease in the number of work-related MSD by 9.3% six months after the program was introduced.

Two other papers showed positive effects as well, including significantly reduced exposure to CTS risk factors. A high quality study comparing eight groups showed that in particular employees with repetitive job tasks and jobs demanding awkward postures benefit from exercise programs. Negative effects were found only in two studies where a significant increase in MSD incidence occurred despite the program.

To conclude, Lincoln et al. point out that no causal conclusions are possible although positive effects were found several times in multi-component studies. Often adequate control for potential confounders is made or there is a lack of baseline assessments. Furthermore, an effect in particular regarding CTS incidence has not been documented clearly yet. According to the current state of research, multifactor programs still seem to constitute the best approach for reducing CTS risk.

## 5.7 Summary

More than 400 studies from 1960 to 2005, assembled and examined in 19 reviews, form the basis of the present chapter. When comprehensively contemplating the abundance of papers, which seemed initially rather unmanageable, a quite uniform picture results which allows answering the question which strategies in workplace health promotion are successful to prevent work-related MSD.

In general, it has to be said that despite the large number of studies there are disappointingly still gaps limiting the evidence base for interventions to prevent work-related MSD. In some cases, based on the literature found, no statements can be made on the fact whether a specific intervention has a preventive impact or not. Mostly, this is not due to inconsistent study results for the intervention concerned, but simply caused by the fact that currently only a few or no high-quality studies are available.

As expected, the evidence base for organizational and environmental interventions is much weaker than for individual-focused prevention approaches. Only six of the reviews included (which is less than a third) evaluate and/or identify studies dealing with the effectiveness of environmental changes (Hignett 2003, Karsh et al. 2001, Lincoln et al. 2000, Lüthmann et al. 2006, van der Molen et al. 2005, van Eerd et al. 2006). In most cases, the methodological quality of the studies is poor. Review articles that exclusively examine the effect of modifications in the working environment were not found in the literature search.

But also in the field of individual approaches where more research was done, review authors are confronted with problems regarding the study methods used. Even the conclusions in reviews that take into account only randomized controlled studies and, if applicable, quasi-experimental studies of similar quality (e.g. Maher 2000, Tveito et al. 2004, van Poppel et al. 2004), are limited by a certain number of conceptual and methodological difficulties in the papers found. The most common shortcomings reported include inadequate randomization procedures, lack of blinding of participants and investigators, low compliance rates (and/or no information on compliance), lack of control of potential confounders as well as too short intervention and follow-up periods.

In these cases it is more difficult to determine whether an effect clearly refers to an intervention since systematic distortions of individual study results cannot unequivocally be ruled out. It is also possible that existing preventive effects cannot be detected by the studies at all because, for example, the chosen follow-up period is too short or the effect is underrated due to unadjusted confounders (e.g. when no information on physical activity is gathered in the control group when evaluating an exercise program).

Further difficulties crop up for the generalizability of the results to other persons, situations and points in time. The studies vary considerably – besides target groups of the interventions (different professional groups), contents, intervention sequence and duration as well as different context factors in companies, facilities and organizations that can be both favorable and limiting to an intervention (e.g. the work climate) differ. As long as mediating factors and associated mechanisms are not clarified, conclusions based on aggregated study results have to be interpreted with caution. Despite these limitations, the findings on the effectiveness of workplace interventions – as already mentioned above – are relatively consistently pointing to the same direction. In detail, results for the interventions found are as follows:

### **Individual approaches**

#### *Education/training (back schools, neck schools, ergonomic trainings, stress management trainings)*

The scientific literature suggests that educational interventions in traditional lecture format aiming at knowledge transfer and information are ineffective regarding relevant outcomes such as sickness absence due to MSD, incidence of musculoskeletal and cumulative trauma disorders, musculoskeletal symptoms and duration of the complaints. Since no statistically and clinically important differences between groups were observed in studies of acceptable to high methodical quality either, some of the review authors even state moderate to strong evidence that programs of knowledge transfer are not suitable for MSD prevention (e.g. Hignett 2003, Maher 2000).

Neither trainings on ergonomics (e.g. body mechanics, lifting and carrying techniques, back-friendly load handling) nor theoretical and practical exercises for the “correct” use of technical auxiliary devices were convincing regarding the essential outcomes – and this irrespective of whether programs focused on different professional groups (e.g. health care workers, computer users, industrial workers) or selectively addressed different clinical pictures (e.g. low back pain, neck and upper limb disorders, carpal tunnel syndrome).

The same applies to traditional back schools, neck schools and stress management trainings that are considered to be ineffective as well (e.g. Lincoln et al. 2000, Sachverständigenrat für die Konzertierte Aktion im Gesundheitswesen 2000, van Poppel et al. 2004). In particular for back school programs, Linton and van Tulder (2001) found strong evidence that the trainings do not provide any preventive benefit regarding back pain since several RCT showed no results. However, as described by Lüthmann et al. (2006), there is at least a short-term positive effect on the incidence of recurrent back pain episodes when the back school also includes active exercises in addition to theoretical information. Moreover, it seems that back schools at the workplace can successfully be used in the therapy of chronic and recurrent low back pain. For further information, reference is made to a Cochrane review by Heymans et al. (2004).

According to van Poppel et al. (2004), possible reasons for the general ineffectiveness of educational interventions may be the often low intensity and duration of the programs (in this example, they ranged between one hour and five lessons of 90 minutes each), the lack of tailoring the interventions to the employees' individual needs as well as the fact that a change in automatic behavioral patterns and habits (e.g. modes of work, usual body postures) cannot be easily induced by a single training. However, the extent to which these factors play a role and how they influence the effectiveness of the interventions in detail, remains to be studied.

#### *Physical activity/exercise programs*

In the reviews analyzed the clearest evidence for effectiveness in MSD prevention comes from exercise programs which aim to increase physical strength, improve mobility and enhance the fitness of employees. As the systematic reviews examined show, both sickness absence due to MSD as well as MSD incidence and prevalence can be reduced by means of physical activity. Moreover, according to Tveito et al. (2004), there is limited evidence for the cost effectiveness of physical exercise programs even though other authors consider that this has not yet been proven sufficiently, for example van Poppel et al. (2004). Maher (2000) arrives at a similar conclusion for pain intensity – exercise programs can achieve a reduction here as well.

On account of the heterogeneity of the interventions, it cannot be determined exactly yet to which extent the effectiveness depends on content, duration and intensity of the exercises. As a rule, the intervention period covered a rather long – albeit strongly varying – time period (in most of the reviews, between three months and one and a half year). As stated by Lüthmann et al. (2006), long-term, continuous exercising seems to be important for the effectiveness.

#### **Organizational approaches**

##### *Lumbar supports*

The findings of ten reviews suggest that currently there is no scientific evidence for a preventive effect of back belts on musculoskeletal disorders, in particular disorders of the lower back. Whereas some authors give a cautious assessment and, like e.g. Ammendolia et al. (2002), neither support nor reject a benefit, others see limited to strong evidence for the fact that lumbar supports do not have any primary preventive effect on the incidence of back disorders in healthy employees (e.g. Linton and van Tulder 2001, Maher 2000). Furthermore, there is no evidence for a preventive benefit of the supports regarding sick leave, pain intensity as well as the cost effectiveness of the interventions (e.g. Tveito et al. 2004).

There is evidence suggesting that employees at high-risk – in particular those who have already suffered from back pain before – might benefit from back belts for reducing lumbar strain.

More detailed statements, however, cannot be deduced from the current state of research.

##### *Technical interventions*

The provision of technical devices (e.g. ergonomic keyboards, new work tables or equipment, lifting or carrying devices etc.) seems to contribute to the reduction of physical strain, as yielded by reviews like e.g. the one conducted by Lincoln et al. (2000) or by van der Molen et al. (2005). Van Eerd et al. (2006) find moderate evidence for the impact of alternative pointing devices (ergonomic mouse models) on neck and shoulder complaints, inconsistent results for ergonomic armrests and keyboards as well as insufficient evidence for the effectiveness of screen filters. There is no clear picture regarding outcomes such as the incidence of musculoskeletal disorders or associated sick leave.

Whereas van der Molen et al. (2005) partly question a preventive effect, Hignett (2003) states there is moderate evidence for the use of patient transfer devices in health care. On the contrary, Lincoln et al. (2000) cannot make any statement on the effectiveness of technical equipment on important outcomes such as incidence of or sickness absence due to carpal tunnel syndrome since not even a single one of the identified studies reports a corresponding result. Karsh et al. (2000) do not find a single randomized controlled study among the analyzed technical intervention studies.

In all, the picture is inconsistent first of all because of the lack of relevant high-quality studies that measure suitable outcomes (in particular incidence and sickness absence). Therefore, the evidence base regarding the preventive benefit of technical interventions, tools and devices cannot be clarified at present.

##### *Workplace redesign*

Only one recent review (van Eerd et al. 2006) provides information on the effectiveness of workplace redesign. As a result of the specificity of the setting examined in this study – van Eerd et al. (2006) deal with musculoskeletal disorders in computer-users – the transferability of these results to other work contexts is difficult. A large number of further valid evaluation studies – also in multiple professional fields – is required for determining the evidence for ergonomically redesigned workplaces. Van Eerd et al. (2006) tend to suggest that computer workstation adjustment does not have any influence on outcomes such as musculoskeletal symptoms. Available data, however, are not convincing since only four studies were included of which only two were of good quality.

##### *Changes in the work organization*

On account of a lack of information in the included review articles, hardly any statements can be made on the evidence of interventions aiming primarily at structural and organizational changes in the work organization or of job tasks. Only one review (Karsh et al. 2000) analyzes job redesign as an

individual intervention, a second one (van Eerd et al. 2006) finds four studies that evaluate different break patterns. The weak data base and the mainly poor methodical quality of the small number of studies do not allow any valid conclusions on the effectiveness of organizational-administrative interventions. There is an urgent need for selective research in this field. In the context of alternative patterns of short rest breaks, however, van Eerd et al. (2006) point out that there has been inconsistent evidence up to now that could be considerably improved already by two more high quality studies with significantly positive findings.

### **Other and combined approaches**

#### *Lifting Teams*

There are currently no valid results from controlled studies that show the benefit of lifting teams for the reduction of physical demands in health care. According to a certain number of promising pilot studies, however, this approach seems to have clearly preventive potential (cf. Haiduven 2003, Lühmann et al. 2006). The extent of this potential has to be determined in future systematic research. There are indications suggesting that the lifting team approach is not suitable for every setting in health care. Its success rather seems to depend on structural context factors such as regular work processes, administrative requirements, infrastructural circumstances or personnel resources.

#### *Multi-component programs*

Besides exercise, programs geared to the principle of multi-causality of musculoskeletal disorders constitute the second category of interventions mainly associated with positive findings in scientific papers. On account of the considerable effort, controlled studies of high methodical quality are still too rare in this field, which becomes particularly clear in reviews that only admit randomized controlled studies for the evidence assessment (e.g. Maher 2000) or apply very strict methodical criteria (e.g. Tveito et al. 2004). Altogether, the evidence found in the eleven reviews that examine multimodal interventions, however, strongly suggest a positive effect of the programs. Some authors even consider it to be the most effective approach (e.g. Karsh et al. 2001, Lincoln et al. 2000, Silverstein and Clark 2004).

In most cases, successful programs were a combination of behavioral interventions (education or exercise) and traditional administrative ergonomic interventions (technical auxiliary devices, modifications of work organization, workplace redesign). In this context, several review authors emphasize the necessity of an active involvement of the employees before and during the program implementation (Gatty et al. 2003, Lühmann et al. 2006, Silverstein and Clark 2004, van der Molen et al. 2005). Furthermore, the findings of the papers indicate that:

a) the participation of employees in the context of multifactor programs constitutes one of the essential preconditions to

influence important process outcomes (e.g. risk awareness, willingness to change their behavior),

- b) the effectiveness of the programs can be increased by preceding individual risk assessment of the employees and
- c) the programs have to be intensive, continuous and job-specific, in particular when educational interventions are part of the program.

### **Recommendations for practice**

Even though considerable need for research is revealed in the field of the evidence-based practice of interventions for the prevention of musculoskeletal disorders, the following recommendations for workplace health promotion and prevention can be deduced from the results found:

- In the healthy working population, lumbar supports and education and/or trainings are not suitable as single interventions for the prevention of musculoskeletal disorders. At worksites they should therefore not be used as “blanket” prevention tool.
- The effectiveness of organizational interventions like technical devices, changes in work organization and ergonomic workplace redesign has not been investigated sufficiently. Therefore, their use is recommended currently only under study conditions for the purpose of evaluation for clarifying the evidence. The same applies to the use of lifting teams in health care facilities.
- Physical exercise and activity programs constitute the most promising interventions which employees can benefit from as they were shown to reduce musculoskeletal disorders and sickness absence. In this context, it seems to be particularly important that the program becomes a regular part which is offered and utilized continuously for a longer time.
- Comprehensive multifactor programs that both address individual behavior and environmental work conditions at the same time can be recommended as well (e.g. a combination of ergonomic interventions involving education, technical improvements, changes in work organization and workplace redesign). An active participation of the employees in all program-relevant decision-making processes can contribute considerably to the effectiveness of the intervention. For increasing the effectiveness, an assessment of the individual risk of the employees before implementing the program is also recommended. Job-task specific program contents and components based on the individual needs of the employees are indispensable.

### **Recommendations for research**

It has already been suggested several times that a certain number of implications for future research arise from the current scientific state of workplace health promotion assembled in the present chapter. In summary, in particular the following issues turned out to be essential:

- conduction and documentation of evaluation studies of high methodical quality, in particular of studies on the effectiveness of organizational approaches and interventions with environmental changes,
- adjustment and documentation of potential confounders in evaluation studies,
- identification, clarification and documentation of the influence of moderating context factors,
- conduction and documentation of process evaluations,
- conduction and documentation of cost-benefit analyses and
- development, evaluation and documentation of strategies for increasing participation and compliance rates.

Even though the first research results have laid the foundations for a successful prevention of musculoskeletal disorders, the lack of knowledge and information has to be filled as soon as possible. In this context, the scientist who conducts a systematic review as well as the practitioner who helps to realize a complex evaluation project with his company can contribute to this.

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## 6 Economic benefit of workplace health promotion and prevention

A large number of scientific studies prove that interventions of workplace health promotion can have economic effects as well as positive health effects. Six other studies were included for the publication period chosen in addition to the four reviews that are already listed in the IGA-Report 3 and have been used for this report as well (Aldana 2001, Chapman 2003, Golaszewski 2001, Pelletier 2001). Three of these reviews refer to interventions in general and/or multi-component programs (Chapman 2005, Pelletier 2005, Riedel 2001). They are presented in more detail first. Statements on the economic benefit of programs for nicotine cessation and tobacco control (Moher et al. 2005), on alcohol prevention (Rey-Riek et al. 2003) and the prevention of mental disorders (LaMontagne et al. 2006) were found in one review each.

When dealing with the question of the financial impact of workplace health promotion programs, the target figures of medical costs and absences due to illness (absenteeism) of the employees are usually recorded. The studies dealing with the evidence of cost effectiveness of workplace health promotion already included in the IGA-Report 3 arrive at the conclusion that the positive effects on absenteeism and medical costs are sufficiently proven. Regarding the medical costs, the studies assume a cost-benefit ratio (return on investment, ROI) of 1:2.3 to 1:5.9. The savings regarding the absences are stated as 1:2.5 and/or 1:4.85 to 1:10.1 (cf. Kreis and Bödeker 2003). This means that, for example, in the first result, US\$2.3 are saved for each dollar spent through reduced medical costs.

### 6.1 Economic benefit in general

#### Chapman (2003, 2005)

In 2003, Chapman reviews studies that deal with the economic benefit of comprehensive programs for workplace health promotion in a meta-evaluation. The focus is on white literature (peer-reviewed). After certain selection criteria have been defined, 42 studies were identified that are assessed according to their methodical quality. Studies with a higher sample size,

a longer duration, a better study design and of a more recent date are rated higher in a ranking and carried more weight in the assessment than others.

The meta-evaluation reflects the lack of uniform methodology and quality in the evaluation of workplace health promotion. Different methods of measurement, varying categories for the determination of the economic variables and different statistical tests are used for the determination of the economic benefit. Despite the different approaches, the studies have some things in common. The most frequently used economic variables include medical costs and the costs caused by absences due to illness (absenteeism). After having evaluated the studies, Chapman comes to the conclusion that there is an evidence for a reduction of the medical costs and the costs caused by absenteeism.

In 2005, Chapman publishes an update of this meta-evaluation. The meta-evaluation covers now in all 56 evaluation studies (peer-reviewed) published between August 1982 and January 2005. In this meta-evaluation, Chapman points out that, despite the frequent methodical shortcomings, a surprising correspondence of the results was found. The result of 2003 is confirmed by the newly included studies as well. The results are summed up in the following graphs based on the information given in the meta-evaluation (Fig. 6-1 and Fig. 6-2, own illustration):

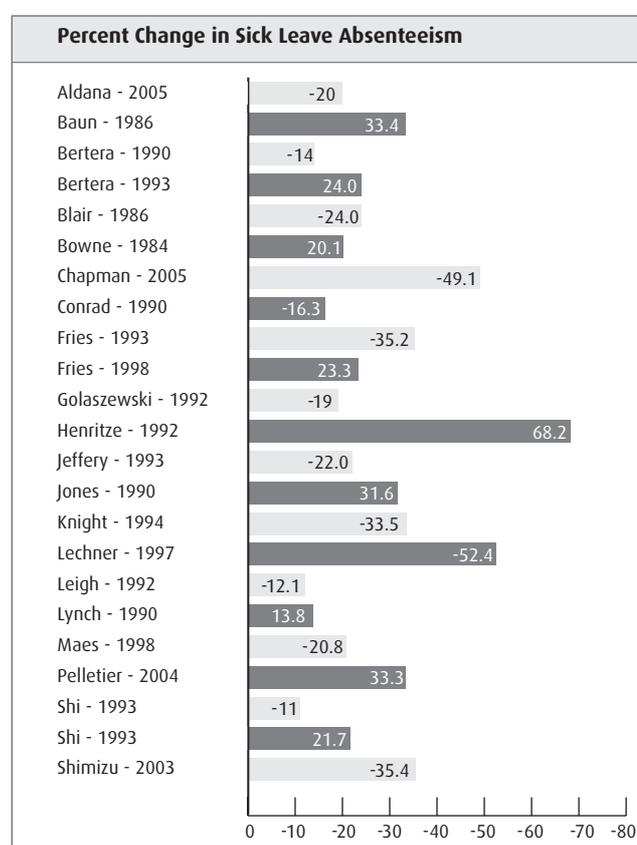


Fig. 6-1: by Chapman (2005)

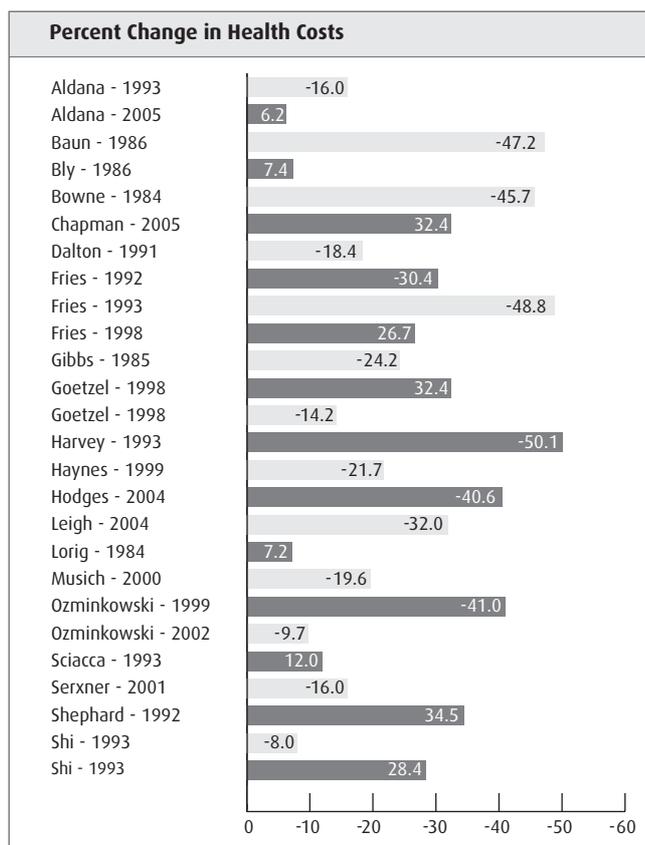


Fig. 6-2: by Chapman (2005)

### Riedel et al. (2001)

The paper by Riedel et al. reviews the scientific literature on the connection between workplace health promotion and work performance and/or productivity. Publications of 1993 to 1998 are taken into account, including articles on the topic and evaluation studies on the effectiveness of workplace health promotion and prevention. According to the type of the measure of health promotion or prevention, the results were assigned to one of three categories: early detection, behavior-related programs for risk reduction and appropriate care-seeking to reduce the unnecessary use of medical services.

First of all, Riedel et al. establish in general that interventions for health promotion and prevention may pay off in the long run regarding direct medical costs and might effect an improvement of the work performance after a short period already (e.g. smoking cessation programs). According to them, the benefit potentially associated with an intervention always depends on its definition – for example if cost reduction alone, the increased work performance, the avoidance of losses of productivity or very immediate effects are considered to be valid indicators.

As it also results from literature, however, there is a clear lack of methods for the determination of the connection between health and work performance and/or productivity. This results in the fact that the evidence base for a monetary benefit of workplace health promotion and prevention regarding work

performance still is very limited to date. Moreover, as a rule, exclusively absenteeism data that are supposed to be connected with the respective diseases are used for quantifying these costs.

Based on three assessment criteria that are of particular importance for the world of work – the extent of the risk factor, the evidence for the fact that this factor can be influenced by the intervention and the evidence for a positive return on investment (ROI) within an adequate period of time – seven of 14 different intervention areas have turned out to be promising according to the authors. They include depression screenings in the field of early detection, back pain-related exercise programs, smoking cessation programs, approaches of stress management, influenza vaccination as well as care-seeking programs for the reduction of unnecessary medical visits for minor medical problems and emergency room use.

Riedel et al. arrive at the following detailed conclusions regarding the three categories that were used for systematizing the interventions found:

#### Early detection

According to Riedel et al., there is solid evidence for a sustainable monetary benefit of blood pressure screenings regarding medical costs incurred. On account of large treatment successes recorded, early detection of breast cancer and depression also count among the cost-effective measures in view of the medical costs saved by them.

The results of prostate cancer screening are controversial and increasingly suggest that the measure does not pay off regarding the medical costs. This is largely due, among other things, to the large number of false-positive results of tests for prostate cancer and cancer of the intestine, which not only causes increased anxiety on the part of the persons affected, but also requires a certain number of follow-up examinations. No evidence exists for the cost-benefit of early detection examinations in terms of a positive ROI for the company. The evidence for the influence of early detection on work performance is similarly weak, primarily due to a lack of relevant literature. Depression screening constitutes an exception – increases in the work performance were observed after a short time already.

#### Behavior change programs to reduce risk

Intervention periods of three to five years usually are required for the determination of the cost-benefit ratio of behavior-related workplace interventions. According to the authors, literature generally shows a positive cost-benefit ratio regarding the medical costs – with the exception of specific exercise programs for back pain and stress management programs the medical cost-benefit ratio of which is still unknown. It has to be qualified that, however, by saying that they are mainly the cumulative effects of comprehensive multi-component programs, i.e. it is still unclear which impact individual interventions can have.

Physical activity programs for back pain seem to have a financial benefit by short-term reducing absences and fluctuation rates. Smoking cessation programs pay off to the extent the time spent before for cigarette breaks by the employees now is gained. Influenza vaccinations can both avoid absenteeism and medical costs due to influenza. According to the authors, the evidence for the effectiveness of the programs concerning work performance and productivity of employees is moderate in quality and limited in quantity.

#### *Appropriate care-seeking*

Riedel et al. find strong evidence for the fact that self-help books and corresponding guides contribute to the reduction of the number of unnecessary visits to the doctor in case of minor illnesses. The findings for offers such as advice over the telephone or other supporting systems regarding a positive ROI and reduced visits to the doctor are inconsistent. It also seems that such information and advice programs can only have a limited influence on the work performance and the productivity of employees.

## 6.2 Economic benefit of multi-component programs

### **Pelletier (2005)**

In a series of reviews, this paper is the sixth survey of studies focusing on health and cost effects of comprehensive, multifactor workplace health promotion programs. The author identified eight relevant studies for the period from 2000 to 2004. Pelletier criticizes that, compared to the previous papers, both the quantity and the quality of such studies has steadily decreased.

Like in his earlier reviews, Pelletier arrives at the conclusion that workplace health promotion has both positive health and economic effects. In particular those programs that aim at the employees with high health risks generate a return on investment. According to Pelletier, employees with a high health risk involve the highest cost saving since higher direct and indirect costs are attributed to them. Three of the eight identified studies report a positive ROI according to Pelletier.

## 6.3 Economic benefit of smoking cessation programs and tobacco control

### **Moher et al. (2005)**

Only six of the 61 studies identified by Moher et al. report economic data that provide information on the efficiency of workplace smoking cessation. Five of them were carried out in the USA, and one in Australia. The most recent one of the six papers dates from 1994, there are no analyzes of a more recent date.

Three of the studies only provide information on the costs associated with the intervention for the company. They ranged from US\$ 1.500 for a smoking cessation seminar offered four times within two years to US\$ 21.000 for a program consisting of a group intervention, supporting media (video), self-help material and financial incentives.

The other three evaluation studies made a differentiated comparison of costs and benefits and arrived at the following conclusions:

US\$50 per employee were estimated for material and lost working time for a study realized in 1989 with four different intervention groups. The costs for the program implementation varied depending on the complexity of the intervention. Group one and three for which the intervention consisted of a brief counseling covering ten minutes and self-help material (group one) and brief counseling, self-help material and an additional bonus for successful quit attempt (group three) caused costs of in all US\$9.500. With an observed quit rate of 5.8% and an estimated saving of US\$1.000 per person who stopped smoking – the estimated saving amounted to US\$9.000.

Group two in which another detailed counseling, support by a person chosen by the participants themselves and a „stop smoking“ contract were part of the intervention in addition to brief counseling and self-help and group four (with the same program as group three plus additional financial incentives) together caused costs of US\$9.500 as well. With an observed quit rate of 15% (27 abstainers) and the same saving of US\$1.000, costs of roughly US\$27.000 were avoided.

Even if the actual benefit was by 50% lower than the US\$1.000 estimated per abstainer, the savings of US\$13.500 would still exceed the estimated costs by 40%. Therefore, in all a positive cost-benefit ratio with an estimated return on investment of 1:2 resulted for the most effective methods (group two and four).

Another study compared four companies with interventions of different complexity. In the control group (company one), only a screening for the determination of the individual risk of the employees was performed without any subsequent intervention; an additional health education was offered in company two; company three also included a counseling and, in company four, company-wide actions on the topic of non-smoking took place additionally. It turned out that the interventions in the companies three and four were approximately ten times more cost effective regarding the recruiting of participants and approximately five to six times more cost effective regarding risk reduction and relapse prevention than company two.

For estimating the potential financial benefit of absolute bans on smoking and additional cessation programs, the reduction in the daily cigarette consumption by an average of 5.2 cigarettes achieved in the context of an Australian study in the public service was extrapolated to the entire public service. Accord-

ingly, with a smoking prevalence of 24.7%, the consumption of cigarettes would be reduced by 52 million of cigarettes per year, which – in addition to the benefit on the public health – would be associated with a saving amounting to 5.2 million of Australian dollars.

Only two studies provided information on outcomes such as absences or improved productivity. One of them documented a reduction by 3.7% of the number of employees who reported a day absent during the last month in the intervention group compared to the control group and found a positive association of this reduction with the participation in the program. In the second study that evaluated a comprehensive lifestyle intervention, the number of days absent during the last four months of the intervention year decreased significantly from six to approximately three days, whereas it significantly increased in the control group.

According to Moher et al., the successful reduction of the tobacco consumption of employees may absolutely be associated with economic benefit e.g. in terms of less absences and increased productivity. The data available up to now, however, do not allow any definite conclusions particularly as, besides the lack of analyses, strongly varying calculation approaches exist that can hardly be compared.

## 6.4 Economic benefit of programs for alcohol prevention

### Rey-Riek et al. (2003)

As a result of the lack of evaluation studies from the German-speaking area (cf. 3.4), Rey-Riek et al. only find very limited information on the cost effectiveness for workplace prevention for alcohol problems.

According to literature, a model of the Stanford Research Institute (SRI) often is used for estimating the overall company costs incurred by absences due to alcohol, inability to work and accidents at work. This model assumes a global reduction factor of 25% of the salary of an employee; the costs due to alcohol problems additionally depend on the position of the employee. However, several authors point out that the resulting costs rather underestimate the real effort since variables hard to quantify such as a poorer quality of the work, a bad working climate or the costs for substitute staff are not included. The possible efficiency of care programs for alcoholics is illustrated in a hypothetical example of a cost calculation for a company with hundred employees that is quoted by the authors and for which figures from the USA, Germany and Switzerland are used. In case of an assumed percentage of 4.3% of alcoholics and a general loss of performance of at least a third, an overall charge of approx. €157.000 per year would result for the company. If additionally taken into account

share of replacement costs for early retirement of the persons concerned amounting to approx. €570 per person, this would result in an annual overall damage of approx. €2.140 per employee. An estimated amount of €19.667 per employee would have to be invested for a suitable care program over a period of ten years. The overall damage to be expected amounts to €21.400 per person in case of no action taken by the company. The breakeven point (the point where neither profit nor loss is created) would be reached by the program after 4.3 years according to the calculation.

Therefore, the present state of knowledge suggests that alcohol prevention can pay off economically – in particular concerning the issue of absences. Nevertheless, we quickly meet the limits when we try to describe the economic benefit of corresponding programs in more detail since many factors that can hardly be quantified monetarily play a role in the context of alcohol addiction. Therefore, the authors see an increased need for extended calculations of cost effectiveness that use more complex data collection and analysis procedures.

## 6.5 Economic benefit of programs for the prevention of mental disorders

### LaMontagne et al. (2006)

The comprehensive review by LaMontagne et al. deals with the question of the effectiveness of stress interventions both on the individual level and on the organizational level. The paper includes in all 95 systematically evaluated studies (cf. 4.1). They are assigned to three categories and assessed: “high systems approaches” (combination of organization- and individual-related interventions), “moderate systems approaches” (interventions on the organizational level) and “low systems approaches” (interventions on the individual level). Six studies of the 95 papers included are classified as “high system approach”. Regarding the economic evaluation, these studies altogether report a positive economic benefit of the interventions. The studies of the other categories only rarely provide any information in this context. One study each contains statements on efficiency, also arriving at a positive conclusion.

According to LaMontagne et al., costs due to illness-related absences (absenteeism) are in the center of the economic evaluation in most cases. In a few cases, they are completed by statements regarding productivity.

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## 7 Summary

As is known, the strategic and methodical aim of workplace health promotion and prevention is to improve the health and well-being of employees and to prevent work-related disorders. But – is there sufficient evidence for the success of

existing interventions? Or, in other words: What actually is the scientific state of knowledge on the health-related and economic benefits of workplace health promotion and prevention? IGA has been dealing with these questions for a rather long time already. In 2003, the initiative published the IGA-Report 3, a systematic survey of the scientific literature on workplace health promotion with a clear result: many studies showed that there is an evident connection between preventive interventions at the workplace and the investigated effects; in particular the economic benefit was considered to be indisputable in the literature. Many studies, however, had methodical shortcomings and examined mainly individual-focused, single interventions so that a reliable evidence assessment often could not be made and in particular the effect of organizational interventions and environmental modifications still is not enough researched.

The present report aims to update the review (for the publication period 2000 to August 2006) in order to search for new findings and to connect existing results to these – in particular in the field of organizational interventions. This report, however, also strives for an extension by not only asking generally about the effectiveness of interventions for promoting health and well-being, but selectively focusing on widespread work-related diseases whose impact has grown alarmingly in the last years – mental disorders and disorders of the musculoskeletal system.

The general message of the IGA Report 3 is confirmed by the reviews added. There is consensus in recent scientific literature on the fact that interventions of workplace health promotion and prevention make an important contribution to the preservation of employees' health. They can reduce health risks, decrease the prevalence of illnesses as well as promote health-conscious behavior. In specialist literature, there is also consensus about the fact that workplace health promotion pays off for companies by reducing medical costs and decreasing sickness absenteeism from work.

When making a differentiated analysis of different groups of interventions, it becomes clear that the evidence of effectiveness is more convincing in some fields of intervention than in others. Thus, the reviews also reveal where the research on workplace health promotion and prevention is lacking and so provide valuable information for future study in this field. The key messages of the reviews on the individual fields of intervention regarding general, mental and musculoskeletal health as well as the findings of the economic analysis are again summarized on the following pages. We then conclude by a short appraisal regarding the possibilities and limits of the evidence-based practice approach in the field of workplace health promotion.

### *General health and well-being at the workplace*

The results of controlled studies show that individual-focused physical activity programs can influence the employees' exercise behavior positively, albeit to a limited extent. They contrib-

ute to an increased physical activity of the employees, but they do not essentially improve cardio-respiratory fitness. According to the scientific findings, individual tailored education and physical exercise courses of high intensity are effective as well. A simple physician advice during health checks was not associated with a significant behavior change in the evaluation studies. According to the evaluation literature, incidental interventions such as motivating signs for encouraging stair use have the potential of reaching the entire staff. Environmental changes combined with individual interventions e.g. sports facilities and lockers on-site plus selective counseling and behavioral skills trainings can successfully increase the employees' physical activity. The same applies to low-cost interventions such as e.g. the initiation of jogging groups or prompts to go to the colleague's office instead of using the telephone.

Positive results can be achieved through dietary programs. The studies found important changes in the consumption of fruit, vegetables, fat and dietary fibers both for individual (e.g. nutrition education) and organizational interventions (e.g. healthy canteen food, posters with information on healthy diet). The literature, however, also shows that studies of sophisticated methods as well as innovative intervention strategies are required in this field.

There is quite convincing evidence for individual workplace interventions for smoking cessation. Except for self-help material (e.g. brochures), the effectiveness of group cessation programs, intensive individual counseling and pharmacological treatment is considered to be well proven. It must be pointed out that the results commonly refer to a small number of abstainers due to an often small number of smokers participating in the program. Nevertheless, the interventions mentioned can help smokers who are willing to quit smoking. On the organizational level, smoking bans are a tried and tested policy for non-smoker protection since they clearly reduce the cigarette consumption of smokers during working hours and thus improve air quality. It seems, however, that the bans only have a small or no impact on smoking prevalence or cessation rates. Evidence also suggests that social support (e.g. by colleagues) and incentives (e.g. bonus for participation and successful quit attempt) do not affect these two outcomes as well. Incentives and bonuses, however, constitute a possibility for increasing participation rates and thus (despite an equal cessation rate) the number of abstainers at the end of the program.

The evidence base for programs on alcohol prevention is rather weak due to a lack of studies. Employee Assistance Programs (EAP) are still considered to be potentially effective for providing corresponding help offers to the employees concerned. The decisive core element here is the so-called „constructive confrontation strategy“ describing the addressing of the alcohol problem by a superior. According to literature, it has been proven that addressing the problem is associated with the work performance of employees addicted to alcohol.

No clear evidence was found for interventions for weight reduction either, in particular for individual measures. If at all, there seems to be evidence for the effectiveness of combined programs including components of diet and physical activity. As shown by a large number of reviews, health risks in employees can be reduced by the use of comprehensive multi-component programs. Moreover, they have the potential of improving the employees' eating habits. The effectiveness on physical activity has not been clarified yet since, according to the literature, not enough controlled studies assessing this outcome are available.

Health circles have become established in Germany as a popular instrument of workplace health promotion. Despite the large positive experience, there is insufficient evidence only for the benefit of the intervention since hardly any high-quality controlled studies on important outcomes were found. Many uncontrolled studies, however, report positive results for outcomes including sickness absence or psychosocial stressors at the workplace.

Limited evidence was ascertained for the effectiveness of participatory ergonomic interventions. Employees can thus benefit from these interventions in the form of improved physical comfort, reduced musculoskeletal complaints and fewer injuries. Interventions following the participatory approach also contribute to reduced absenteeism and the number of compensation claims.

#### *Mental ill-health and stress*

As it results from a certain number of reviews, the interventions in the field of mental disorders primarily focus on individual-related interventions for the adequate coping with stress. They often are cognitive behavioral interventions for stress management aiming at developing personal and social skills. Such interventions on the individual level have proven to be useful both for symptom-free, employees at high risk for mental illness and employees who already have symptoms. Even strong evidence was found for the effectiveness of individual-focused interventions on sickness absence. Furthermore, controlled studies indicate that the implementation of physical activity programs represents a successful strategy to tackle mental ill-health.

Individual interventions can only identify and eliminate sources of stress that originate in behavior-related (e.g. no breaks, not much sleep) and psycho-mental experiences (e.g. unrealistic beliefs, self-defined demands) of employees. On the contrary, they do not have any influence on possible environmental stressors such as leadership style, work climate, company culture or also factors of work organization. As the scientific literature shows, organizational interventions addressing selectively these sources of stress have been evaluated systematically much more rarely so that the evidence in this context (still) has to be considered to be relatively poor. Nevertheless,

organizational interventions and changes of the work environment absolutely tend to have the potential of promoting the employees' mental health.

Several authors ascribe the largest health-related and economic benefit in the field of prevention of mental disorders to combined programs involving interventions on the individual and on the organizational level. Since these programs have a comprehensive design in contrast to individual interventions, a greater sustainability of the effects can be achieved.

#### *Musculoskeletal disorders*

From the evidence-based point of view, only physical activity programs by means of which sickness absence due to musculoskeletal disorders can be reduced and prevalence can be decreased are convincing individual approaches in the field of prevention of musculoskeletal disorders. Several reviews arrive at the conclusion that educational interventions, theoretical trainings (e.g. on load handling) as well as stress management trainings do not have a primary preventive effect on the prevalence of musculoskeletal disorders or associated absences from work. The traditional back school, a popular intervention of workplace health promotion is considered to have no primary preventive effect either. As it has been shown, back schools seem to be useful in secondary and tertiary prevention for persons suffering from back pain. They should therefore be implemented preferentially in this context.

No evidence was found for the preventive effectiveness of lumbar supports – in particular regarding back pain. Low compliance rates constitute an additional problem. As the case may be, persons with already existing complaints can benefit from the auxiliary device.

As in the field of prevention of mental disorders, organizational-focused interventions against musculoskeletal disorders have been investigated much more rarely than individual interventions. Due to the lack of studies of high methodical quality, the evidence for the effectiveness of organizational interventions either is still unclear – like for technical auxiliary devices (e.g. lifting auxiliary devices) and workplace redesign (e.g. ergonomic workstation for computer users) – or it is inconsistent like for changes in work organization (e.g. break patterns).

There is a lack of valid studies assessing the effectiveness of lifting teams as well. However, since the existing pilot studies consistently reported positive findings, the corresponding reviews ascribed a preventive potential to the lifting team approach.

The results of the reviews on multi-component programs indicate a positive effect on reducing musculoskeletal disorders. Several authors even consider the comprehensive approaches to be the most promising strategy, although they state a need for further studies of high methodical quality.

#### *Economic benefits of workplace health promotion and prevention*

For the publication period chosen, ten relevant reviews were identified that aim at investigating the economic benefit of measures of workplace health promotion and prevention. As already mentioned, the included studies agree that workplace health promotion and prevention pay off. Positive evidence for the economic benefit was found both for interventions in general and for disease-specific interventions.

The economic outcomes used most frequently include health care costs and costs due to sick leave absenteeism. Despite different evaluation methods, a large part of the studies indicates a positive effect on reduced health costs and costs caused by absenteeism. For health care costs, the studies assume a cost-benefit ratio (return on investment, ROI) of 1:2.3 to 1:5.9. The savings for absenteeism are stated as 1:2.5 and/or 1:4.85 to 1:10.1. In a few cases, the economical evaluation is completed by statements on productivity. As literature shows, there is a clear lack of assessment methods for determining the connection between health and work performance and/or productivity. This results in the fact that to date, the evidence base for the cost-effectiveness of workplace health promotion and prevention focusing on work performance still is very limited.

The lack of analyses and a uniform methodology as well as the poor evaluation quality make the determination of the health-related and economic benefit in all more difficult. The potential financial benefit of an intervention always depends on its definition and/or on the indicators (e.g. cost reduction, avoidance of loss of productivity) used for the evaluation. Accordingly, the reviews state an increased need for studies of high methodical quality using advanced data collection tools and analysis methods. The evidence demonstrating the financial effectiveness of programs could then be clarified easier.

#### *Final appraisal: chances and limits of evidence-based practice in workplace health promotion and prevention*

The present report does not want to be only a plain synopsis of the current state of research on the effectiveness of workplace health promotion and prevention. Rather it is intended to be a guideline and practical guidance to actors and decision makers in workplace health promotion, whether in the consulting or acquisition context, for optimizing already existing approaches or for developing new programs. These are the chances of evidence-based practice: on the one hand, it strengthens the position of workplace health promotion and prevention as an effective and efficient approach for reducing health risks and avoiding diseases, on the other hand, it gives decisive indications for the best use of existing resources in the interaction of the levels of human being, organization and work.

The reported findings emphasize the importance of the work environment as a suitable context for the implementation of

interventions of health promotion and prevention. At the same time they show that, up to now, the existing programs don't tap the full potential of workplace health promotion yet. This is reflected not only in the call for a stronger cross-linking of interventions on the individual and the organizational level expressed repeatedly in the analyzed reviews – but also in the fact that not enough attention is paid to essential factors when performing and evaluating programs. They include in particular a thorough needs analysis before a program is implemented, the development of interventions that are individually tailored to the employees' needs, the participation of the employees or the constant provision of permanent programs that just allows an integration of workplace health promotion into the company culture.

The report explains in detail several times that, to a large extent, the quality assurance of workplace health promotion and prevention still is in an early stage both concerning study quality and quantity. Methodical problems such as self-selection bias, low participation and compliance rates or too short intervention and follow-up periods are only some of the challenges to be tackled in the future. Nevertheless, the existing findings as well as the increasing call for evidence-based practice and evaluation in the field of workplace health promotion and prevention show that selectively advancing research in this field is worthwhile.

## 8 Annex

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Table A-1: Systematic reviews on the effectiveness of interventions to promote general health and well-being

| Authors             | Data sources                                                                                                                                                              | Number of Studies                                                          | Study Population                                                                                                                                                                                           | Study design                                                                                                                                                                                                                                                                                                                                                                   | Evaluated interventions                                                                              | Methodological problems                                                                                                                                                                                                                  | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Overall assessment          |
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| Janer et al. (2002) | Medline, own archives, articles identified from earlier reviews, backward searches of reports on workplace health promotion trials articles in English, French or Spanish | 45 studies from the USA, European countries, Australia and other countries | Employees, mainly in service companies or factories, half were blue-collar, 15 studies included more than 70% men (although programs were addressed to both sexes), 3 studies included more than 70% women | 32 RCT (9 used individual randomization, 6 had a cross-over design, remaining studies were cluster RCT), 13 non-randomized controlled studies<br><br>24 studies used no-intervention control groups, remaining studies had comparison groups (4 studies compared different kinds of interventions, rest used self-help material or minimum intervention like short counseling) | Smoking cessation, nutrition, physical activity, obesity, alcohol consumption and other risk factors | Differences in target population characteristics, study designs and intervention strategies, lack of adjustment for covariates, low participation rates, low participation at baseline and follow-up (approximately 50%), selection bias | <p><u>Smoking cessation:</u><br/>all of 16 studies that used quit rates as outcome reported increase in intervention groups, average smoking cessation rate 6.1%, magnitude of the effects varied, statistical tests were significant (sign.) in 9 studies, 10% – 15% quit rates in intervention groups if changes in control groups were not considered similar quit rates in studies with no-intervention control groups and studies using minimum intervention as control some studies reported changes in prevalence, ranging from 0.5% to 6% 6 studies reported continuous abstinence rates ranging from 1% to 6% reduction of the effect after 6 months after the end of intervention by 40% to 80% (may be due to late effect of self-help material)<br/>intensity of the intervention and quit rate only weakly associated, high number of contacts not associated with higher number of abstainers<br/>studies including incentives reported higher quit rates than studies without incentives, 5 studies compared effectiveness within the same trial, 4 of them reported a higher quit rate (by 0.9 to 3.5%), one study showed negative effect of incentives, one study significant effect only in the subgroup with lower education (18.6% vs. 8.8%)<br/>a study on social support showed that actions like e.g. being asked by colleagues not to smoke were correlated with larger changes in abstinence rates<br/>environmental changes like creating non-smoking areas were investigated in 2 studies, in one study additional health education and follow-up support lead to a reduction of smoking prevalence by 1.5%<br/>higher effectiveness among managers, moderate smokers (&lt; 1 pack per day or less than 10 cigarettes per day), smokers of light cigarettes, smokers with previous quit attempts, smokers who considered it less difficult to stop smoking, smokers who have been smoking for less time</p> <p><u>Nutrition:</u><br/>all 14 studies identified reported positive results for at least one relevant outcome, 11 studies showed statistically sign. results<br/><i>Vegetable intake:</i> sign. increase in six of seven studies, 3 studies: increase in consumed servings, ranging from 0.09 and 0.19 per day<br/><i>Fruit intake:</i> sign. increase in 4 of 5 studies, ranging from 0.11 to 0.24 servings per day<br/><i>Fat consumption:</i> 6 of 10 studies reported sign. results, effect ranged from a reduction by 3% to an increase by 1.3% in kilocalories from fat</p> | small, but positive results |

| Authors | Data sources | Number of Studies | Study Population | Study design | Evaluated interventions | Methodological problems | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Overall assessment |
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|         |              |                   |                  |              |                         |                         | <p><b>Dietary fiber intake:</b> 5 studies, 3 of them reported increase by 0.02 g to 1.7 g per 1,000 kilocalories</p> <p><b>Environmental changes (e.g. healthier food offer in canteens and vending machines):</b> 5 studies, results similar to studies that did not include environmental changes</p> <p><b>Involving employees in intervention planning and implementation (in 7 of 13 studies)</b> had no larger effect</p> <p>5 studies had more than one follow-up, maintained changes (regarding increased consumption or reduction) after 6 or 12 months between 30% and 65%, one study found no difference between follow-ups after 3 months and 6 months</p> <p><b>Physical activity:</b></p> <p>2 types of intervention: counseling and education or access to sport facilities and offering time for physical activity</p> <p>outcomes included body fat percentage, aerobic capacity, percentage of regularly active employees</p> <p>results of programs that focus exclusively on physical activity were more consistent than those of programs with wider focus</p> <p>7 of 13 studies showed sign. results: 4 of 9 studies evaluating education and information material reported sign. effect, outcomes directly related to phys. activity, 3 of 4 studies on the effectiveness of offering sport facilities showed sign. effect</p> <p>1 study comparing both intervention types showed better results if additional behavioral education was offered (65% of persons at risk did weekly exercises vs. 50% in control group)</p> <p>maintenance examined in 3 studies with more than 2 follow-ups, longest follow-up period 7 years, in this study no reduction of the intervention effect observed, participation in the activities with 17% after 7 years as high as at the end of the intervention, other two studies: decrease of the effect, 4 studies with 1 follow-up (after 2.3 or 10 years), study with 10-year follow-up did not find a difference between the groups</p> <p><b>Weight control:</b></p> <p>3 studies examined programs for weight control, 5 which used nutritional or physical activity programs reported body fat percentage changes ranging from 0.25 kg increase to 3.5 kg loss of weight, short-term effects larger than long-term ones (after 2-3 years) 2 studies measured reduction of body fat, 0.45% to 1.19%, 2 studies measured BMI, reduction by 0.3 and -0.3, one study found no effect after 1 year</p> <p><b>Alcohol consumption:</b></p> <p>3 studies investigated alcohol interventions</p> <p>significant improvements in knowledge on alcohol, socially responsible attitudes, self-efficacy</p> <p>2 studies showed sign. reduction of weekly consumption compared to control group</p> <p>in 1 study alcohol was part of a comprehensive program: in intervention group significantly higher increase for moderate drinkers</p> |                    |

| Authors         | Data sources                      | Number of Studies | Study Population                                                                                                                                   | Study design                                                                                                                                    | Evaluated interventions                                                                                                                                                                                       | Methodological problems                                                                                                                                                                                                                                                                   | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Overall assessment                                                                                                                                           |
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| Marshall (2004) | Medline via Pubmed (from 1997 on) | 32 studies        | 9 studies blue-collar workers, 23 white-collar, most common workplace setting civil/public service agencies, hospitals, universities and factories | 5 RCT, 6 randomized trials, 7 quasi-experimental studies with reference or comparison condition, rest were cohort studies with no control group | Workplace physical activity programs, most of them consisting of several components: health checks, trainings, motivational prompts to be more physically active, exercise programs, incentive-based programs | number of randomized studies too small, interventions not always described in detail, more information needed on recruitment, implementation, reach of interventions, compliance and retention, detailed data required in order to identify successful components of multifactor programs | <p>overall studies reported positive results, mainly in cases of high participation in the program</p> <p>low participation in health checks, referring individuals at high risk to fitness facility or education not effective, financial incentives were ineffective (e.g. in one study 39% of the participants stated to have completed the program because of the incentive)</p> <p>sport facilities often used by already active persons</p> <p>controlled study on exercise (3 times 30 min. per week + payment of half the time spent at any of the sessions) reported limited success only</p> <p>additional training of behavioral skills or individual consultation combined with access to sport facilities more successful than access alone</p> <p>behavioral theory-guided educational, individual-tailored measures more effective than generic health education</p> <p>one RCT examined 4 programs (aerobic dance, stress management, health information and combined health and stress management) showed no significant change in stress levels or sickness absence</p> <p>motivationally-designed self-help material proved to be more effective than standard material (in case of voluntary participation only)</p> <p>4 studies examined motivational prompts to encourage stair use or active traveling to work (e.g. by bike), all showed significant short-term effects, to achieve long-term effects more innovative methods required</p> <p>one study suggests larger effect of a combination of social-behavioral programs and structural changes in the work environment</p> <p>average effect sizes (outcome physical activity):</p> <p>4 studies on motivational prompts: 0.34</p> <p>1 study on exercise programs: 0.37</p> <p>1 study on individual counseling: 0.4</p> <p>4 studies on 'single risk factor' programs: 0.4</p> <p>2 studies on 'multiple risk factor' programs: 0.24</p> | workplace is appropriated for health promotion interventions, little evidence for long-term effectiveness for workplace physical activity programs up to now |

| Authors              | Data sources                                               | Number of Studies | Study Population           | Study design                                | Evaluated interventions                                                                                                                       | Methodological problems                                                                                                                                                                                                                                                                                                                                                                                       | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| Proper et al. (2003) | Medline, Embase, Sportdiscus, Cinahl, Psychlit (1980-2000) | 26 studies        | Healthy working population | 15 RCT, 11 non-randomized controlled trials | worksite physical activity programs to improve individual fitness, relevant outcomes: physical activity, physical fitness and health outcomes | mainly poor methodological quality, 6 high-quality RCT, most common shortcomings: inadequate description of randomization procedure, inappropriate blinding of the person performing the measurements, lack of intention-to-treat analyses, almost all studies use self-reported data only, lack of objective valid measures, description of intervention of-ten insufficient or lack to report on compliance | <p>Levels of evidence: strong, moderate, limited, inconclusive, no evidence (rating based on the methodological quality, in case of 2 high-quality RCT conclusions based on these only, irrespective of the results of the other studies, if only one or no high-quality RCT, strong evidence was not possible)</p> <p><u>Physical activity:</u><br/>5 RCT, 2 high-quality (HQ), 3 controlled studies<br/>both HQ RCT showed positive (pos.) effects, increased physical activity in intervention group, higher energy expenditure in intervention group than in nutrition and control group<br/>→ strong evidence</p> <p><u>Cardiorespiratory fitness:</u><br/>3 HQ RCT, 7 low quality (LQ) RCT, six controlled studies<br/>2 HQ RCT pos. effect (sign. higher oxygen consumption among intervention group, significant improvement in perceived fitness), third study reported no change in oxygen consumption<br/>→ inconclusive evidence</p> <p><u>Muscle flexibility:</u><br/>4 LQ RCT, 4 control studies, inconsistent results<br/>→ inconclusive evidence</p> <p><u>Muscle strength:</u><br/>1 HQ RCT, 3 LQ RCT, 4 controlled studies<br/>HQ RCT reported sign. increase in muscle strength in training group, one LQ RCT showed sign. effect on abdominal muscle strength (stomach muscles), another LQ RCT sign. change in intervention group, but not significant compared to control group, third LQ RCT observed no effect on handgrip strength<br/>→ inconclusive evidence</p> <p><u>Weight and body composition:</u><br/>3 HQ RCT, 3 LQ RCT, 4 controlled studies on body weight<br/>2 HQ RCT found no effect, one HQ RCT sign. difference between groups, 2 LQ RCT no effect, third one found pos. effect<br/>→ inconclusive evidence</p> <p>1 HQ RCT, 5 LQ RCT, 4 controlled studies on body fat and/or BMI, HQ RCT showed sign. change in BMI and body fat vs. reference group, a LQ RCT found a sign. pos. effect for an exercise program, four residual studies showed no effect<br/>→ inconclusive evidence</p> <p><u>General health:</u><br/>3 HQ RCT, 1 LQ RCT, 3 controlled studies<br/>1 HQ RCT observed trend of reduction in general health complaints (not sign.) and relevant effect sizes, other 2 HQ RCT no effect → inconclusive evidence</p> <p><u>Fatigue:</u><br/>2 LQ RCT, one reported relevant effect size, other one found sign. larger increase in mental and physical exhaustion in reference group → limited evidence</p> <p><u>Musculoskeletal disorders:</u><br/>5 RCT, 3 HQ, 2 controlled studies, one HQ RCT showed no sign. effect regarding prevalence and complaints, but important differences, other 2 HQ RCT reported sign. effects<br/>→ strong evidence</p> | <p>primary aim of worksite physical activity programs is achieved (general improvement of physical activity)<br/>possible reason for lack of evidence that programs effect cardio-respiratory fitness: programs possibly do not reach required intensity and duration of training<br/>physical activity programs are an important component of a strategy for avoiding musculoskeletal disorders<br/>except for fatigue, no convincing evidence for health-related outcomes was found with respect to body weight results are in contrast to pertinent literature, possibly due to generally healthy, non-obese study populations (effect of programs presumably small), other explanation: sign. increase in phys. activity does not necessarily result in weight loss<br/>Conclusions:<br/>→ strong evidence for positive effect on musculoskeletal disorders<br/>→ limited evidence for positive effect on fatigue<br/>→ no evidence for positive effect on muscle mobility, body weight, body form, general health, blood lipids and blood pressure</p> |

| Authors                           | Data sources                                                                                        | Number of Studies                                                                                                                                                           | Study Population   | Study design                                                       | Evaluated interventions                                                                                                                                                                                                              | Methodological problems                                                                                                                                                                                                                                                                                                                                                                                                                                | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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| Proper et al. (2003)<br>continued |                                                                                                     |                                                                                                                                                                             |                    |                                                                    |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p><u>Blood serum lipids:</u><br/>4 RCT, 1 HQ, 3 controlled studies, no RCT found relevant effects → no evidence</p> <p><u>Blood pressure:</u><br/>1 HQ RCT, 1 LQ RCT, 3 controlled studies<br/>HQ RCT found no sign. effect on systolic blood pressure, second RCT reported no sign. changes between pretest and any of the follow-ups after 12, 24 and 48 weeks (exception of sign. change after 24 weeks in favor of the exercise group)<br/>→ no evidence</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Matson-Koffman et al. (2005)      | Medline, Psych-Info, Chronic Disease Prevention, ERIC (1970 to 1990), Web of Science (1990 to 2003) | Physical activity:<br>2 studies published before 1990, 10 studies published 1990-2003<br><br>Nutrition:<br>18 studies published before 1990, 13 studies published 1990-2003 | working population | also studies included that did not meet formal evaluation criteria | policy or environmental interventions to promote physical activity or improve nutrition, including modifications of the physical environment and/or social, economic or organizational systems to promote individual behavior change | <p>few studies met methodological criteria, control groups too rarely, in most studies only self-report used, lack of relevant outcomes, sustainability of the effects is difficult to determine because follow-up-period is often too short, need for methodologically rigorous studies on long-term effects, more data on the long-term effectiveness of environmental interventions alone and in combination with traditional approaches needed</p> | <p><u>Physical activity:</u><br/>2 studies before 1990, one uncontrolled study reported that financial incentives, prompts to encourage stair use, safety notes and other behavior strategies increased stair climbing (nearly 33% of the staff reached program goal), second study took place at Johnson &amp; Johnson, provision of facilities for physical exercise, shower facilities and lockers on-site, after 1 year consume of aerobic calories/kg/week increased by 43% in intervention group compared to 6% in control group (received screening only)</p> <p>10 studies after 1990, intervention was a combination of health education with screenings, counseling and sport equipment on-site, desired change in participant's cholesterol level, systolic blood pressure, physical fitness and frequency of training; 2 studies on nutrition + physical activity interventions, significant reduction of participant's blood cholesterol and body weight, increased organizational support for exercise by managers after training on establishing a wellness committee, employees' heart check scores increased on average by 75%, increased organizational support for health promotion, 3 studies on training, exercise program and fitness facilities, locker room on-site increased number of employees walking or bicycling to work, counseling and health promotion offers proved more effective than exercise facilities alone, one study showed that providing free fruit increased stair use</p> <p><u>Nutrition:</u><br/>18 studies before 1990, 10 studies involved healthier food and point-of-purchase information on menus, posters or flyers, sales of selected items increased in 4 studies, posters on the benefits of low-fat nutrition and daily offer of low-fat food increased sale of low-fat meals, addressing both taste and health has greater influence on the selection of healthy foods than health information alone, combination of colored signs, information and offering low-calorie snacks in vending machines increased sales of these snacks, studies on financial incentives showed inconsistent results like studies competitions: in one study no changes observed, two showed reduction of average calorie intake per person and day, one study reported decline in selected desserts and bread + increased sale of skim-milk, other study found reductions in number of calories and the amount of salt and fat per tray (but greater variety of low-calorie food than in study which found no change)</p> | <p>strong evidence (more than 10 quasi-experimental and/or experimental studies) for the effectiveness of point-of-purchase prompts, labeling of food, providing healthier food, price reductions</p> <p>moderate evidence (5-9 quasi-experimental studies): motivational prompts increase stair use, access to exercise facilities promote physical activity</p> <p>preliminary evidence (4 quasi- or experimental studies): comprehensive programs that include counseling, education, group activity, incentives and access to fitness facilities can improve employee's physical activity</p> <p>comprehensive approach with consultation, trainings, health promotion trainings and access to fitness facilities on-site is more effective in the long term than individual measures alone</p> <p>recommendations (based on controlled studies)<br/>to promote physical activity: sign prompts encouraging stair use like signs, on-site fitness facilities, counseling offers, promotion of group activities (e.g. jogging group), educational trainings, incentives, access to facilities such as lockers, showers, health clubs</p> |

| Authors                                   | Data sources                                                                                                   | Number of Studies                                       | Study Population  | Study design                                                           | Evaluated interventions                                                                                                                                                               | Methodological problems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                        |
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| Matson-Koffman et al. (2005)<br>continued |                                                                                                                |                                                         |                   |                                                                        |                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Johnson & Johnson: restructuring the environment, scales in restrooms, weight control and nutrition programs, offering healthier food in cafeteria and vending machines and information where food was sold, on diet behavior no data recorded, prevalence of overweight in the intervention group reduced by 1% after 1 year (statistically significant)<br>13 studies after 1990, in 5 studies showed positive effect of access to healthy food in cafeterias and/or vending machines, in 2 studies significant reduction in reported fat consumption, 4 studies showed sign. increase in food and vegetables consumption, one study found sign. increase in dietary fiber intake, 3 studies on access to healthier food + labeling observed no behavior change, 4 studies showed increased sale of healthy food for labeling and price reduction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | to promote nutrition: point-of-purchase prompts to increase the sale of healthy food, labeling of healthy food, informational posters, offer of healthier food (low-fat, low-sugar, low-calorie) in cafeterias and vending machines                                                                                                                                                                                       |
| Seymour et al. (2004)                     | Medline, Chronic Disease Prevention Combined Health Information Database, Psycinfo, Web of Science (1970-2003) | 38 studies, including 10 work-site intervention studies | adult populations | 6 studies used good or very good design (no further information given) | nutrition environmental interventions in various settings (university, workplace, grocery stores, restaurants), either single intervention or part of a larger socio-ecologic program | outcomes not always suitable, valid instruments hardly used, criteria like change in sales in per cent with reference to diet behavior difficult to interpret<br>lack of data on overall sales<br>other covariates like e.g. spices which influence calorie content are considered infrequently,<br>no study evaluated long-term effects of the interventions or cost issues<br>need for true environmental interventions that involve incentives and access to healthier food instead of informational strategies<br>because they address individual behavior only<br>lack of attention to factors such as taste and enjoyment although this is one of the most important factors for the selection of food | 8 studies conducted in workplace cafeterias, 2 studies used vending machines, 7 times sales figures as outcomes, 4 reported key figures of nutrition, duration of the interventions varied between 1 week and one year (short durations were more frequent)<br>Information strategies:<br>3 studies, sales figures were significantly affected, labeling of the energy content of food resulted in decreased calories per tray, listing of low-fat entrées on a sign and placing a heart symbol next to the entrée resulted in increased sale of these, information on reasonable substitution of certain products (e.g. apple instead of apple cake) resulted in reduced calorie and sodium intake per tray, grams of fat decreased, but no statistically significant change, offer has already changed 8 months before)<br>Changes in foods offered:<br>4 studies combined modified food offer with other strategies, 3 with information, 1 used information and price changes.<br>2 studies reported changes in the desired direction, 1 study found no sign. change, forth study also involved vending machines and did not find any change in the sales figures<br>Incentives:<br>3 studies found, one used price change and information (price reduction resulted in increased sale of low-fat snacks, signs had no effect, neither alone nor in combination with price strategy, increase in overall sale, not only for healthy food), one used a raffle and a game (no difference found in energy content per tray when playing cards with nutrition recommendations were given to customers and/or tickets were given to persons who bought targeted products like salad, fruit or low-fat milk, increase in sale of products on raffle days was found), 1 study on cards with dietary information reported decrease in the sale of desserts and bread, increased sale of skim milk and fewer calories per day | most of the 10 studies at the workplace reported results in the desired direction<br>from a general public health perspective:<br>for being successful, interventions must go beyond simple labeling of products<br>more research is required in the field of interventions that involve improved access, healthier food offer and incentives in general, worksites are suitable settings for environmental interventions |

| Authors                  | Data sources                                                                                                                                                                                                                                                               | Number of Studies | Study Population                                                                                                                                                         | Study design                 | Evaluated interventions                                                                                                                                                                                                                                                                                  | Methodological problems                                                                                                                                                                                                                                                                                                            | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| Smeds-lund et al. (2004) | ABI/Inform, BRS, CHID, Dissertation Abstracts International Database, ERIC, Medline, Occupational Health and Safety Database, PsycInfo, Smoking and Health Database, Social Sciences Citation Index and Sociological Abstracts Database, references in reviews (1989-2000) | 19 studies        | working population, 6 worksites manufacturing/ construction, 2 utilities/transport/communication, 3 service/education/hospital, 6 "mixed", 1 "other", 1 had missing data | 9 RCT, 10 controlled studies | Smoking cessation programs<br>Interventions varied: 16 studies on self-help material, 13 studies on group cessation, 12 studies on "other type", 9 studies on incentives, 7 studies on steering committee, 4 studies on smoking bans, 2 studies on physician advice, 2 studies pharmacological treatment | despite the large number of evaluation studies (initial list included more than 100) studies often show methodological shortcomings, insufficient information on design, sample characteristics, industry sector and the like generalization of the results considered difficult since there is no standard of study documentation | 2 large RCT could not enter the meta-analyses since no abstinence rates were reported (study 1: implementation of local workplace smoking laws, smokers were more likely to report quitting in the prior 6 months, OR 1.5, 95% CI 1.1 – 1.7. study 2: 111 worksites, worksite was randomization unit, effects were evaluated by comparison of changes in intervention and control worksites, 2-year intervention related both to individuals and working environment, cross-sectional survey at baseline and follow-up changes in the desired direction observed, but not statistically significant)<br>meta-analysis was carried out using a random effects model sample size varied between 56 and 2317 with a median of 426.5<br>abstinence rates observed in follow-ups varied considerably both in intervention and control groups, large number of studies were carried out in worksites with high smoking prevalence and white, heavy smokers<br>potentially relevant covariables such as previous quit attempts, cigarettes smoked per day and educational level reported only inconsistently<br>OR and quit rates:<br>up to 3 independent treatment conditions and up to 3 time points per study were extracted (42 effect sizes), in most cases the two simplest conditions were focused (treatment vs. no treatment)<br>weighted ORs: 2.03 (95% CI 1.42 – 2.90) after 6 months, 1.56 (95% CI 1.17 – 2.07) after 12 months, 1.33 (95% CI 0.95 – 1.87) after more than 12 months<br>overall quit rate: 16.7% in the intervention group vs. 8.5% in the control groups after 6 months, 20.8% vs. 12.2% after 12 months, 17.25 vs. 13.9% after more than 12 months<br>RCT show stronger effect (OR 4.65) than non-randomized (1.74), greater precision of the estimates in the RCT, both types show homogeneity in the 6-month follow-up<br>funnel plot shows strong evidence of publication bias<br>effects do not seem to persist for more than 12 months, randomized studies were not homogeneous, set of non-randomized studies was heterogeneous, no evidence of publication bias was found here | meta-analysis confirmed results of a previous one<br>effect might be underestimated because of conservative comparison strategy (but results can be interpreted easier)<br>randomization effect: non-randomized studies showed stronger effects for all three follow-ups<br>due to publication bias, effects are overestimated in randomized studies as well<br>surprisingly, despite becoming more popular pharmacological treatment still is used rarely as a treatment condition (may be due the fact that most smoking-cessation drugs did not become over-the-counter medications until the late 1990s or that persons using these drugs were excluded from studies)<br>authors wonder why program success did not increase over the decade of the 1990s, reasons could be that restrictions at the workplace became more widespread and smokers were more marginalized in the workplace and in general society, these factors possibly contribute to proportion of committed smokers not willing to quit and more likely to be nicotine dependent<br>smoking cessation not only influenced by smoking cessation programs, but also determined by factors of organizational context |

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| Moher et al. (2005) | Cochrane Tobacco Addiction Group Specialised Register (in October 2004), Medline (1966-October 2004), EMBASE (1985-2004) and PsycINFO (to October 2004) | 61 studies found, assigned to one of the categories or to several | employees over 18 years of age who smoked | interventions aimed at individuals: only RCT included, interventions aimed at the working environment: also non-randomized controlled studies or time series studies | smoking cessation interventions aimed at the individual and interventions aimed at the workplace as a whole (for detailed information see reported effects) | analysis in some studies using cluster-randomized design ignored clustering, too few studies reported randomization procedures in sufficient detail<br>18 studies reported no appropriate randomization procedure or no randomization at all<br>participation rates varied remarkably (between 11% and 88%) | <p><i>Interventions aimed at the individual</i></p> <p>Group interventions: 10 RCT with follow-ups after 6 to 24 months, in cases of more than one intervention arm control group (mostly self-help material or waiting list) was compared to next simplest treatment, also comparison of various treatments, some studies examined additional impact of incentives or monthly booster sessions</p> <p>support groups had additional impact in 2 of 3 large RCT, point prevalence after 12 months for group participants 26%, 16% for non-group participants, abstinence rates 11% and 3% (significant difference), second study: abstinence rate 31.2% after 12 months (sign. difference compared with other groups), 2 other studies showed trend of higher smoking cessation rates in group condition than in self-help (not sign.), small study tested a multi-component program with group intervention and self-help condition, showed no sign. difference (abstinence rates 19% versus 7%), in one study no long-term effect was found for relapse prevention and competition, abrupt versus gradual reduction: one third abstinent after 6 months in gradual condition, no participants abstinent in gradual condition, on account of small sample not significant, target behaviors in reducers found (sign. reductions), behavioral support and hypnosis had no effect, 3-month multi-component program showed 12% abstinence rate after 6 months vs. 9% in control group, relapse prevention more successful if supported by a psychologist (43.7% were abstinent after 12 months), than by ex-smokers (37.5%) and no formal support (35.5%), but no significant difference was found</p> <p>Intensive individual counseling:<br/>large RCT conducted in 160 civil service administration sections, 3 or 4 counseling sessions for participants depending on their cardiovascular risk, no intervention control group, after 2 years 21.4% of the smokers abstinent vs. 13.4% in control group, not sign. because participants lost to follow-up still were heavier smokers than attenders and controls, studies on physician counseling: participants more likely to stay abstinent than those with simple warning, point prevalence of abstinence rate 18.4% in intensive condition vs. 13.5% in warning condition, another study reported 12.9% vs. 3.1% cessation rates, 48.6% of the abstainers still were abstinent after 18 months, comprehensive program in 28 ambulance stations found no difference in abstinence rates in 6 or 12 months follow-up, when testing for effect of the counseling component a sign. effect was found (1% vs. 10%), study of male factory workers (screening of cardiovascular risk, written advice was given to workplace doctor and family, high-risk group received 6-monthly physician counseling, anti-smoking poster at the workplace, conferences on the hazards of smoking), smoking prevalence in high-risk group decreased by 18.7% after 2 years, 15 to 20 minute counseling by trained nurse,</p> | <p>workplace is an ideal setting for the offer of measures for smokers who want to quit</p> <p>strong evidence for effectiveness of group interventions, individual consultation and pharmacological treatment</p> <p>generally little participation in consultation programs, therefore in most cases only small absolute number of abstainers</p> <p>despite less strict study designs, the included papers suggest that bans on smoking and restrictions are well accepted, may lower the cigarette consumption at the workplace and consider-ably reduce the exposure to passive smoke, inconsistent evidence on the fact whether this can also reduce prevalence and overall consumption</p> <p>limited evidence for the fact that participation rate can be increased through incentive systems and competitive strategies, no influence on abstinence rate</p> <p>limited evidence for the fact that cessation programs that address individual behavior are more effective where they are extended with institutional approach, despite good theoretical foundation, to date no systematic evidence found for comprehensive programs for the effectiveness regarding smoking prevalence</p> |

| Authors                          | Data sources | Number of Studies | Study Population | Study design | Evaluated interventions | Methodological problems | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Overall assessment |
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| Moher et al. (2005)<br>continued |              |                   |                  |              |                         |                         | <p>if smokers participate in group cessation 4 follow-up calls for support quitting, after 12 months point prevalence cessation rate of 11.1% in intervention group vs. 1.8% in control group (but only 25 of 117 counseled smokers agreed to stop smoking)</p> <p>Self-help programs:<br/>computerized interventions: group with nicotine fading schedule showed abstinence rate twice as high as contest group after 6 months, not sign. (21.4% vs. 11.5%), no difference found between "American Lung Association Program" and internet-based program</p> <p>4 studies on video interventions found no effect on validated abstinence rates in groups receiving different videotapes, one study found a difference between video group and non-participants, testing self-help vs. group intervention: no statistically sign. effect found in abstinence rates between 3 types of self-help material</p> <p><u>Pharmacological treatment:</u><br/>12% abstinence after 1 year in group with nicotine gum vs. 2% in control group, with intention-to-treat analysis 7.8%, another study reported validated abstinence rate of 22% after 1 year compared with 2% in control group, complete rate (participants who had not smoked at all) was 6.3% vs. 2.4%, dose study on nicotine gum: after 3 months in 2mg dose group: 36.2% abstinence, 44% in 4mg dose group, after 1 year 22.3% and 32.2%, respectively (self report), effect not sign., placebo study: chewing gum and patch (18.1% vs. placebo chewing gum and patch (12.7%) vs. placebo chewing gum and placebo patch (13.3%) abstinence after 12 months, OR group 1 vs. 2 and 2 vs. 3 was not significant, study on counseling and patch: validated abstinence rate after 12 months: 20.2% vs. 8.7% in control group, OR 2.58</p> <p><i>Interventions aimed at the workplace as a whole</i><br/><u>Workplace smoking bans and control policies</u><br/>in 8 studies reduction of tobacco consumption at the workplace (e.g. initially 16.9% smokers with more than 15 cigarettes per day; 7.5% after one month, 4.9% after 6 months), less consistent evidence that general tobacco consumption is influenced as well (8 studies report small effect, three found no change at all in general consumption), inconsistent evidence that smoker prevalence is influenced by bans (5 studies found no difference, 4 studies showed only small decrease), 2 studies found sign. differences (from 22% to 14% and from 29% to 24%, after 1 year, respectively), validated abstinence rate after 3 months in worksite with ban higher than in company without ban (9.2% vs. 1.4%, sign.), in hospitals cessation rates decreased by approx. 4% (7% in policy, 11% in control hospital), 2 studies found decreased smoke exposure, 3 studies improved air quality, 12 studies on acceptance of the bans: only one reported disapproving attitude by smokers (approx. 60%) still after 6 months, rest reports acceptance (but: large number of studies were conducted in medical facilities)</p> |                    |

| Authors                                  | Data sources | Number of Studies | Study Population | Study design | Evaluated interventions | Methodological problems | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Overall assessment |
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| <p>Moher et al. (2005)<br/>continued</p> |              |                   |                  |              |                         |                         | <p><b>Social support:</b><br/>2 studies found no difference between basic program and program plus additional support by a person chosen by the participants themselves, participants relapsed after 6 months regarding number of smoked cigarettes, second study found reduction of nicotine content in both conditions after 6 months, but number of cigarettes per day was statistically sign. higher than at immediate post-test, same pattern found for percentage of each cigarette smoked, although group rate in support condition was lower after 6 months than at baseline, same pattern for carbon monoxide level as well, but metabolites in saliva were higher concentrated than at baseline</p> <p><b>Environmental support:</b><br/>comprehensive program resulted in abstinence rate twice as high in environmental intervention worksite, training program for cessation group leaders plus manuals to carry out plant-wide tobacco control and health promotion activities failed to detect an effect, 12-months quit rates were 22% and 18% with environmental support, program involving 4 conditions showed slightly higher abstinence rates in groups with supporting components, differences were not sign.</p> <p><b>Incentives:</b><br/>cluster RCT found no difference between groups with vs. without monetary incentives, in another RCT: payments delayed relapse, but did not prevent it, other RCT detected no effect of monetary incentives, RCT with groups: higher participation rate in worksites with incentives, but abstinence rates were not influenced, cluster RCT (in 28 hospitals; see results on individual counseling) found no effect of individual or group incentives</p> <p><b>Comprehensive programs:</b><br/>program to reduce cardiovascular risks, consisting of employee steering committee and range of activities tailored to each worksite, no change found in smoking rates, nutrition or cholesterol levels, not even short-term effects compared to control group, second study with modified menu and added guidance for steering committee found no effect either, one study conducted in 4 companies combined individual and environmental interventions on dietary and smoking behavior, each site added an additional component for addressing an additional risk factor, no sign. difference in abstinence rates and smoker prevalence was found when compared with control group after 6 months</p> <p>RCT on 2-year intervention, aim: modification of dietary and smoking behavior, integrated health promotion through co-operation between employees and health protection through worker-management participation regarding workplace changes, education including smoking cessation, differences between blue-collar and white-collar workers were addressed, 6-month abstinence rate was higher in intervention group than in control group (15% vs. 9%, not sign.), study based on this trial tested similar program, no significant difference found, reduction in point prevalence after 6 months 4.1% vs. 1.6%,</p> |                    |

| Authors                          | Data sources | Number of Studies | Study Population | Study design | Evaluated interventions | Methodological problems | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| Moher et al. (2005)<br>continued |              |                   |                  |              |                         |                         | <p>cohort analyses detected no sign. effect on overall abstinence rate (11.3% vs. 7.5%), study focusing on physical activity found no sign. difference between 7-day point prevalence cessation rates (25.6% vs. 21.8% in control group) or after 6 months (8% vs. 8.1%), study comparing a program consisting of self-help material, group courses, mass media campaign, smoking bans with minimum intervention found no effect on abstinence rate after 6 months, another multiple program including smoking cessation to control cardiovascular risk with individual counseling plus 16 annual group sessions, lectures, videotapes, discussions and outdoor activities, after 12 and 18 months smoking prevalence decreased from 65% to 31% vs. 65% to 63% in control group. study with 4 conditions (no non-intervention group), components (one additional intervention at each level): health risk appraisal, health newsletter, self-care books, behavioral workshops, social support team, after 2 years on all intervention levels but one a sign. reduction of smoking prevalence was observed (prevalence declined by 12% to 44%, but participation rate in cross-sectional surveys was relatively small (no cohort analysis);<br/>Economic analysis (see chapter 6):<br/>only 6 of the studies identified reported economic data, 5 from the USA, one from Australia<br/>4 studies: information on program costs only, varied between US\$1.500 for smoking cessation program offered 4 times in 2 years and US\$26.867 for group cessation study conducted in 1989: material costs + lost employee time to participate were approx. US\$50 per employee, costs of program implementation for group 1 (brief counseling+ self-help material) and group 2 (as 1 + monetary bonus) approx. US\$9.500 (50x190 per combined group), estimated savings with quit rate of 5.8% US\$9.000 (9 employees at US\$1.000), estimated costs in group 3 (as 1 + intensive counseling + buddy selection + contract) and group 4 (like 3 + bonus) US\$9.500, with cessation rate of 15% (27 abstainers, each US\$1.000), estimated savings US\$27.000, in case of reducing benefit by 50% still savings of US\$13.500, still 40% more than estimated costs, return on investment for the most effective methods approx. 1:2<br/>study conducted in 1991: direct intervention costs per year and employee for screening in control worksite (intervention: risk information and advice) US\$2.97, in worksite 2 (intervention: health education) US\$17.68, in worksite 3 (intervention: as worksite 2 + follow-up counseling) US\$30.96, in worksite 4 (intervention: as worksite 3 plus plant organization for health promotion) US\$38.31, worksites 3 and 4 estimated to be 10 times more cost-effective than worksite 2 for engaging participants, regarding risk reduction and relapse prevention 5 – 6 times more cost effective than worksite 2;<br/>Australian observational study: 2114 employees in public service, 6 departments, intervention: smoking ban and smoking cessation programs, reduction of daily cigarette consumption</p> | <p>less smoking may be associated with economic benefit in the form of less absences and increased productivity<br/><br/>economic analyses difficult to compare, calculation methods vary from study to study, sometimes costs per abstainer compared only with smokers vs. overall staff as reference<br/>pure program costs are not sufficient as basis for the calculations, other costs disregarded<br/><br/>cost effectiveness analysis performed in the USA have only limited validity for other health care systems</p> |

| Authors                          | Data sources                                                                                                                                          | Number of Studies                                                                                                                     | Study Population   | Study design                                                                                                          | Evaluated interventions | Methodological problems | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Overall assessment                                                                     |
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| Moher et al. (2005)<br>continued |                                                                                                                                                       |                                                                                                                                       |                    |                                                                                                                       |                         |                         | <p>by 5.2 cigarettes on average, estimated savings when extrapolated to the entire public service assuming a smoking prevalence of 24.7%: smoked cigarettes reduced by 52 millions per year, which corresponds to a saving of A\$ 5.2 millions in addition to public health benefit in general</p> <p>only 2 studies provided information on efficiency outcomes such as absenteeism or improved productivity</p> <p>study 1: reduction in the percentage of employees who reported a sick day during the last month between intervention and control workites was 3.7% (cross-sectional analysis) and 3.4% (cohort analysis), participation rate and change in absenteeism positively associated (0.9), strongest in smokers, programs might have important short-term economic benefit</p> <p>study 2: comprehensive lifestyle intervention, outcome was mean number of sick days over the last 4 months of the first year of intervention, decreased from 6 to 2.9 in intervention group (difference sign.), increased from 4.5 to 7.4 in control group (difference sign.), but: smoking was not the only behavior targeted, effect cannot only be attributed to smoking cessation component</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                        |
| Fichtenberg and Glantz (2002)    | Medline, Science Citation Index, Social Sciences Citation Index, Current Contents, Psychinfo, plus manual search in references of reviews and studies | 26 studies from USA, Australia, Canada and Germany, reported in 14 papers, 21 workplace intervention studies, rest population studies | working population | prospective studies, sequential cross-sectional studies, retrospective population studies used cross-sectional design | workplace smoking bans  |                         | <p>data analysis: computation of differences in consumption per smoker and per employee and prevalence before and after implementing a workplace smoking ban or between comparable samples with different regulations in population studies; t-test revealed no different effects between workplace studies and population studies</p> <p>analysis of variance for comparing results from different studies: sequential cross-sectional studies reported significantly smaller changes in number of cigarettes per smoker than other study designs, but no difference between studies regarding prevalence, consumption per employee or relative change in consumption, therefore pooling all studies in a random effects meta-analysis</p> <p>Smoke-free workplace:<br/>reduction of the absolute smoking prevalence of 3.8% (2.8 – 4.7), decrease in consumption of 3.1 cigarettes per day (2.4 – 3.8) per continuing smoker, i. e. number of cigarettes smoked per day per employee reduced by 1.3, corresponds to a relative reduction of 29% (11%– 53%),<br/>time between implementation and follow-up ranged from one to 24 months, no significant correlation between effect and duration of the follow-up period, effect stable over time</p> <p>Comparison with tax increases:<br/>price increases by 10% results in a 4% decrease in consumption per capita, for achieving a reduction by 29%, cigarette prices would have to be increased by 73%, average tax per pack would have to be increased from US\$0.76 to US\$3.05 in the US, from £3.44 to £6.59 in the UK, but since workplace regulations concern the working population only and not the overall population,</p> | smoking bans protect non-smokers from passive smoking and help smokers to stop smoking |

| Authors                                    | Data sources                                                                                                                                                                                                                                 | Number of Studies                                                                    | Study Population   | Study design                                                                                    | Evaluated interventions                                                                               | Methodological problems                                                                                                                                                                                                                                                           | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| Fichtenberg and Glantz (2002)<br>continued | Centers for Disease Control and Prevention's Office of Smoking and Health website, Tobacco Control website, Medline, Science Citation Index, Social Sciences Citation Index, references of articles, books, reviews, interviews with experts | 19 workplace intervention studies, 9 population studies on public clean air policies | working population | either pre-post design or cross-sectional comparison of exposed persons vs. non-exposed persons | clean indoor air laws (comparison of the effectiveness of public policies and workplace smoking bans) | population studies did not consider when bans were adopted, different types of bans were not distinguished, if states are highly committed to tobacco control it is difficult to say which part of the effect is attributable to the ban and what is caused by attitudinal change | effect of workplace smoking policies corresponds to a lower tax increase, only marginal effect if all workplaces were smoke-free: in the US, estimated reduction in consumption per capita would be 4.5%, in the UK 7.6%, for reaching this effect, a tax increase from US\$0.76 to US\$1.11 per pack in the USA and from £3.44 to £4.26 in the UK would be required<br>3 studies allowed to compare effects of total smoking bans and partial policies: total ban on smoking had about twice the effect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Levy and Friend (2003)                     | Centers for Disease Control and Prevention's Office of Smoking and Health website, Tobacco Control website, Medline, Science Citation Index, Social Sciences Citation Index, references of articles, books, reviews, interviews with experts | 19 workplace intervention studies, 9 population studies on public clean air policies | working population | either pre-post design or cross-sectional comparison of exposed persons vs. non-exposed persons | clean indoor air laws (comparison of the effectiveness of public policies and workplace smoking bans) | population studies did not consider when bans were adopted, different types of bans were not distinguished, if states are highly committed to tobacco control it is difficult to say which part of the effect is attributable to the ban and what is caused by attitudinal change | workplace studies:<br>decrease in cigarette consumption of 10-20% after 6 to 13 months, prospective cohort studies reported reductions in prevalence rates ranging from 7 to 20% after ban had been in place 1 year or more, effect on cessation rates less consistent<br><u>maintenance</u> of the effects: reductions in quantity smoked, greatest decrease within the first 6 months, then slow decline, on the contrary, prevalence and cessation rates show no or no immediate effect, but increase over time (evidence for this trend is less consistent)<br>overall, there is considerable variation regarding different outcomes<br>results hard to generalize<br>population studies of worksites:<br>in most cases, random selection of employees from a rather large region (e.g. population of a state in the USA or entire country), they might be more representative (there can still be differences between the sectors, but not between individual firms), disadvantage: cross-sectional design, no information on how long ban has already been in place, but in general, long-term effects were examined because smoking behavior was assessed over a period of time (possibility of control given: adjustment for confounders)<br>consistent results regarding reduced cigarette consumption, range 7-15%, larger effects in studies without adjustment<br>lower smoking prevalence in firms with ban than in companies without, e.g. 15-20% difference<br>workers in firms with bans had higher rates of quit attempts and successful attempts lasting for at least 3 months, higher abstinence rates, but some studies did not find any associations<br>partial smoking bans: no or only small effects, in case of strict regulation consumption was reduced by 10-15%, prevalence by 15-20% compared to companies without ban | Summary: strict smoking bans reduced daily cigarette consumption by 10-15% and prevalence by 15-20% compared to worksites without ban, in most cases, cessation rates increased by 10-15%, effects associated with working hours, dose-effect relation is likely<br><br>Smoking bans promote lower overall cigarette consumption, (was reduced by 4-20%), prevalence reduction and higher cessation rates<br><br>worksite Intervention studies rarely show changes of prevalence, but cross-sectional population studies provide clear evidence<br><br>Implications for further research: study social norms as influence factor, examine long-term effects, use valid instruments |

| Authors                | Data sources                                                                                                                                                          | Number of Studies | Study Population   | Study design                                                                     | Evaluated interventions                                                                                                                                                                                                                                                                                                                                                                                                                  | Methodological problems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| Hey and Perera (2005)  | Cochrane Tobacco Addiction Group Specialized Register, MEDLINE, EMBASE, CINAHL, PsycINFO, manual search in specialist journals, grey literature                       | 15 studies        | adult smokers      | 9 RCT, 6 controlled studies (5 studies in medical facilities, rest in worksites) | incentives and competitions for smoking cessation: lottery tickets, cash payment for successful quit, payment plus site-wide prize draws, varying amount of deposits and repayment, comparison of the effect of different amounts of money, payment for participation without refund, max. achievable cash reward higher than participation fee, awarding depending on team performance, 7 studies rewarded participation and compliance | studies often have too little power, very large variability in study quality                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>none of the studies found an effect of monetary incentives, rewards or competitions at last follow-up point</p> <p>some studies found short or medium term effects on cessation rates in intervention groups, but effects were not sustainably, single study which found long-term effect was non-randomized and had only small sample size</p> <p>meta-analysis performed with 9 studies, grouped by follow-up points:</p> <p>after 6 months no sign. effect, but confidence interval (CI) indicates clinical relevance, 2 studies found sign. effects (but in both final reward was paid at the follow-up point)</p> <p>after 12 months or longer no significant odds ratios and narrow CIs for the studies were adjusted</p> <p>consistent picture showing that monetary incentives an/or competitions are only effective as long as they are present and when they are no longer offered the usual relapse pattern reemerges</p> <p>rates of participation in incentive groups were partly twice as high as in control groups, but is not reflected in sustainably higher abstinence rates</p> <p>nearly all studies use biochemical validation of smoking cessation (precondition to get reward or prize); 3 studies showed good correspondence between claims of abstinence and tests (95%-100%), 2 studies showed remarkable discrepancy, but: in both studies persons were not warned</p> <p>cost analyses:</p> <p>efficiency of incentives as separate component not determined</p> | <p>workplace offers number of advantages for smoking cessation: easy access to target population, occupational health support, peer support, reward systems can easily be set up because of existing salary structure, lower risk of deception</p> <p>material and monetary incentives as well as competitions do not contribute to improve sustainability</p> <p>short-term effects disappear when the incentive no longer is present and the smokers relapse into their old smoking pattern</p> <p>incentives and competitions seem to increase number of participants and successful quitters</p> <p>only small evidence that levels of deception vary between experimental and control group or that the rates of disconfirmation are unacceptably high</p> |
| Rey-Riek et al. (2003) | Medline, ETOH, SOMED, Nebis, writing to experts, homepages of health institutions (1965 to 2003) empirical studies, theoretical essays, bibliographies and monographs |                   | working population |                                                                                  | employee assistance programs (EAP) for workplace prevention of alcohol problems                                                                                                                                                                                                                                                                                                                                                          | <p>aim was meta-analysis of German-speaking literature, could not be performed since not enough papers were identified, so qualitative analysis was done</p> <p>larger number of studies conducted in North America (but also no exhaustive knowledge on effectiveness of EAP): 2 reviews found, one analyzed 11 studies from the late 1950s to 1984, second one analyzed 13 studies published since 1975, both conclude that organizations benefit from EAP, but it is difficult to prove that workplace alcohol programs actually reduce costs (due to shortcomings in study designs)</p> <p>other authors also conclude a clear association between constructive confrontation strategy and work performance and that EAP can bring affected employees to appropriate treatment</p> <p>studies from Germany:</p> <p>most workplace substance abuse prevention programs are not evaluated systematically, only case studies or descriptions available, focus on analysis of costs due to sickness absence, other alcohol-related consequences not taken into account, nevertheless, studies report reduction of alcohol-related sickness absence and concomitant economic benefit of the intervention</p> | <p>alcohol abuse prevention pays off regarding sickness absence</p> <p>considerable need for extended calculations of productivity and more complex analysis procedures</p> <p>EAP have mainly proven themselves in large companies (&gt; 1.000 employees), but there are many small and medium-sized companies in Switzerland, therefore more offers for companies of this size needed</p> <p>EAP are appropriate to tackle alcohol-related problems, but more suitable interventions are required for truly preventing the disorder</p> <p>suggestion: implementation of brief interventions (effectiveness has proven in several meta-analyses, sustainability confirmed in recent studies as well as cost effectiveness)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| Authors                             | Data sources                                                                                        | Number of Studies | Study Population | Study design | Evaluated interventions                                                                | Methodological problems | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Overall assessment                                                                                                                                                                                                                                                                                                                                |
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| Rey-Riek et al. (2003)<br>continued |                                                                                                     |                   |                  |              |                                                                                        |                         | <p>studies from Switzerland (for economic aspects see chapter 6); literature situation similar to Germany, one relevant study (already older): comparison of a group of alcoholics with a 3 times larger control group (case control study), outcomes were sickness absence and illness, demonstrated associated excess costs (approx. 1.525 € per person per year)</p> <p>cost calculation in another study: company employing 100 people, 4.3% are alcohol-addicted employees, estimated performance loss 1/3, overall burden for company 157.000 € plus compensation costs for early retirement (approx. 570 €), annual overall damage per employee: 2.140 €, costs of a suggested EAP program with a duration of 10 years amount to 19.667 € per employee, compared with an estimated overall damage of 21.400 € in case of no intervention, breakeven point would be reached after 4.3 years</p> <p>to calculate company overall costs due to alcohol-related sickness absence, inability to work and work accidents authors often use a model of the Stanford Research Institute (SRI), estimates alcohol-related costs in relation to an employee's occupational position, assumes a global reduction of 25% of the salary</p> <p>several authors point out that, based on this formula, the estimated costs have to be considered as rather being too low compared with the real costs (reason: costs are difficult to quantify, those caused by low quality of work, breakdown, standstill, wrong decisions, bad working climate or replacement of sick employees or employees unable to work are not included)</p> |                                                                                                                                                                                                                                                                                                                                                   |
| Katz et al. (2005)                  | studies from 1966 to 2001, publication language: English, no further information on databases given | 20 studies        |                  |              | Interventions for preventing and control of overweight in school and worksite settings |                         | <p>based on the results of seven papers the Task Force on Community Preventive Services recommends that dietary and exercise-related approaches should be combined to control overweight and prevent obesity</p> <p>successful interventions often involved the following components:</p> <ul style="list-style-type: none"> <li>dietary education, aerobic or strength training exercise prescription, behavioral training, self-directed material, specific dietary prescription, supervised group exercise;</li> <li>2 studies reported cost-benefit analysis: it costs &lt;US\$1 per employee per year to activate 1% of the population at risk on account of too a small number of studies, insufficient evidence exists for the effectiveness of single-component worksite interventions focusing nutrition, physical activity or other behavioral interventions</li> </ul> <p>criterion for success of the program focused only on weight loss, i.e. some of the studies may have effected positive results regarding other target figures that were not included in the subject matter of the present review</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p>Task Force on Community Preventive Services recommends a combination of dietary improvement and increase in physical activity, evidence for effectiveness exists</p> <p>lack of studies on the primary prevention of overweight</p> <p>many additional programmatic and strategic research efforts are required for controlling overweight</p> |

| Authors          | Data sources                                                                        | Number of Studies                                    | Study Population   | Study design                                                                                                                                                                                | Evaluated interventions                          | Methodological problems                                                                                                                                                                                                                                                | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Overall assessment                                                                   |
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| Pelletier (2001) | Medline, ERIC, ADI, EDGAR, CARL, Inform, Lexis-Nexis (1998-2000), inquiring experts | 12 studies, 3 additional papers from previous review | working population | 1 experimental study, 2 quasi-experimental, 9 non-experimental studies, studies on comprehensive programs reporting health and cost outcomes included only                                  | comprehensive worksite health promotion programs | all studies used individuals as the unit of analysis, even when study was cluster randomized, differential attrition from the sample                                                                                                                                   | Health risks:<br>general reduction of employee risks for chronic disease<br>decrease in glucose levels and (glyco) hemoglobin<br>lower influenza rates and less influenza complications<br>decreased number of headaches<br>smaller number of caesarean sections, preterm deliveries and underweight newborns<br>reduction of sick days<br>reduction of doctor visits and hospital days<br>ROI (also see chapter 6) 1:4.56 – 4.73                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | overall assessment: “indicative” evidence for positive clinical and cost effects     |
| Pelletier (2005) | Medline, ERIC, ADI, EDGAR, CARL, Inform, Lexis-Nexis (2000-2004), inquiring experts | 8 studies                                            | working population | 1 experimental study, rest quasi-experimental studies, cohort studies or non-experimental studies<br><br>studies on comprehensive programs reporting health and cost outcomes included only | comprehensive worksite health promotion programs | considerable decrease in number and quality of studies<br><br>might be the result of difficulty to gain endorsement, but: systematic evaluations desirable and required<br><br>problem of publication bias might be more important if only a few studies are published | Development trends:<br>→ reduction of the number of RCT conducted in worksite settings<br>→ trend towards to simple observation studies with pre-post design on disease management programs on areas of specific importance to employers (show innovative possibilities)<br>→ trend towards studies which use a comparison of participants and non-participants<br>→ increased interest in mental health topics<br>→ development of new measurements to link medical costs and productivity costs, as well as more sophisticated integration systems<br>→ significant increase in international workplace health promotion and programs (in particular Ireland, Denmark, Japan)<br>→ core element of comprehensive programs: individualized risk reduction with special attention to high-risk employees<br>→ focus: disease management with persons at high-risk, combinations of public-health strategies and individualized behavioral risk management and telemedicine, most likely to produce a positive ROI (3 of 8 studies report a positive ROI)<br>→ overall, the majority of the studies shows health-related and economic benefit<br>→ future implications: comprehensive programs involving high-risk interventions, should focus on a dose-response model of increasing levels of intensity | comprehensive programs are associated with positive health outcomes and cost benefit |

| Authors               | Data sources                                    | Number of Studies | Study Population                                             | Study design | Evaluated interventions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Methodological problems                                                                                                                                                                                                                                                                                                                                                                                                                                            | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| Engbers et al. (2005) | Medline via PubMed, Embase (up to January 2004) | 13 studies        | healthy workers/employees, both blue-collar and white-collar | RCT, CTs     | comprehensive worksite health promotion programs with environmental changes (8 studies on cancer risk reduction, 3 studies on cardiovascular risk reduction, 1 study on lowering serum cholesterol levels, 1 study on promoting a healthy lifestyle in general, in most cases mixture of educational interventions (e.g. group sessions and skills training), counseling, incentives and information for increasing health awareness (flyers, brochures, kick-off events, presentations, newsletters, seminars), one study comprised a policy change (on smoking), one included a family counseling | most frequent shortcomings: no blinding of the outcome assessment, problematic outcomes (5 studies), poor description of company characteristics (7 studies), no study described randomization procedure, hardly any information on the validity of the outcome measures, insufficient description of interventions (e.g. no detailed information on the kind of information provided on point-of-purchase signs etc.)<br><br>publication bias cannot be ruled out | <p>levels of evidence: strong (at least 2 high quality (HQ) RCT with consistent results), moderate (1 HQ RCT and at least 1 low quality (LQ) RCT or 1 HQ RCT and at least 1 HQ CT with consistent results in both cases), limited (1 HQ RCT plus at least 1 LQ CT or more than 1 LQ RCT or more than 1 HQ CT, in each case with consistent results), inconclusive (only 1 study or several LQ CTs or with inconsistent results) and no evidence (more than 1 study with consistent results that no significant or relevant results were found)</p> <p>Physical activity:<br/>3 LQ studies found, a program involving a walking track on company grounds showed no change in exercise behavior (days of exercise and/or distance covered per day), program aiming at general improvement in physical activity; sign. increase in self-reported activity (at least 20 min. of continuous exercise three times a week or more times) and exercise behavior (e.g. motivation and phase of change) in follow-ups compared with control group, strategy for promoting stair use contributed to sign. increase of self-reported activity (hours per week) (was observed in control group as well), stair use itself was not recorded → inconclusive evidence</p> <p>Nutrition:<br/>13 studies, four outcomes: reported intake of fruit, vegetables, fat and dietary fibers<br/>6 studies, 3 nearly HQ, all found sign. positive changes compared to control groups<br/>6 studies on fat consumption, 2 HQ, sign. reduction in fat consumption found in all studies but one<br/>→ strong evidence<br/>1 study on fiber intake, no effect found</p> <p>Health risk factors:<br/>4 studies, outcome were cholesterol levels (serum or blood), no effect found<br/>3 studies on BMI, in 2 no sign. change found, one study found small, but sign. increase<br/>1 study on blood pressure, no sign. effect<br/>→ no evidence</p> | <p>evidence for the effectiveness on dietary intake, but all programs evaluated comprehensive interventions, i.e. effect cannot be clearly attributed to the environmental component</p> <p>probably effective: labeling of healthy food, expanding food offer, using information material (brochures, poster), placing the food easily visible</p> <p>disappointing results for work-site health promotion programs with environmental changes regarding physical activity, reason: on the one hand, small number of studies, on the other hand poor methods (outcomes not directly associated to the program content)</p> <p>results of the review generally difficult to interpret, but: interventions at the workplace have to be comprehensive and intensive and consistently pursue environment factors in order to create health awareness at the workplace</p> |

| Authors               | Data sources                                                                                                                                                                                                                                         | Number of Studies | Study Population   | Study design                               | Evaluated interventions                                                                                                                                                                                                                                                                  | Methodological problems                                                                                                                                                                                                                                                                                                                                                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| Aust and Ducki (2004) | 10 German and international data bases: Psyn dex, S omed, OCLC- PsycFIRST, Medline, PsycLIT, ZPID database of dissertations, OCLC-Social Science Index, OCLC disserta- tions, OPAC of the German Library Frankfurt, psy- chological online documents | 11 studies        | working population | Wilson's approach, 5 categories (* to ***) | health circles (studies report on 81 health circles, more than half of them (43) conducted in steel industry, 12 in chemical industry, 5 in hospitals, remaining 21 circles in companies and organizations in various fields of the production sector, tele- communication and services) | only 3 of the 11 studies used control groups (not randomized), but even these used only simple evaluation procedures most frequently: before-and-after comparison by circle participants or these and several or all em- ployees in the depart- ments where the circle was carried out statistical analyses performed in 3 studies only, in most cases only report of frequen- cies despite limited use of reliable methods, a certain number of subjective and objec- tive outcomes was observed to evaluate the intervention poor methodical quality might be due to the fact that health circles are rather a practical design, strict evaluations are not seen as primary aim, circles are often initi- ated by the companies themselves, positive reaction of participants is considered to be a relevant outcome, acceptance among the employees who do not participate actively might be more reliable | majority of the circles conformed to the Düssel dorf model (73), 5 cor- respond to the Berlin model, in most cases model was only a general guide with individual changes according to the particular situation Satisfaction with health circles (HC): overall participants report great satisfaction with the composition of the circle groups, the number of sessions and the overall process of identifying problems and developing possible solutions in one study participants were satisfied with composition of the circle, but not with information flow within the company, in one study 40% of employees did not support the intervention Implementation of suggestions for improvement: 7 studies: 45% to 86% of suggestions were implemented within 6 to 12 months after the final circle session study on 41 health circles: highest implementation rate for sugges- tions to improve psychosocial situation (67% of all suggestions imple- mented after 6 months), followed by organizational and environmen- tal interventions (60%) and suggestions for reducing physical strain (54%), one study with rate of 86%: interventions comprised basic ergonomic (e.g. improved driver's seats), technical (e.g. improved air condition) and organizational (e.g. reduced ticket sale through driver) improvements, other examples of implemented interventions: introduction of team structure and job rotation to improve communication, wage increases, hiring more personnel during summer months, additional equipment, improvement of shower rooms, trainer for improving communication and management style in one study only a few suggestions implemented (but was one of the early pilot studies of Berlin model, study author's conclusion: further development required) Improvement of working conditions: except for one study aiming primarily at coping strategies, all studies found at least some improvements in work conditions, stress reduction as a result of improved work organization, physical strain was reduced by providing improved equipment, technical or ergonomic improve- ments, study on 41 HC: nearly 60% of all circle participants reported positive changes, additional 35% reported improvements of their work situation, survey of employees showed that 55% noticed some and/or significant improvements in social support and appreciation experi- enced, 53% reported improved equipment, 50% remarked improve- ments in decision latitude, further examinations in companies with already 6 HC: 48% of 156 improvement suggestions show positive cost-benefit ratio in most studies communication within the company and social support by superiors and colleagues improved, in one study only circle partici- pants reported improvements, in another study 60% did not remark any improvements (but survey was conducted before the major part of the interventions have been implemented) Health effects: 5 studies assessed effectiveness on health-related outcomes by self- rated health, one study also used objective measurements 2 studies with control groups, 3 performed statistical analyses | no demanding studies that evaluate health circles systematically results have to be inter- preted with caution (e.g. absenteeism influenced by a large number of fac- tors, if there is no control group, the effect is not clearly attributable to the health circle) but available data support the fact that circles result in ergonomic, techni- cal and organizational improvements as well as in reduced psychosocial stress, so it is likely that these positive effects can also influence the health of the employees implementation calls for comprehensive problem analysis, continuous staff information during the intervention and encour- aging explicit feedback is important, cooperation with the management is needed companies and researches seem to be convinced that health circles are successful and thus willing to invest time, money and energy intervention is very promising, health circles are accepted by employ- ers and employees, but: evidence base is weak, better studies required |

| Authors                            | Data sources                                                                                                                             | Number of Studies | Study Population       | Study design                                                                                                                                                                                                                                 | Evaluated interventions                                                                                                                                                                                                              | Methodological problems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                      |
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| Aust and Ducki (2004)<br>continued |                                                                                                                                          |                   |                        |                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>4 studies had positive results: 40% of participants had some or considerable improvements in health state, substantial improvement in job satisfaction and self-effectiveness, statistically significant improvements for 3 stress indicators compared to control group, stat. sign. improvements in mental well-being and work satisfaction</p> <p>objective outcomes (triglycerides, cholesterol): stat. sign. improvements in pre-post comparison in participants</p> <p>Sickness absence:<br/>7 of 11 studies, evaluation based on company or health insurance data, simple before-after comparison without statistical tests</p> <p>only 1 controlled study, absenteeism increased in both groups, 1 study no change, 5 studies substantial decrease (from 10.2% to 7.4%), sick days due to musculoskeletal diseases decreased from 2.000 to 1.000 days per 100 full-time employees, turnover rate decreased by 40% in one case reduction of absenteeism from 10% to 5%, saving of \$ 1 million, company attributed more than one third of this effect to HC, one study: increase in all departments, reduction of absenteeism only in circle department</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | on account of heterogeneity of methods, only limited evidence up to now the available data provide enough certainty to recommend that participatory ergonomic interventions should continue to be implemented since there is evidence linking work-related risk factors to the burden of musculoskeletal disorders any intervention proven to have at least a small positive effect is useful and should be implemented |
| Cole et al. (2005)                 | MEDLINE since 1966, EMBASE since 1980, CINAHL since 1982, CCINFO web, Safety Science and Risk since 1981, Ergonomic Abstracts since 1969 | 10 studies        | any working population | rating of methodological quality (very high – 100%, high – 75-99%, medium – 45-74%, low – 0-44% of 16 quality criteria met) quality had to be at least “medium” one study had very high quality, one high quality, eight were medium quality | participatory ergonomic interventions, at least one relevant outcome assessed (pain/discomfort, musculoskeletal complaints, injury rates, accident/first aid rates, absenteeism, sick leave, work function/limitation of performance | <p>recommendations for research:<br/>use of comparable control or reference groups whenever possible including randomization (if several organizations are involved)<br/>better description of study population<br/>better documentation of the level of participation within the organization, of the extent of involvement, of the extent and/or portion of those involved<br/>describe ergonomic changes as detailed as possible in order to increase comparability and transferability<br/>delineate risk factors and analyze their links to health parameters<br/>description of co-interventions and consideration of their impact in the evaluation<br/>description and adjustment of individual confounders</p> | <p>considerable heterogeneity in the evaluated interventions, in particular regarding duration, voluntariness and/or obligation to participate and role of ergonomist</p> <p>majority implemented changes in the physical design of equipment and workplaces, a smaller number of studies comprised task redesign, changes in work teams, in work organization, the implementation of new policies or specific trainings</p> <p>6 studies involved interventions that could not be assigned to the classical categories: development of a stretching and exercise program, development of better strategies to maintain existing equipment, arrangement and implementation of new break rooms, cooperation with suppliers, in general participatory ergonomic interventions can be expected to include a certain number of interventions that cannot be easily categorized</p> <p><u>musculoskeletal complaints and physical discomfort:</u><br/>1 Very High Quality (VHQ) study: positive, but small effect, 1 High Quality (HQ) small change as well, 3 Medium Quality (MQ) studies showed improvements, but no effect size can be calculated<br/>→ limited (partial) evidence for a small positive effect on musculoskeletal complaints<br/><u>injuries and worker's compensation claims:</u><br/>6 MQ studies, all show reduction in injury records and worker's compensation claims, in particular in the field of musculoskeletal disorders (e.g. low back pain), effect sizes ranged from large (in crude analyses) to small (in more differentiated analyses adjusting for staff turnover and co-interventions)<br/>→ limited (partial) evidence (effect may be considerable or only small) lost work days and sickness absence:<br/>2 MQ studies showed positive results, no effect size can be determined<br/>→ limited (partial) evidence, but further research is needed to determine magnitude of the effect overall:<br/>9 of 10 studies of medium or better quality reported positive effect on health outcomes</p> |                                                                                                                                                                                                                                                                                                                                                                                                                         |

Tab. A-2: Systematic reviews on the effectiveness of interventions to prevent mental ill-health

| Authors                     | Data sources                                                                                                                                                               | Number of Studies            | Study Population                                      | Study design                                                                           | Evaluated interventions                                                                                                                                                                                                                                       | Methodological problems                                                                                                                                                          | Reported effects                                                                                                                                                                                                             | Overall assessment                                                                                                                                                                                                             |
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| van der Klink et al. (2001) | Medline (1966 – 1996), CinPsych (1980 – 1996), Current contents (1997), Nioshtic (1970 – 1996) and manual research;<br>language: English                                   | 48 studies                   | working population, n=3736                            | experimental or quasi-experimental with no-intervention control group                  | 4 types of interventions: cognitive-behavioral methods (18), relaxation techniques (17), multi-component programs (8), organizational interventions/environmental changes (5)<br>intervention level: I,0                                                      | specific data such as age, gender, profession not provided in the original studies; follow-up periods in studies examining organizational interventions                          | individual level:<br>cognitive-behavioral interventions → more effective than relaxation techniques and multimodal programs;<br>organizational level:<br>→ no effect determined                                              |                                                                                                                                                                                                                                |
| Proper et al. (2002)        | Medline, Psychinfo, Sportdiscus, OSHrom, Cisdac (1980 – 2000) completed with references of other studies and personal databases search<br>language: German, English, Dutch | 12 publications on 8 studies | working population. both blue-collar and white-collar | randomized-controlled (RCT) or controlled trials (CT)                                  | interventions for the promotion of physical activity and/or physical ability;<br>3/4 of the RCT: combined programs of aerobics, strength & mobility;<br>1/4 of the RCT: only aerobics;<br>4 CT involved different types of programs;<br>intervention level: I | poor methodical quality of the RCT/CT; insufficient description of randomization procedures and inclusion criteria; drop-outs; poor compliance; in part too small random samples | absenteeism:<br>→ limited evidence;<br>job satisfaction:<br>→ no conclusive evidence;<br>work stress:<br>→ no conclusive evidence;<br>productivity:<br>→ no effects;<br>fluctuation:<br>→ no conclusive evidence (only 1 CT) |                                                                                                                                                                                                                                |
| Mimura and Griffiths (2003) | among others, Cochrane Library, CINAHL, Medline, Psychinfo (since 1990)<br>language: English and Japanese                                                                  | 10 studies                   | nursing staff                                         | randomized-controlled studies (6), prospective cohort study (1), auxiliary studies (3) | various interventions such as education, role plays, relaxation, music, sports, cognitive techniques, individual and organizational interventions<br>intervention level: I, 0                                                                                 | poor methodical quality of the studies → in part conclusions are not feasible and/or possible                                                                                    | individual level:<br>physical activity, music and relaxation → potentially effective;<br>cognitive technique → weak evidence;<br>social support measure → inconclusive                                                       | more evidence for the effectiveness of individual level interventions than for organizational level interventions;<br>it is not possible to determine what kind of approach is more effective → number of studies is too small |

| Authors                    | Data sources                                                                           | Number of Studies                                 | Study Population                                                                                     | Study design                                                                                | Evaluated interventions                                                                                                                                                                                                                             | Methodological problems                                                                                                                                                                                                                                                                                                                 | Reported effects                                                                                                                                                                                                                                                                                                                                                          | Overall assessment                                                                                                                                                                                                                                                                                                     |
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| Michie and Williams (2003) | Medline, PsycInfo, Cochrane Trials Register, Embase (1987 – 1999)<br>language: English | 49 studies including 6 referring to interventions | mainly health care workers, completed by other professional groups                                   | RCT, randomized-uncontrolled study, observational study, matched-controlled study           | aerobic exercise and stress management training, sessions to teach skills to enhance social support and problem solving, communication training; identification of key factors associated with psychological ill-health<br>intervention level: I, 0 | only one of the studies comprised an economic evaluation                                                                                                                                                                                                                                                                                | improvement in stress management, improved working climate, reduced depression, decrease of stress hormone levels, reduced sick leave<br><br>identified key factors: work overload, work pressure/time pressure, long work hours, conflicting demands, lack of control over work, lack of participation in decision making, poor social support, intransparent management | individual trainings and organizational modifications → successful in promoting mental well-being and reducing sick leave                                                                                                                                                                                              |
| Giga et al. (2003)         | PsycInfo (1990 – 2001), Medline (1990 – 2001)<br>language: English                     | 16 studies (exclusively from England)             | working population                                                                                   | randomized-controlled studies, without randomization or control group                       | individual level:<br>e.g. cognitive-behavioral methods, relaxation, time management, EAP;<br>individual-organizational level:<br>e.g. participation; organizational interventions: communication, job redesign<br>intervention level: I, 0          | in most cases, interventions were evaluated over a short period of time only; long-term effect of comprehensive programs not evaluated; only a small number of studies comparing different levels of intervention;<br>in most cases follow-up at 6 months only                                                                          | reduction of anxiety and depression; increase in productivity; reduction of sickness absence                                                                                                                                                                                                                                                                              | no clear conclusions regarding the effectiveness of the specific intervention levels; combination of individual-organizational and organizational level interventions tend to more improvements for employee health and business performance; individual-level in most cases only short-time benefit to the individual |
| Caulfield et al. (2004)    | EBSCO Host (1993 – 2003)<br>language: English                                          | 6 studies (exclusively from Australia)            | working population, professional groups: police officers, nursing staff, employees in public service | remains unclear                                                                             | individual level (5)<br>e.g. relaxation techniques, biofeedback<br>organizational-level interventions (1)<br>intervention level: I, 0                                                                                                               | voluntary participation reduces effectiveness of individual-level interventions;<br>only one study on organizational-level interventions;<br>mainly self-reports                                                                                                                                                                        | individual-level interventions do not lead to a clear reduction of work-related stress;<br><br>reduction of stress through changes in working conditions, job redesign and changing the organizational structure, besides, more employees benefit from the intervention                                                                                                   |                                                                                                                                                                                                                                                                                                                        |
| Jordan et al. (2003)       | PsycInfo, Medline (1990 – 2001)<br>language: English                                   | 74 studies                                        | working population                                                                                   | 47% without control group,<br>53% randomized-controlled or controlled without randomization | mainly individual-level interventions, completed by combination of both levels and a study on an organizational-level intervention<br>intervention level: I, I/0, 0                                                                                 | interventions only lead to a small and/or short-term benefit if the necessity and the need for the program are not analyzed before;<br>individual-level interventions have a short-term effect, in case of permanent offers more long-term effects; clear evidence for the necessity of inclusion of organizational-level interventions |                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                        |

| Authors                  | Data sources                                                                                                                                                                      | Number of Studies                                                  | Study Population   | Study design                                                           | Evaluated interventions                                                                                                                                                                                                                                                               | Methodological problems                                                                                                                                                                                                                                                                                                                                                                                                      | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Overall assessment                                                                                             |
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| LaMontagne et al. (2006) | Medline, ISI Web of Science (1990 – 2005)<br>language: English                                                                                                                    | 95 studies completed, extension and update of Jordan et al. (2003) | working population | various study design (ranging from qualitative case studies to RCT)    | individual-level interventions (e.g. teaching coping strategies, Employee Assistance Programs), individual-organizational level interventions (e.g. employee participation) and organizational-level interventions (e.g. reduction of work load)<br><br>intervention level: 1, 1/0, 0 | only limited description of the intervention (literature focused on the description of evaluation methods)                                                                                                                                                                                                                                                                                                                   | individual-focused interventions with little or no primary prevention (PP) → benefit to the individual;<br>individual-focused interventions with little or no PP → tend to have no positive influence on the organizational level;<br>organizational-focused interventions with mainly PP, completed by secondary prevention (SP) or tertiary prevention (TP) and interventions with PP only → positive influence on both levels;<br>I/O level → economic evaluation showed positive results                                                                                                                                                                                                                                                                | combination of individual- and organizational-focused interventions more effective for employees and employers |
| Seymour and Grove (2005) | PsychInfo, Nioshtic, Ciscodoc, Medline, Cinahl, Sociafile, ASSIA, IBSS, Cochrane, Business Source Premier, Emerald, Pub-Med, EMBASE (1980 to April 2004)<br><br>language: English | 31 papers                                                          | working population | experimental studies (19), non-experimental and narrative studies (12) | work-based interventions and those that affect employment<br><br>intervention level: 1, 1/0, 0                                                                                                                                                                                        | often poor methodological quality of the studies; selection bias; small sample sizes; often self-report; short intervention period; limited follow-up period; only limited information on the individual interventions; hardly any information to which degree results can be generalized (cultural characteristics, different professional groups, workplace conditions); few studies on organizational-level interventions | individuals and organizations benefit from stress intervention measures → “moderate evidence”;<br><br>individual interventions are less effective compared with comprehensive measures → “limited evidence”;<br><br>effectiveness of multimodal approach → “moderate evidence”;<br><br>organizational-focused interventions benefit to the individual → “limited evidence”;<br><br>individual-focused interventions are effective for employees at high risk → “strong evidence”;<br><br>effectiveness of physical activity programs → “limited evidence”;<br><br>effectiveness of cognitive-behavioral interventions for rehabilitation → “strong evidence”;<br><br>positive effects of cognitive-behavioral approaches on absenteeism → “strong evidence” |                                                                                                                |

Tab. A-3: Systematic reviews on the effectiveness of interventions to prevent musculoskeletal disorders

| Authors             | Data sources                                                                   | Number of Studies | Study Population          | Study design                                                                                                                              | Evaluated interventions                                                                       | Methodological problems                                                                                                                                                                             | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Overall assessment                                                                                                                                                                                                                                                             |
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| Karsh et al. (2001) | Psychlit, Engineering Index, Medline (until January 1999)<br>language: English | 101 studies       | employees at a work-place | experimental, quasi-experimental, observational with or without pre-post design, non-equivalent control groups or pre-experimental design | ergonomic interventions to reduce musculoskeletal disorders or to affect risk factors for MSD | lack of confound control, stratification, measurement of between group differences at baseline, but: experimental standard difficult to realize in field studies, other designs are also noteworthy | <p>8 studies on back belts: 50% were randomized, four studies found no evidence that belt affected e.g. back injuries, pain, lost work days, 2 studies had mixed results, 2 studies had positive results</p> <p>21 studies on ergonomic training: 7 studies were randomized, 5 studies found no effect on e.g. body mechanics, back injury rates, lifting on the job, 14 studies found mixed results</p> <p>10 studies on tools: all studies were non-randomized, 4 studies found positive results e.g. for incidence of back injuries, lost work days, severity rates, 5 studies found mixed results</p> <p>14 studies on physical exercise: 7 studies were randomized, 4 studies found positive results e.g. for lost work days, pain, back muscle strength, 6 studies had mixed results</p> <p>1 study on job redesign: only one of the four outcomes changed</p> <p>47 studies on multi-component programs: 2 studies were randomized, 19 studies found positive results on e.g. incidence rates of upper limb disorders, nursing practice, use of manual handling equipment, reduced back injury rates, 27 studies found mixed results, one found no improvements at all</p> <p>84% of all studies found some positive results, 50% of the back belt studies found at least some positive results, 67% of the training studies found some positive results, 90% of the tool studies found some positive results, 86% of the exercise studies had some positive results, 97% of the multi-component studies yielded some positive results, 32% of the studies used experimental or quasi-experimental designs</p> | The question whether ergonomic interventions to control MSDs are effective can be answered with a qualified "yes" if one chooses to examine only the most methodological rigorous studies, the effectiveness of back belts and training interventions would have to be doubted |

| Authors                      | Data sources                                                                                                    | Number of Studies                                                            | Study Population                                                                                         | Study design                                                                                                                   | Evaluated interventions                                                                                                                                                                                                     | Methodological problems                                                                                                                       | Reported effects                                                                                                                                                                                                                                                                                                                                   | Overall assessment                                                                                                                                                                                                                                                                                                                                  |
|------------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hess and Hecker (2003)       | Medline (1975-2001)                                                                                             | 3 studies                                                                    | working population, (firemen, industrial workers)                                                        | quasi-experimental, pre-post design without control group                                                                      | stretching programs for improving flexibility and reducing musculoskeletal disorders (MSD)                                                                                                                                  | poor study quality in 2 studies flexibility was not correlated to interesting outcomes (e.g. MSD incidence)                                   | programs lead to improved flexibility and increase in strength, 1 study found significant difference in injury-related time-loss costs                                                                                                                                                                                                             | in addition to flexibility, increase in strength might also be important, when shorter periods of sickness absence really are associated with stretching → possible approach for the reduction of long-term sickness absence                                                                                                                        |
| Silverstein and Clark (2004) | PubMed, OSH-ROM, EMBASE, Ergonomic Abstracts on Line, Social Science Index (1990-2003)                          | 17 reviews (1990-2003), 20 RCT and 17 quasi-experimental studies (1999-2003) | working population                                                                                       | systematic and narrative reviews, RCT, quasi-experiment                                                                        | all interventions that are applied for prevention of MSD                                                                                                                                                                    | in the individual studies: short follow-up periods, small sample sizes, high drop-out rates, no adjustment of potentially confounding factors | no summary of partial results given                                                                                                                                                                                                                                                                                                                | multimodal programs → most promising approach                                                                                                                                                                                                                                                                                                       |
| van der Molen et al. (2005)  | Medline, EMBASE, HSE-line, Nioshtic (1990-2003)                                                                 | 46 publications on 44 studies                                                | employees in professions with physical work demands due to manual handling at work, industry and nursing | experiment, quasi-experiment, laboratory and field studies, pre-post design, post design                                       | ergonomic measures for reducing physical strain and associated musculoskeletal disorders: technical, administrative, individual implementation strategies: informational, compulsory, educational, persuasive, facilitating |                                                                                                                                               | technical engineering controls reduce physical demands, causal connection with musculoskeletal disorders not proven without doubt, combination of technical auxiliary equipment with educational implementation strategies (e.g. training) and facilitating strategies (e.g. availability of the auxiliary equipment) recommended                  | reduction of physical demands and back pain by providing technical lifting devices, positive results when participative ergonomic approach is involved, educational or training program or both with direct involvement of the employees/target group is recommended                                                                                |
| Haiduven (2003)              | PubMed                                                                                                          | 9 reports                                                                    | health care workers                                                                                      | pilot studies, intervention studies, report on the results observed in one center of a multi-center study, program evaluations | lifting teams in health care facilities                                                                                                                                                                                     | none of the studies meets minimum methodological quality criteria                                                                             | Incidence rates/costs: reduction of absenteeism, saving of medical costs<br>Staff/patient satisfaction: high satisfaction in all studies<br>Lifting team performance: team absorbed 88-95% of all lifts that had to be performed, time from call to lift: 5-6 min., time to complete lift: 3.5 - 4 min.                                            | due to the lack of methodologically strict studies the effectiveness of lifting teams cannot be determined definitely, but it is a promising approach, recommendations: careful selection of the members, intensive training, supporting institutional policy (administrative requirements, nurses not allowed to perform transfer activities etc.) |
| Hignett (2003)               | Medline, AMED, Psycinfo, Ergonomics Abstracts, EMBASE, CINAHL, British Nursing Index, Best Evidence (1960-2001) | 63 studies                                                                   | health care workers                                                                                      | remains unclear (only information on percentage reached in the methodological quality ranking given)                           | Interventions to reduce MSD associated with handling patients, technique training based interventions, single factor interventions and multifactor interventions                                                            |                                                                                                                                               | technique training:<br>→ ineffective (strong evidence)<br>single factor interventions:<br>provision of auxiliary equipment<br>→ moderate evidence for effectiveness<br>Lifting Team<br>→ moderate evidence for effectiveness<br>multifactor interventions:<br>→ moderate evidence for effectiveness, more successful when based on risk assessment | programs based primarily on technical trainings are not effective, should better be replaced by alternative interventions (taken from the seven most frequently used interventions included in the suggested generic multifactor intervention program)                                                                                              |

| Authors                | Data sources                                                                                       | Number of Studies                                     | Study Population                                                                                                       | Study design                                       | Evaluated interventions                                                                                                                            | Methodological problems                                                                                                                                         | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Overall assessment                                                                                                                                                                                                                                                                                                                                                                                                             |
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| Bos et al. (2006)      | Medline, EMBASE, CINAHL, WebScience (1985-2005)                                                    | 13 studies                                            | health care workers                                                                                                    | RCT, CCT or CT<br>11 high-quality studies          | interventions for the primary prevention of musculoskeletal disorders in health care workers; training/exercise had to be part of the intervention | limitations of the studies concerning design, characteristics of random samples, outcomes, risk of recall bias is given on account of retrospective questioning | → strong evidence that interventions lead to less physical discomfort, improved patient transfer technique and reduced frequency lifts<br>→ inconsistent evidence that interventions reduce absenteeism due to MSD and musculoskeletal symptoms, fatigue, perceived physical strain and increase knowledge of risk factors and ergonomic principles<br>→ training/exercises in combination with ergonomic interventions proved potentially effective                                                                                                                                                                                                                                                       | training as single measure does not affect relevant outcomes such as MSD incidence<br><br>multifactor programs should be preferred                                                                                                                                                                                                                                                                                             |
| van Eerd et al. (2006) | Medline, EMBASE, CINAHL, Academic Source Premier (1990-2005),<br><br>Publication language: English | 31 studies identified, 28 included evidence synthesis | computer users, traditional office setting                                                                             | RCT, CCT, crossover design, 9 high-quality studies | interventions for the reduction of musculoskeletal symptoms in computer users                                                                      | participation rates too low, lack of adjustment of potential confounders, no documentation of group differences at baseline                                     | neck school, stress management training, new office, new office chairs, VDT glasses (only 1 study each):<br>→ "insufficient evidence" found<br><br>ergonomic trainings rest breaks, arm supports, alternative keyboards, screen filters:<br>→ "mixed evidence" found<br><br>workstation adjustment:<br>→ "moderate evidence" against preventive effect<br><br>alternative pointing devices:<br>→ "moderate evidence" for preventive benefit<br><br>ergonomic training + workstation adjustment, lighting + workstation adjustment + VDT glasses:<br>→ "insufficient evidence"<br>(only 1 study each, positive effects)<br><br>breaks + exercise:<br>→ "insufficient evidence"<br>(only 1 study, no effect) | "mixed evidence"; conclusions are very difficult on account of extremely heterogeneous interventions<br><br>recommendations concerning alternative pointing devices under reserve, since different mouse models were evaluated in part,<br><br>for several interventions already 2 high-quality studies could improve the evidence basis (in particular rest breaks, ergonomic trainings, alternative keyboards, arm supports) |
| Leonard-Dolack (2000)  | remains unclear                                                                                    | 6 reports                                             | employees at risk for work-related musculoskeletal disorders of the neck and upper limbs (cumulative trauma disorders) | pre-experimental, not randomized, controlled       | trainings for preventing cumulative trauma disorders                                                                                               | studies methodologically not reliable, no control groups, no statistical evaluations                                                                            | training should include active exercises, demonstration of the behavior to be learnt might be favorable,<br><br>exercise effects might depend on the type of tasks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | up to now no evidence for the effectiveness of educational measures for the prevention of cumulative trauma disorders                                                                                                                                                                                                                                                                                                          |

| Authors                                 | Data sources                                                                                                             | Number of Studies | Study Population   | Study design                                                                              | Evaluated interventions                                                                                                                                           | Methodological problems                                                                                  | Reported effects                                                                                                                                                                                                                                                                        | Overall assessment                                                                                                                                                                                   |
|-----------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------|--------------------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Linton and van Tulder (2001)            | Medline, PsycInfo Arblne (1967 – 1998)                                                                                   | 27 studies        | working population | 19 RCT, rest CT                                                                           | all interventions for the prevention of work-related neck and/or back pain (back schools/trainings, exercise programs, supporting belts, ergonomic interventions) | methodical quality not assessed because assessment has already been made in other reviews                | back schools/trainings, lumbar supporting belts: → “strong evidence” against a preventive effect<br>exercise/physical activity programs: → “strong evidence” for a preventive effect<br>ergonomic interventions: → no evidence since no relevant controlled studies could be identified | exercise programs seem to be the only suitable prevention                                                                                                                                            |
| Gatty et al. (2003)                     | CINAHL, EBSCO Online Citations, EBSCOhost, ERIC, Health Source: Nursing/Academic Edition, MDConsult, Medline (1995-2000) | 9 studies         | working population | RCT, CT, retrospective cohort study, pre- and post studies with and without control group | interventions were attributed to one of 3 categories: supporting belts training + task modification, training + task modification + workstation redesign          | -                                                                                                        | back belts: → not suitable, 75% of all results: no effect<br>comprehensive programs: → promising when tailored to the job tasks and the employee’s specific needs<br>→ trainings as element should be intensive, continuous and related to the job tasks                                | back belts not applicable as universal prevention instrument, tailored approaches recommended, e.g. workstation redesign and task modification, contents have to be related to job tasks in any case |
| van Poppe et al. (2004), update of 1997 | Medline, ERIC, EMBASE, PsycLitt (1997-2002)                                                                              | 16 studies        | working population | RCT, CT                                                                                   | lumbar supports, education, exercise programs                                                                                                                     | rather poor study quality, compliance problems, lack of blinding, inappropriate randomization procedures | lumbar supports: → “no evidence”<br>education: → “no evidence”<br>exercise programs: → “limited evidence” for preventive benefit, → magnitude of the effect was moderate, effect size of 0.53 for incidence                                                                             | disappointing evidence base, only exercise programs effective                                                                                                                                        |

| Authors               | Data sources                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Number of Studies                            | Study Population                                           | Study design                                                                                           | Evaluated interventions                                                                                                                                                                                                                                                                                                                                   | Methodological problems                                                                                                                                                                                                                                                        | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Overall assessment                                                                                                                                                                                 |
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| Lühmann et al. (2005) | Medline, EMBASE, AMED, BIOSIS, MEDIKAT, Serline, gms, Sozialmedizin, CAB Abstracts, ISTPB-HSTP/ISSHP, Derwent Biotechnology Resource, Elsevier BIOBASE, ETHMED, GLOBAL Health, Deutsches Ärzteblatt, EMBASE ALERT, ScSearch, AZO-Leitlinien, CoMed, Social Search, Karger publisher database, Kluwer publisher database, Springer publisher database, Springer publisher database PrePring, Thieme publisher database, Cochrane Library Online Version: CDSR, DARE, CENTRAL, Methodology Reviews, Methodology Register, HTA, NHS EED, About | 15 systematic reviews, 16 controlled studies | working population with or without back pain aged 18 to 65 | HTA reports, systematic reviews, evidence-based guidelines, RCT, controlled studies, economic analyses | interventions to prevent back pain at the workplace used for relapse prophylaxis and symptom progression: education (groups), brochures, cognitive-behavioral approaches etc.), physiotherapy („remedial gymnastics“), sports, risk factor interventions, ergonomic interventions, workplace-organizational interventions, orthoses and auxiliary devices | quality of the included studies varied remarkably, most frequent shortcomings are selection bias and lack of adjustment for potential confounders, studies on organizational-focused approaches were generally of poorer quality than studies on individual-focused approaches | <p><u>training/exercise programs:</u><br/>3 systematic reviews, 6 controlled studies, mainly positive results, effectiveness depending on regular, uninterrupted continuation of the programs, larger effects can be expected in high-risk groups, no reliable analyses on cost effectiveness</p> <p><u>education/information:</u><br/>4 systematic reviews, 3 controlled studies, educational interventions aiming at knowledge transfer, for instance on body mechanics or load handling, are not suitable for the prevention of back pain. inconsistent results for effect of traditional back schools on absenteeism, possibly short-term positive effects on the incidence of new episodes</p> <p><u>multi-component programs:</u><br/>1 system. review, 3 studies, training + information + behavior therapy possibly positive effects on absences in high-risk groups, back school programs in workplace environment + intensive training units effect regarding new episodes and absences (probably attributable to effect of training component)</p> <p><u>lumbar supports:</u><br/>5 systematic reviews, no positive effects found in healthy working population on episodes of back pain, absenteeism, incidence of days with complaints, no statement on undesirable effects, possibly positive effect in persons with preexisting back pain</p> <p><u>lifting teams:</u><br/>1 systematic review, no studies with reliable design, approach has potential to reduce the burden of back pain in health care workers, but careful analysis of context factors required before (work content, process, structures, interactions of health care workers and patients, infrastructure)</p> <p><u>ergonomic interventions:</u><br/>3 systematic reviews, distinction of organizational approaches, individual approaches and combined approaches, no reliable results on organizational approaches (workplace redesign, changes in work organization) due to a lack of studies, individual ergonomic approaches not effective, combined measures proved successful in high-risk groups if participative component was included, but there is considerable need for methodically sounder studies</p> | scientific evidence on the effectiveness of preventive interventions for back pain still warrants study, strong need for further development concerning intervention design and evaluation methods |

| Authors                  | Data sources                                                                                                                 | Number of Studies | Study Population                                                     | Study design                            | Evaluated interventions                                                                                                 | Methodological problems                                                                                                                          | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Overall assessment                                                                                                                   |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| Maher (2000)             | Medline, EMBASE, CINAHL, OSHROM, PEDro, PsycLit (up to January 1999), publication language: English                          | 13 studies        | workers in an industrial setting                                     | solely RCT                              | education, exercise programs, lumbar supports, workplace modification + education                                       | study quality considered as moderate                                                                                                             | Lumbar supports:<br>→ "strong evidence" against preventive effect on sick leave, prevalence and severity of back pain<br>education:<br>→ "moderate evidence" against a preventive effect on sick leave, severity and prevalence<br>→ "limited evidence" that back belts are ineffective in reducing costs<br>exercise/physical activity:<br>→ "limited evidence" for an effect on prevalence<br>→ "moderate evidence" for an effect on sick leave and severity of back pain<br>→ no evidence for cost effectiveness, since only 1 study identified<br>workplace modification + education:<br>→ no evidence for or against use, since only one study with statistical analysis found | activity programs are currently the only workplace intervention with proven efficacy                                                 |
| Ammendolia et al. (2002) | Medline, EMBASE, HealthStar (up to June 2002)                                                                                | 10 studies        | employees with physically demanding work, exposed to manual handling | 5 RCT, 2 CT, 2 cohort studies, 1 survey | back belts                                                                                                              | RCT: methodical shortcomings, no adjustment of potential confounders, no blinding, no intention-to-treat analyses, no adequate follow-up periods | RCT report no or only marginal reduction of the incidence of back pain, sub-group analyses suggest positive effect in persons with previous complaints, methodically poorer studies also found no and/or only partial positive effects                                                                                                                                                                                                                                                                                                                                                                                                                                              | based on present evidence, no recommendation can be made for or against the use of back belts; compliance problem has to be resolved |
| Tveito et al. (2004)     | Medline Advanced, PsycINFO, ISI base, Cochrane Controlled Trials Register (1980 to June 2002), publication language: English | 31 studies        | employees                                                            | controlled studies                      | back belts, educational interventions (mainly back schools) exercise, multi-component programs to prevent low back pain | inadequate randomization procedures, high drop-out rates, no blinded outcome assessment, no intention-to-treat analyses                          | lumbar supporting belts:<br>→ no evidence for effect on sick leave, costs, pain,<br>→ "limited evidence" that there is no effect on new episodes of pain<br>educational interventions:<br>→ "no evidence" for effect on sick leave, costs, pain<br>→ "limited evidence" for no effect on new episodes of pain<br>physical exercise programs:<br>→ "limited evidence" for an effect on sick leave, costs, new episodes<br>→ no evidence for an effect on pain intensity<br>multi-component programs:<br>→ "no evidence" for an effect on costs, new episodes<br>→ "limited evidence" for an effect on pain intensity<br>→ "limited evidence" that there is no effect on sick leave   | physical exercise programs and multifactor programs suitable for preventing low back pain                                            |

| Authors                  | Data sources                                                | Number of Studies | Study Population                                    | Study design                                                                             | Evaluated interventions                                                                                                                   | Methodological problems                                                                                                                                                                                                                        | Reported effects                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Overall assessment                                                                                                       |
|--------------------------|-------------------------------------------------------------|-------------------|-----------------------------------------------------|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| van Tulder et al. (2006) | Medline, CINAHL, Current Contents (until September 1999)    | 7 studies         | employees aged 18 to 65 years                       | 5 RCT, 2 CT                                                                              | back belts for the prevention of low back pain                                                                                            | only 2 studies met more than 50% of the methodical criteria<br>most common shortcomings:<br>insufficient randomization procedure,<br>no adjustment of co-interventions, compliance too low, no blinding of participants and outcome assessment | belt vs. no intervention<br>no influence on incidence and absenteeism, "moderate evidence" for no preventive effectiveness belt vs. other intervention (education, instruction):<br>→ no influence on incidence and absenteeism, "moderate evidence" that belt is not more effective than other interventions<br>belt plus other intervention vs. only other intervention:<br>→ no influence on incidence                                                                               | supporting aids not suitable for preventing low back pain as well as not more or less effective than other interventions |
| Lincoln et al. (2000)    | Medline, EMBASE, Nursing, Allied Health, NIOSHTIC, PsycINFO | 24 studies        | adults of working age and/or asymptomatic employees | RCT (laboratory + field), pre-post studies, controlled/not controlled, quasi-experiments | ergonomic interventions for the prevention of work-related carpal tunnel syndrome: engineering, administrative, personal, multi-component | too short follow-up periods (in particular in laboratory experiments), too small samples, no adjustment of potential confounders                                                                                                               | technical interventions:<br>→ incidence not recorded, inconsistent results<br>→ alternative keyboards and key pads had no influence on pain and/or fatigue<br>→ positive medium-term effects found for alternative mouse, wrist support for mouse pad, negative slope keyboard support<br>person-related interventions:<br>→ none of four studies proved positive effect<br>multi-component interventions:<br>→ several studies reported reduced incidence of musculoskeletal disorders | multi-component programs seem to be the best approach for reducing the risk of developing carpal tunnel syndrome         |



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