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Identification and prioritisation of relevant prevention issues for work-related musculoskeletal disorders (MSDs)

Work package 4

Prevention approaches:
evidence-based effects and prioritised national strategies in other countries

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Fachbereich D / Abt. Sicherheitstechnik
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This report summarizes the results of the fourth and final Work Package in the framework of the IPP-aMSE project, “Identification and prioritization of relevant prevention strategies for work-related musculoskeletal disorders (MSDs)”, commissioned by the German Social Accident Insurance (Deutsche Gesetzliche Unfallversicherung, DGUV).

Author: Dr. Martina Michaelis

Assisted by: Niko Karajannis

Project leader: Prof. Friedrich Hofmann

Bergische Universität Wuppertal
Lehrstuhl für Arbeitsphysiologie, Arbeitsmedizin und Infektionsschutz
(University of Wuppertal, Department of Applied Physiology, Occupational Medicine and Infectiology)
Gauss-Strasse 20, D-42097 Wuppertal, www.ariadne.uni-wuppertal.de

*Appendix 3 to Appendix 4.3 (no translation into English): If you are interested in the complete synopsis, please contact michaelis@ffas.de

1 Introduction

In the first section of Work Package 4 of the project “Identification and prioritisation of relevant prevention strategies for work-related musculoskeletal disorders” (WRMSDs; hereafter referred to as “MSDs”), an overview of available scientific evidence on the effectiveness of prevention strategies will be provided. To this end, reviews found by means of a literature search on international databases will first be evaluated (Chapter 3). In the second section, expert reports and several proceedings from recent congresses dealing exclusively with MSDs will be examined (Chapter 4). The aim is to compile a list of areas of prevention which, in the view of designated experts, should be prioritised. Chapter 5 contains comprehensive recommendations for the particular occupational categories, exposure groups and particular intervention strategies that should be focused upon, but also for reviewing gaps in current research.

Remarks about the definition and categorisation of MSDs

When dealing with the concept of musculoskeletal disorders, we are confronted with the following difficulties: on the one hand, the use of the concepts of musculoskeletal disorders, symptoms and complaints/pain is not consistent in the context of studies. What is referred to are either complaints, diseases or injuries affecting one of the components of the musculoskeletal system (e.g. the lumbar spine), or else “MSDs” designates several specific or unspecific areas. Thus, *Boocock et al*. [1] found 14 definitions of "specific conditions" with evidence-based diagnostic criteria and 34 "other specific conditions" with no clearly defined diagnosis, in their comprehensive investigation aimed at finding consensus in definitions of upper extremity disorders. This limits the comparability of studies. The following body regions will be examined by us:

- low back, neck
- upper extremities (elbow/elbow joint, forearm, hand/wrist, hand, finger) including shoulder/arm region and
- lower extremities (knee, ankle joint, foot, hip).

Remarks about the definition and categorisation of interventions

The intervention strategies are categorised in the classic sense into behavioral and environmental preventive health approaches in the framework of primary, secondary and tertiary prevention [2]:

1. *Primary prevention* (i.e. avoiding the occurrence of a disorder by reducing or avoiding risk factors),

2. *Secondary prevention* (i.e. early recognition of disorders and halting their progression) and

3. *Tertiary prevention* (i.e. rehabilitation of disorders already occurred and prevention of sequaelae or recurrence, including maintenance of fitness to work).

As environmental prevention strategies by means of ergonomic and organisational measures in the workplace can not be easily classified in the classic medical (person-related) prevention catalogue, *Nolting et al.* [3] suggest a further dimension of prevention: risk assessment, in their expert report for the BAuA (*German Federal Institute for Occupational Health and Safety*). This means the evaluation of work-related and individual exposure of employees, which takes place in the context of tasks set by the employer. It can take place on the one hand as a primary prevention measure, for example in the framework of pre-placement examinations and risk assessments of the workplace. From a secondary prevention perspective it means the continual occupational health surveillance of employees in high risk groups.

This theoretical differentiation can not be adhered to systematically, neither in practice nor in the analytical evaluation, particularly with regard to the prevention of *general* musculoskeletal symptoms. A behavioral preventive approach promoting health at work (e.g. fitness training to strengthen back muscles) can thus be offered for healthy workers without disorders, but also for those with back complaints, and its effects measured. The boundaries between secondary and tertiary prevention are also not clear-cut and usage of the terms is very inconsistent in the literature. This fact is also addressed by many review authors (e.g. [5]). Some authors put primary and secondary preventive interventions together in their assessment, whilst others put secondary and tertiary preventive interventions together. (For an overview of prevention strategies, see Chapter 3).

2 Material and methods

2.1 Methods used for part I: Successful interventions

The literature search on scientific knowledge of work-related preventive approaches is based mainly on the database MEDLINE[1]. Given the deficit in knowledge available of psychological and psychosocial risk factors for MSDs and their prevention, we extended the search to the PSYCINFO database. We believe that this is sufficient, given the wealth of scientific publications on the topic being treated (for documentation of search strategies, see Appendix 1).

Inclusion and exclusion criterias

Only recent, peer-reviewed systematic reviews, meta-analysis studies and systematic reports (meta-reviews, analysing reviews and single publications) were used. These included only one German language publication [15]. These reports were treated like “normal” reviews, but were appropriately distinguished. In addition, important gray literature from the Internet in the form of systematic reviews from the European *Occupational Safety and Health Administration* (OSHA) and the *National Work and Health Institute* in Canada were integrated into our overview. Three German, non peer-reviewed expert reports [3], [6], [7] were not integrated, but their findings were taken into account. Book publications and individual studies were not included. Further criteria for exclusion were publications in languages other than English and German as well as the interventions taking place in countries where the circumstances of work and sickness are not comparable with the environment over here (Asia, Africa). In view of the wealth of material and of improvements in quality in recent years, as well as the importance of keeping the findings up-to-date, the publication period was restricted retrospectively to the year 2000. The compilation of material was completed in early summer 2009. Primary and secondary preventive MSD

[1] MEDLINE also contains publications from the Cochrane Collaboration which gather systematic overviews on the topic of MSDs.

interventions had to have taken place in a workplace setting. Tertiary preventive approaches were taken into account where a relation was established between clinical sickness rehabilitation and the workplace.

To reduce the complexity of the material, we also concentrated on reviews which did not just focus on single occupations (e.g. only nursing). This seemed justifiable, as such setting-related publications have already been assessed in reviews compiled by us.

In the publications on the topic of primary prevention (Chapter 3.1) we determined that many reviews have a large common overlap of evaluated studies; redundancies due to repetition or an overestimation of findings must therefore be taken into account. In the field of tertiary prevention we learned from this and avoided working on redundant findings (Chapter 3.3) and instead cite a representative OSHA review in order to present the current – consistent – state of research. Due to a lack of reviews and peer-reviewed publications that focus on aspects of occupational medicine, we also examined the following sources for information on secondary preventive strategies in the workplace, and also for the second part of the Work Package:

– the OSH research database in Germany of the *Federal Ministry of Labour and Social Affairs*[2] and

– the research database[3], links to partner institutions[4] and congress proceedings[5] on the website of the *German Social Accident Insurance* (DGUV).

However, the search was not successful (which may also be because risk assessment is a preliminary for subsequent interventions rather than an individual measure).

Remarks on the evidence-based approach used in systematic reviews

[2] www.arbeitsschutz-forschung.de; research strategy: MSD AND “all sectors” AND (health and safety management OR risk assessment OR preventive occupational medicine).

[3] www.dguv.de/bgia/de, research strategy: term “muscle”.

[4] www.dguv.de, research strategy: block=”*musculoskeletal disorders“.* Relevant partner institutes: *Safe Work Australia* (www.safeworkaustralia.gov.au) and *Health and Safety Executive*, Great Britain (HSE, www.hse.gov.uk*)*.

[5] Congress proceedings “Arbeitsmedizinisches Kolloquium“**,** 13 March 2008, Hamburg, www.dguv.de/inhalt/praevention/aktionen/arbeitsmed_kolloquium/index.jsp

The assessment of studies in new systematic reviews is based on the model of evidence-based medicine. Therefore, a health-related intervention should in principle be supported by studies of the best possible methodical quality. Randomised controlled trials (RCTs) are the methodological “gold standard”, as they have the lowest probability of systematic errors. The assignment of participants to the intervention or control group takes place randomly – unlike in controlled trials without randomisation (CTs). After such randomisation, the same structures with regard to intervening disruptive factors are expected. Despite criticisms regarding the transferability of the concept of evidence-based medicine onto complex occupational prevention [8], controlled studies are overwhelmingly seen as more conclusive than non-controlled studies. In most reviews (e.g. [5], [9], [10], [11], [12]), the four-tier hierarchy of evidence applied by the *Cochrane Collaborative Back Review Group* is used as a “best evidence synthesis approach” [13]:

1. *strong* evidence: several, high-quality RCTs with consistent findings;
2. *moderate* evidence: consistent findings from at least one high-quality RCT and one or several lower quality RCTs;
3. *limited* evidence: only one RCT of lower methodological quality or consistent findings from several RCTs of lower quality or CTs*;*
4. *no evidence*: only one RCT of lower quality, negative or contradictory findings or no relevant studies.

This classification has now been revised to become a five-tier hierarchy of evidence, including a further category

5. *inconclusive/ inconsistent/ conflicting evidence:* several studies with inconsistent findings [14]:
6. This categorisation is used by the most recent authors). [6]

[6] The *Institute of Work and Health in Canada* uses other, similarly hierarchical evaluation criteria as a basis [e.g. #40]: 1. Strong evidence: minimum quality high (>85% criteria met), minimum quantity ≥ 3 studies, all high quality studies converge on the same findings. 2. Moderate evidence: minimum qual medium (50-85% crit. met), minimum quantity ≥ 2 studies, majority of medium quality studies

Data extraction and publication quality assessment

The publications found in the database research were examined by a reviewer, or by two reviewers in cases of doubt, and the excerpts extracted using a standardised data extraction sheet and transferred to a tabular synopsis (Appendix 4). A structured evaluation of the quality of the publications was carried out using AMSTAR [17], an instrument developed specially for reviews. It includes aspects of transparency in the publication and observance of methodological hallmarks of quality. The AMSTAR evaluation was encoded and the data processed in the form of “quality mean values”. (On items and mean values see Appendix 2).

2.2 Methods used for part II (Experts’ recommendations for work-related prevention strategies)

For the second part of this Work Package on the evaluation of priority prevention strategies from the perspective of national and international experts, a search of relevant publications in MEDLINE was carried out and three publications examined [18], [19], [20]. (For search strategy see Appendix 1). Furthermore, the following sources were determined and their findings compiled:

a) Two German expert reports from 2007 [3], [6], commissioned by the BAuA on innovative prevention approaches for the reduction of MSDs (Chapter 4.1).

b) Internet paper on action goals of the eight Sector Councils for the *National Occupational Research Agenda* (NORA) located at the *National Institute for Occupational Safety and Health* (NIOSH) in the USA, and on the Australian government’s

converge on the same findings 3. Mixed evidence: minimum qual. medium (50-85% crit. met), minimum quantity ≥ 2 studies, medium and better quality studies have inconsistent findings. 4. Partial evidence: minimum qual. low (0-50% crit. met), minimum quantity ≥ 2 studies, majority of low quality studies converge on the same findings and 5. Insufficient evidence = all criteria not met.

National Occupational Health and Safety (OHS) Strategy 2002-2012 (Chapter 4.2).

c) Proceedings of the following conferences held recently, which dealt exclusively with our topic (Chapter 4.3): *European Foundation for the Improvement of Living and Working Conditions* 2007 (“Musculoskeletal disorders and organisational change”), *PREMUS* 2007 (“Prevention of Work-Related Musculoskeletal Disorders”), and the *Annapolis Conference* of the Current State of Research on Work-related Upper Extremity Disorders 2005), and two events in the framework of the *European Week 2007*, organised by the European *Agency for Safety and Health at Work*, OSHA.

3 Intervention strategies: evidence-based results

The findings on the evidence of successful intervention strategies on avoiding musculoskeletal disorders (MSDs) will be reported separately for the three areas, primary, secondary and tertiary prevention. The intervention type “risk assessment” will be subsumed in Chapter 3.1 in the context of primary prevention. The separate Chapter 3.2 deals with this intervention type in relation to secondary prevention. Table 3.1 provides an overview of types, ways and content of intervention for every sector as they are understood by this report.

Table 3.1
MSD-prevention sectors, intervention types and workplace-related measures (modified model following *Nolting et al.* [3])

Type of intervention	Measures
Primary prevention	
Exercises	Sport and fitness programs to strengthen physical health/ fitness, muscle strength/flexibility at work
Education on risk-reducing working techniques	Training (e.g. back/ neck school), dissemination of written information (brochures), training/ guidance/ instruction on physical and work techniques to reduce strain
Adaption of workplace using ergonomic work equipment and tools and ergonomic workplace design	Provision of strain-reducing work equipment (e.g. chairs, keyboards) and technical tools to reduce strain (e.g. lifting or standing aids, lumbar supports, arm or hand rails, knee protectors etc.)
Optimisation of work organisation, organisational development	Improvement of work processes (e.g. change staffing levels, work cycle frequencies, breaks), of work tasks (e.g. job enrichment/ job enlargement, job rotation, increase scope for action). Organisational development with regard to health and safety (e.g. improvement of leadership skills of superiors, development of team spirit, participative work(place) design, health panel/ occupation-specific expert body (“task force”)
Expert-supported identification of workplaces and activities with increased MSD exposure	Risk assessment of the workplace, MSD risk register to guide work(place) modification and optimisation
Individual-specific occupational health evaluation (pre-placement assessment)	Assessment of the MSD risk to employees for the adaption of requirements and effort generally (before the job is taken up)
Secondary prevention	
Identification and health monitoring of persons at risk	Recognition of “red and yellow flags” (potentially serious physical or psychological/psychosocial risk factors for the chronification of MSDs). Targeted occupational health preventive check-ups of employees with pre-existing conditions/ earlier disorders or exposures with regard to particular risks in the place of work
Analysis of MSD cases at work supported by experts	Systematic check-ups of employees with existing disorders by health and safety experts (e.g. repetition/ up-date of risk assessment), analysis of company accident data
Tertiary prevention	
Return-to-work programs (reintegration return to work in subacute and chronic cases of MSDs) after absence from work	Multifactor and interdisciplinary measures for modification of the work process or workplace, (“work conditioning”), individual training (“work hardening” etc) and psychomental education (cognitive behavioural therapy, modification of pain behaviour and cognition), combination of setting in rehabilitation clinic and at work

3.1 Primary prevention

A total of 21 publications dating from 2000 to 2008 were evaluated for the area of "primary prevention" (15 systematic reviews [5], [9] [10], [11], [16], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], four reports [12][15][31][32]) and two meta-analysis studies [33], [34]). The relevant body localisation of MSDs is addressed here in various ways and combinations. [7] The focus on certain types of intervention is divided as follows:

- 9 reviews, all types of intervention (8 reviews, 1 meta-analysis),
- 8 reviews, only one or two types of intervention (7 reviews, 1 meta-analysis: 3 ergonomics and training, 1 participatory ergonomics, 2 lumbar supports, and 2 exercises/ fitness training n=2), and
- 4 reports, all types of intervention.

[7] Number of publications addressing specific body localisation of MSDs: 10 low back pain (0 neck pain), 3 unspecific MSDs, 3 specific MSDs (low back and neck pain), 2 specific MSDs (low back and neck pain and upper limb disorders), 2 upper limb disorders/neck pain, 1 carpal tunnel syndrome.

Table 3.2
Structural details of primary prevention reviews, meta-analysis studies and reports

Legend
(1) **Review type**: MA= meta-analysis, sR= systematis review, nsR= non-systematic review, REP= report, TR= technical report
(2) **Country**: AUS= Australia, CAN= Canada, G= Germany, EU= Europe, FI= Finland, GB= Great Britain, N= Norway, NL= Netherlands, S= Sweden
(3) **Publication type**: p-r=peer-reviewed, gL= grey literature, CLr= Cochrane Library review
(4) MSD-specification/body localisation: CTS= carpal tunnel syndrome, MSDs=musculoskeletal diseases/symptoms/complaints, no details, LBP= low back, LEP= lower extremity, NP= neck pain, UEP= upper extremity, RSI= repetitive strain injury
(5) **Period of included studies**: w-L= without limit
(6) **Prevention sector(s)**: a= primary, b= secondary (treatment), c= tertiary prevention
(7) **Intervention type**: 1 exercises (fitness training), 2 education (training, back schools, brochures), 3 ergonomics (body/posture techniques, work(place) modification, technical tools), 4 protective equipment (lumbar supports (LS) , hand wrists (HW), lifting aids (LA)), 5 organisational developments (work organisations (WO), implementation strategies (IS), health & safety culture (HSC), lifting team (LT))

Internal ID #	Authors/year	Review type (1)	County (2)	Publ. type (3)	MSD- spec. (4)	Period (5)	Prevention sector(s) (6)	1 Exercises (7)	2 Education (7)	3 Ergonomics (7)	4 Protect. equipm. (7)	5 Organisat. Dev. (7)
26	Martocchio et al. [34]	MA	USA	p-r	LPB	1977-1999	a,b	*	*	-	-	-
02	Linton & v. Tulder [5]	sR	S	p-r	LPB, NP	1967-1998	a	*	*	-	LS	-
11	Maher et al. [11]	sR	AUS	p-r	LBP	1989-1998	a	*	*	*	LS	-
33	Lincoln et al. [33]	sR	USA	p-r	CTS	1985-1999	a	*	*	*	HW	-
19	Karsh et al. [22]	sR	USA, CAN	p-r	MSDs	1979-1998	a	*	*	*	LS, LA	WO
27	Verhagen et al. [23]	sR	NL	CLr	NP, UEP	1976-2004	a,b	*	*	*	HW	-
40	Amick et al. [24]	sR	CAN	gL	UEP	1991-2008	a	*	*	*	LS	-
06	Tveito et al.[10]	sR	N	p-r	LBP	1980-2002	a,b,c	*	*	-	LS	-
05	van Poppel et al. [9]	sR	NL	p-r	LBP	1990-2001	a	-	*	*	-	-
52	Martimo et al. [25]	sR	FI, NL, CAN	CLr	LBP	1999-2005	a	-	*	*	LA	-
09	Martimo et al. [33]	MA	FI, NL, CAN	p-r	LBP	1981-2005	a	*	*	*	LA	WO, IS
46	v.d. Molen et al. [26]	sR	NL	p-r	MSDs	1990-2002	a	-	*	*	-	WO, IS
36	Cole et al. [27]	sR	CAN	gL	MSDs	1993-2002	a	*	-	-	-	-
34	Proper et al. [16]	sR	NL	p-r	LBP, NP	1980-2000	a	*	-	-	-	-
51	Hess & Hecker [28]	sR	USA	p-r	LBP	1990-1998	a	-	-	-	LS	-
10	Ammendolia et al. [29]	sR	CAN	gL	LBP	w-L-2002	a	-	-	-	LS	-
16	v. Duijvenbode et al. [30]	sR	NL	CLr	LBP	1975-2007	a,b	*	*	-	LS	HSC
39	Waddell & Burton [12]	rep	GB	p-r	LBP	w-L-1999	a,b,c	*	*	*	LS	LT
15	Luehmann et al. [15]	rep	G	gL	LBP	1992-2004	a	*	*	*	LS	WO, HSC
49	Silverstein et al. [32]	rep	USA	p-r	LBP, NP, LEP	1990-2003	a,b,c	*	*	*	LS	WO
23	OSHA Prev. Rep. [31]	rep	EU	gL	LBP, NP, UEP, LEP	2000-2006	a	*	*	-	-	-

The quality of the publications evaluated is good, according to the AMSTAR checklist (see Chapter 2.1) – the standardised quality mean value is of 0.73 ± 0.12 (range from 0.50 to 0.91, see Appendix 2). A short summary of the most important findings of all publications considered can be found in Appendix 3; the detailed information is given in the synoptic overview in Appendix 4. On the basis of a “best evidence synthesis approach”, the majority of authors consistently come to the conclusions summarised below.

3.1.1 Behavioural prevention programs

a) Exercises

In almost all research work, there is clear evidence (strong to moderate according to review) pointing to the effectiveness of – intensive – physical exercise programs (particularly with elements of muscle strengthening) on the reduction of low back pain prevalence and incidence rates, and related sick leave [9], [10], [11], [15], [16], [21], [22], [31], [32], [34]. Approaches based on stretching to increase flexibility of the musculoskeletal system do, however, require further validation of its effects on MSD outcomes [16]. With regard to neck symptoms and those of the upper extremities, there is a further need for research, in order to achieve similarly clear positive findings compared to low back pain (contradictory evidence in [23] and no effect with regard to carpal tunnel syndrome in [21]).

The heterogeneity of interventions limits an assessment of the effectiveness of individual structural program elements (content, duration and intensity of the exercise). Most successful programs last for between 3 months and 1.5 years; it therefore seems to be important for effectiveness that there is physical activity which is sustainable in the long-term, leading to a lasting lifestyle change [9], [15]. In general, the lack of cost-benefit evaluations is criticised.

b) Education

- *Instruction:* The review authors reject the notion that there is a primary preventive effect of single educative measures i.e. classic back or neck schools on MSDs [5], [9], [10], [12], [34] , but also of stress prevention programs [24]. As even in studies of a minimal acceptable methodological quality there were in general no statistical

effects, there is moderate to strong evidence for this result. The same was found of other methods of knowledge transfer, e.g. brochures etc. [5]. In back schools with active exercise sessions and a relation to the workplace, *Luehmann et al.* [15] discuss the – at least short-term – reduction of instances of recurring low back pain episodes, particularly for those with chronic disorders.

– *Training*: Singular measures to encourage ergonomic ways of working and handling techniques are also characterised by strong evidence for a lack of effect in terms of prevention on lower back pain [10], [21], [31]. This is independent of the occupational groups studied (dominantly health care workers and such in the production industry). The lack of effects also exists in occupational settings in which measures concentrate on neck or upper extremities (computer users).

  The *OSHA Prevention Report* [31] summarises that ergonomic training can reduce back pain. *Cole et al.* [27] also find that training programs carried out participatively, have slight positive effects on MSD injuries (limited evidence). In the review by *van der Molen* [26] only a limited number of studies that considered MSDs as an outcome could be included. But clear evidence exists for the reduction of the biomechanical work load in combined interventions with technical equipment. The authors of two Cochrane publications, one of which applies meta-analytical methods, come to the conclusion, however, that neither ergonomic training alone, nor when combined with the provision of technical aids, is effective [25], [33]. They, but also other authors, discuss possible, non-evaluated compliance deficits, habits and behavioral patterns of test subjects that are difficult to change, as well as difficulties of implementation in the workplace as possible causes for the lack of effects.

– *Modification of individual risk factors (overweight):* Only a small number of reviews tackle this subject. *Linton and Tulder* [5] terminated their according evaluation due to a lack of RCT/CT studies. *Silverstein et al.* [32] also found only limited evidence that individual risk factor modification has any effect. There is a clear need for research in this area.

3.1.2 Ergonomic interventions at the workplace

The effectiveness of ergonomic adaption of the workplace as a single intervention has been less well investigated than behavioral approaches. The majority of controlled investigations found were related to the computer user occupational group and the reduction of disorders of the upper extremities (e.g. alternative keyboards and pointing devices, work environment). Based on the often low quality and heterogeneous nature of intervention and study approaches, there is contradictory/mixed to limited evidence of positive effects [23]. *Amick et al.* also summarised mixed evidence for a lack of effectiveness on the basis of 23 studies, including 14 RCTs of high quality, in their actual review in 2008 [24]. Effects are observed most clearly, if at all, where the adaption of the workplace is linked to an integrated concept of prevention. The findings of studies which do not comply with the strict requirements for a randomised controlled design provide much clearer indications of positive effects on MSD related outcomes [32]. A publication bias resulting in an over-representation of positive findings from studies must, however, be considered in this case. Authors of studies with appropriate outcome measurement can generally provide strong evidence pointing to a reduction in exposure or disorders thanks to technical or ergonomic interventions, even if simultaneous effects on MSDs are not often empirically identifiable [15], [31]. The conclusion that a reduced workload will lead to a sustainable reduction of MSD symptoms appears plausible in any case. To date, there has been a deficit in RCTs with ergonomics-related programs. This is also plausible, as a randomisation is much more difficult to carry out in real working conditions than a behavioral prevention approach. For the individual measures, the following outcomes can be summarised:

- *Tools/ engineering measures:* Workplace improvements with tools seem to have definite effects on the reduction of MSD outcomes and exposures, if we also consider a large number of studies that do not apply evidence-based evaluation methods (experimental and non-controlled studies, including gray literature). This is only the case in two of the works assessed here [22], [32].
- *Lumbar supports:* Back belts are very well evaluated, but there is strong evidence for a lack of primary preventive effects [5], [10], [11], [12], [29], [30], [31]. Several working groups indicate the comparatively high lack of compliance in wearing the belt as a possible reason for this. In the review by *Karsh et al.* [22], positive ef-

fects were once again noted in half of the eight assessed studies (4 RCTs). There are indications of secondary preventive effects in chronic low back pain; for recommendations in this area to be possible, however, further and high-quality studies are needed [29].

- *Wrist splints:* Studies available are insufficient for a definitive assessment of the extent to which chronification of disorders of the upper extremities can be prevented by using splints; to date, an effect on MSDs is not indicated [21], [23].
- *Technical equipment:* Mechanical aids for the reduction of biomechanical disorders have been mainly investigated for the care professions as well as some industrial occupations. Available studies can only provide a limited evaluation, as technical aids are not often analysed as individual measures. *Van der Molen et al.* [26] found that in seven out of eight studies – which were, however, almost exclusively not randomised – there was a reduction in physical effort required, although seldom a reduction of MSD symptoms. *Sockoll et al.* [7] indicate possible effects in their expert report. *Hignett* [35] report moderate evidence of a preventive effect of hoists during patient transfers. (Both reviews not included in our synopsis as the publication was not peer-reviewed or occupation-specific). Combined with appropriate training strategies, they are cited as effective by the authors of the *OSHA Prevention Report* [31]. The Cochrane working group of *Martimo et al*. [25], [33], on the other hand, found no sufficient effects with their analytical methods – perhaps due to one limitation discussed by the authors themselves, namely that limited effects on MSDs could not be substantiated due to the rigorous selection criteria of Cochrane Reviews and meta-analyses (see also Chapter 3.1.1). Overall, the assessment appears inconclusive. Above all, intervening variables should be controlled and intermediate effects on biomechanical loads should be considered more closely.

3.1.3 Interventions at the organisational level

- *Work organisation*: Information on evidence of interventions aimed primarily at achieving structural and organisational changes in work practices or tasks, is scarce. In the review of *Karsh et al.* [22], a study on changing work tasks was analysed. The *OSHA Prevention Report* reports on the effects of a reduction of

daily working hours on neck and back pain symptom rates in the case of physically demanding work tasks [31]. When additional breaks were taken during repetitive (computer) work, no effects were noted [32].

– *Participatory approaches*: Evidence available on the effectiveness of participatory approaches tends to be positive [7], [31]. However, these approaches do not constitute a separate measure but rather a component of programs focusing mainly on ergonomic changes in the work environment. The working group in the *Cole et al*. [27] review found limited (due to the insufficient number of studies available), yet powerful effects on MSD symptoms, sick leave rates and injuries. In the review by *Karsh et al. [22]* – although less systematic and less rigorous – the advantage of participatory elements in interventions was already emphasised on the basis of much older studies.

3.1.4 Risk assessment

With the database search strategy selected for this project, no systematic reviews were found whose authors *explicitly d*eal with the topic of systematic risk assessment of workplaces or employees as a cornerstone of primary prevention. Many of the reviews on primary prevention considered, however, point out the important role of such assessments (e.g. [5], [32]). Even the author of a review on care professions, which was not taken into account in our evaluation strategy due to its specific focus on one profession, underlines the additional impact of risk assessment tools to indentify prevention priorities [35].

With regard to the importance of pre-placement assessment (more established in the USA than in Germany) for the application of workers' health capability for highly demanding jobs, we analysed some additional publications. The authors rate the assessment to be mostly effective for lowering rates of injuries and worker compensation claims as well as related costs (e.g., [36], [37], [38]). On the other hand, *Waddell et al*. [12] found as result of a systematic review that there is

- limited and contradictory evidence from four studies that attempting to match physical capability to job demands may reduce future low back pain and work loss, and
- strong evidence that back-function testing machines have no predictive value for future low back pain or disability.

The screening programs mentioned can partly result in withdrawal of the employment offer (e.g. in the study of Littleton [39]). Pre-placement asessment in the USA is now only allowed in the form of so-called “post-offer screening”. The law requires that the examination has to be applied consistently to all applicants, if carried out. They must be offered the job, prior to testing, on condition that they meet the physical requirements of the job [40]. Criticisms of the ethical and legal limitations of the procedure have been voiced for twenty years [41], [42]. In Germany, pre-placement screenings to judge the suitability of candidates is not used due to ethical values [43]. Exceptions to this are legally mandatory screenings for fitness to work in certain professions (e.g. commercial drivers, pilots, people working in pressurised atmospheric conditions etc.). For all other jobs, pre-placement assessment for job applicants is voluntary. Extensive standardised databases with the results of pre-placement assessment are discussed as a basis for individual advice and preventive measures focused on a clearly defined target group with health risk behavior [44], [45].

3.1.5 Multi-component intervention strategies

Because of the low number of high-quality studies, only limited to moderate evidence of the effectiveness of multi-component programs has been produced to date. However, all authors point to the high significance of holistic programs in the workplace, which clearly have a greater effect on MSD outcomes in comparison with single measures. They coincide that the strongest evidence is seen in the case of continuous programs that include behavioral, technical/ergonomic and organisational elements (the latter being essential to success). These key elements of successful combined approaches are also confirmed by case studies [31]. However, to date there is insufficient knowledge about the specific contribution of each intervention component to the successful outcomes achieved.

3.1.6 Conclusions and recommendations

In conclusion, currently available evidence-based research on workplace-related programs for primary prevention of musculoskeletal disorders and complaints points to the benefits of intensive exercises as being most often proven. Other single measures – particularly educative strategies unrelated to the workplace and lumbar supports – are also equally well-researched, but are seen as ineffective in the case of unspecific complaints. Holistic approaches with a work-organisational, ergonomic, preventive company culture and individual behavioral elements are seen as highly promising, although still not sufficiently researched as to the sensitivity of their individual components. Again, comparatively stronger effects can be achieved with high-risk groups where these groups are displaying the initial signs of strain injuries and their occupational future is to be secured with these strategies. Furthermore, the evidence related to measures belonging to the situational prevention sector, such as changes in work organisation and ergonomic improvement of the workplace has not yet been sufficiently explored. Tools/ technical aids for the reduction of biomechanical or work posture load indicate predominantly positive effects on physical strain – independently of the quality of the study and therefore measured as outcomes. A direct relation with the reduction of MSDs can, however, not often can be elicited from an empirical point of view. Researchers who criticise the evidence-based approach and also integrate gray literature come to more positive results than those of systematic reviews. However, the results can not be reproduced [22], [32]. In the continuation of this paper, the findings will be discussed from a methodological point of view, in order to achieve a realistic evaluation of primary preventive efforts. Thereafter the current and future research needs in the opinion of the review authors will be summarised.

3.1.6.1 Methodological limitations of reviews and studies

The methodological quality of the latest reviews and reports is satisfactory to good, as our evaluation of the reviews considered with the AMSTAR tool makes clear (see Appendix 2). The quality of the studies evaluated in the systematic reviews has certainly shown a clear improvement in the past ten years. However, with regard to de-

sign and content, the studies are still extremely heterogeneous in almost all intervention areas. Furthermore, the number of high-value studies is still too low for evidence-based assessment in most areas. This is also criticised by all authors in the most recent publications. The methodological deficit of the studies is systematically characterised as follows:

- sample sizes too small,
- too few “true“ concurrent control groups (without any intervention),
- lack of or missing control of confounders while measuring the outcomes pain/ complaints in not randomised or not controlled studies, especially in the case of unspecific low back pain, (e.g. individual/ extraprofessional risk factors, work load, and hazardous postures),
- unclear or missing information on the influence of context variables like organisational culture or barriers to application at process level (low compliance/adherence of study participants, competing interventions), particularly obvious in the case of lumbar supports,
- duration of follow-ups too short for effects on outcomes where changes only become noticeable after a relatively long time,
- inconsistent and unclear survey methods and descriptions of MSD outcomes, but also of intermediate outcomes (such as real exposure to work load), and “soft factors“, such as attitudes, behavioral changes, improvements in production and organisational culture.

Considered critically, a lack of evidence of positive effects does not mean that such effects do not exist in reality. If we look at the current state of research from the point of view of modern, evidence-based evaluation methods, the lacking/insufficient, but also moderate evidence can be attributed to the poor to medium quality of many of the availiabe studies. The evidence-based evaluation approach comes from clinical therapy research, where symptoms of disorders dealt with are often serious, and effects can be more clearly attributed than in the case of multi-causal and diverse musculoskeletal symptoms. The gold standard of randomised controlled participant groups, which is also required for studies in the field of occupational health and safety, is often not applicable in an occupational setting. On the other hand, degrees of success in the practical rollout of a measure in the workplace or participant compliance are often being underestimated. Indeed, this orientation towards evaluation

methods based in medicine is increasingly also being seen as problematic on the theoretical level [46].

3.1.6.2 Recommendations for further research – researchers' point of view

a) Research methods and contents

- *Modified study evaluation*: Critical researchers recommend the addition of at least the following procedural methods, in view of the problems described and in order to achieve an increase in sensitivity:
  a) The inclusion of (further) experimental laboratory studies to investigate the relationship of exposure to disorder as a basis for the optimum design of a preventive work environment.
  b) Carrying out (further) pilot studies in pre-post design with subsequent review of the most promising approaches in controlled studies [24], [32].
  c) The comprehensive inclusion of gray and also non-English language literature [22].
- *Publications***:** Generally improved documentation of the aspects named hereafter.
- *Potential confounders:* Improved control of their influence.
- *Participation und compliance*: Development, examination and documentation of strategies for improvement.
- *MSD-related outcomes*: Standardisation, with systematic inclusion of behavioral and exposure-relevant factors.
- *Cost-benefit ratio*: There is a general lack of sound and consistent economic evaluations of primary preventive measures. Although in various studies there is evidence of financial savings, authors who concern themselves more intensively with this subject almost never find economic analyses that satisfy formal criteria (e.g. [15]). Even *Tompa et al.* [47], who concentrated exclusively on an economic evaluation of workplace-related MSD interventions, came to this same disappointing conclusion. Along with the demand for economic evaluations as an integral part of workplace-based intervention studies, case studies are – particularly as a means of communication to company players – a complementary method. (See *OSHA Prevention Report [31]* or *HSE Research Report* No. 491 [48]).

b) Prevention measures

- *Situational prevention sector***:** More and higher quality studies (technical, ergonomic, organisational sectors).
- *Multi-component strategies*: More and higher quality studies as well as sensitivity analyses of individual intervention components.
- *Risk assessments:* Generally more studies on more systematic and precise risk assessments of exposure factors in the workplace [5], [32].

c) Target-group orientation

- *Target occupational groups:* Interventions focus on some occupations particularly often (nurses, certain industrial sectors, other workers involved in manual handling such as mail/luggage carriers, construction workers with regard to lumbar complaints and diseases, office workers and computer users with regard to symptoms of the neck and the upper extremities). Proposals for action aim, for example, at the intensification of workplace re-design in industries other than office work.
- *Chronicity of MSDs:* The disorder status of the target groups should be addressed more precisely for interventions and differentiated more clearly in evaluative studies (healthy versus differing grades of chronification of MSDs [15].
- *Localisation of MSDs*: The use of the unspecific and poor defined concept “musculoskeletal disorder” is often criticised in single studies (and often continually used as such by some review authors). On closer inspection, working groups record an immense flood of prevention studies on low back pain and a comparative lack of studies addressing other regions of the body. This is true of neck and even more so for shoulder or shoulder-arm syndrome as a precision of “upper extremities”, while carpal tunnel syndrome is relatively often recognised as a definite goal for prevention. *Amick et al.* postulate studies on acute traumatic upper extremity injuries [24]. There appears to be a huge lack of preventive studies that address MSDs of the lower limbs (the authors of the O*SHA Prevention Report* 2008 [31] found only one study, related to shoe orthoses).

3.2 Secondary/tertiary prevention

Chronification of acute complaints of the musculoskeletal system poses a huge problem in the surveillance and management of musculoskeletal disorders. The following measures for prevention-related interventions will be discussed in this Chapter:

1. Secondary preventive screening approaches with a focus on tasks for the occupational health service related to preventing workers with elevated risk from chronification of MSDs before greater rates of work loss occur [49]. (For risk assessment by work safety management see Chapter 3.1, addressing primary prevention issues);
2. Tertiary preventive approach in the sense of return-to-work programs for severely acute disorders and after chronification of MSDs with repeated absenteeism.

3.2.1 Secondary prevention

The surveillance of workers with acute MSD complaints with regard to occupational medicine is a basis for target group-related early intervention approaches (e.g. ergonomic adaption of work requirements, communication on educative and rehabilitative prevention offers). In general, reviews listed in MEDLINE on corresponding studies deal mainly not with issues related to occupational medicine, but with specialist medical treatment structures or medical-rehabilitative strategies or with studies of determinants for chronification of MSDs. If at all, reviews in the framework of return-to-work programs (see below) point to the integrative role of occupational physicians after the rehabilitation of MSDs (e.g. [50]). The only reviews found in our research (see Table 3.3) which provide information on this particular issue in a broader sense, come from

- *Waddell et al.* [12], whose review on all areas of prevention has already been taken into account in the systematic analysis on primary prevention and
- *Gatchel et al*. [51], who discuss the “flags”-system for evaluation of the risk of chronification of acute low back pain (“yellow/ red/ blue/ black flags“). Although it has to date only been adopted in the work context of general practitioners and consultants (in Germany red and yellow flags are specified in medical guidelines

[52]), it seems worthwhile to discuss the system theoretically within the framework of occupational health care. (*Helliwell and Taylor* [53] recommend the flag system with regard to repetitive strain injury issues, but without addressing a target group of medical specialists).

Table 3.3
Predictive value of “flags” to avoid the chronification of acute low back pain in the physicians practice – executive summary of two reviews

Gatchel 2004 [51]
Gatchel emphasises in his review that interventions to prevent the chronification of MSDs must take place promptly and be differentiated by type and level of risk. For this a four color "flag system" is used. This system is based on the findings of risk-factor-related research. The assessment method proposed as “easy to use“covers: – *“Red flags”:* potentially significant physiological risk factors for developing chronic low back pain (e.g. progressive, non-mechanical pain, persistent severe restriction of lumbar flexion, structural deformity). – “*Yellow flags*”: psychosocial risk factors, defined as negative attitudes and beliefs about pain, passive behaviors, negative emotions, (depression, hopelessness), missing motivation because of lack of a financial incentive to return to work, inappropriate diagnosis and treatment leading to patient’s discouragement about their future health, familial factors (e.g. overprotection). – *“Blue flags”:* perceived occupational factors believed by the affected persons to impede their recovery (e.g., high demand/low control work environment, perceived time pressure, perceived poor social support). – *“Black flags”:* objective occupational workplace risk factors (e.g., high biomechanical demands). Gatchel further discusses the evidence of significant effects on lost work time and reduced medical treatment of early interventions (bio-psychosocial education, manual therapy, exercises) among patients in the acute low back pain phase.
***Waddell et al. 2002* [12]**
In a systematic report covering all issues of managing low back pain at work, the authors emphasise the limited value of conventional clinical tests of spinal and neurological function (including in particular height, weight lumbar flexibility and straight leg raising) in determining appropriate occupational management or in predicting the prognosis of non-specific low back pain (moderate evidence). Also, in the analysis there was strong evidence that in patients with non-specific low back pain, X-ray and MRI findings do not correlate with clinical symptoms or work capacity. Screening for “red flags” and diagnostic triage on the other hand is important to exclude serious spinal diseases and nerve root problems. The authors see the identification of individual and work-related psychosocial issues (disaffection with the work situation, attribution of blame, beliefs and attitudes) as the more important risk factors for chronicity (‘yellow flags’). They emphasise needs for further high quality research focusing individual “yellow flags” for chronicity of MSDs.

3.2.1.1 Conclusions and recommendations

Only a small number of researchers are primarily concerned with the occupational medicine aspect of health monitoring of high-risk groups. Consideration should be given to the extent to which the suggestion of a four-tier system for risk assessment, as already partly exists for general practitioners and consultants could be translated

for use by occupational health physicians. There is a high methodological and practical need for action in this area.

3.2.2 Tertiary prevention

These interventions for the earliest possible resumption of work duties following chronic MSDs involving lost working time (return-to-work programs, RTW) generally already start in the clinical setting of rehabilitation following acute treatment. The components are, on the one hand, cognitive-behavioral and, on the other, work-related. The term cognitive-behavioral does not refer to a specific intervention, but rather to a class of intervention strategies that might include self-instruction (e.g. motivational self-talk), relaxation or biofeedback, developing coping strategies (e.g. distraction, imagery), increasing assertiveness, minimising negative thoughts, changing maladaptive beliefs about pain, and goal setting. Work-related programs can include five different elements of modification: 1. light duties, 2. “work hardening” as a training program for building strength and endurance tailored to the work, 3. supported or accompanied activity, 4. multidisciplinary conditioning of physical and functional, but also psychological capacities for adapting to the demands of the workplace (“work conditioning”) during the clinical rehabilitation of chronic MSDs, generally of the lower back [54].

Our search of the literature on tertiary prevention of work-related MSDs resulted in

- 5 reports, i.e. meta-reviews [12], [15], [32], [54], [55]; including one that only deals with this area in a secondary way [15], and
- 11 systematic reviews [50], [10], [56], [57], [58], [59], [60], [61], [62], [63], [64]. These include two that discuss several sectors of prevention [64], [10], as well as a further, non-systematic, review referring to the prevention of psychosocial and personal risk factors [65].

The *OSHA Back to Work Report* [55] summarises the results of a total of 11 systematic reviews from between 2002 and 2006, including five that were also used by us [50], [56], [57], [60], [63]. After establishing that the authors of all other reviews from

our research come to consistent results and that a need for research analogous with the discussed needs in the primary preventive area is formulated, we abandoned the formal work on these publications in order to avoid redundancy. We take the findings of the *OSHA Back to Work* report as a representative basis for a summary of the current state-of-the-art in this field of prevention. In order to evaluate the economic advantages of return-to-work programs, we discuss a publication from the Canadian National Health Institute, which deals exclusively with this topic, thus complementing the other findings, at the end of this Chapter [66].

The OSHA report assesses work-related interventions aiming at the rehabilitation, reintegration and retention of workers with MSD. Interventions were classified with respect to particular body parts (low back, upper and lower limbs). They included interventions with regard to work modification and isolated measures in the clinical setting (lumbar supports, exercise therapy, back schools, behavioral treatment). The effects of multidisciplinary prevention strategies are also discussed (return-to-work programs including physical exercise, education, behavioral treatment and ergonomic measures). The conclusions are described below.

a) Interventions addressing low back pain

a) *Modified work:* Moderate evidence was found that modified duties can reduce time lost per episode of back pain by at least 30% [67]. This is slightly more relevant in sub-acute (4-12 weeks) than in acute phases (less than 4-6 weeks) and only when embedded in good occupational management.

- *Lumbar supports* (back belts and corsets): No evidence was found to suggest that these are effective in secondary prevention. Moreover, their use could even have potentially adverse effects such as decreased strength of the trunk musculature, skin irritation, gastrointestinal disorders etc. [68].
- *Exercises*: Exercises are clearly effective for patients with sub-acute and chronic low back pain, regarding pain reduction and improving function [69], [70]. Furthermore, exercises have additional benefits for the reduction of sick days when combined with other approaches, e.g., manual therapy [71] or cognitive-behavioral approaches [63].

- *Back schools:* There is moderate evidence for positive effects of intensive back schools in the short and intermediate term for patients with recurrent and chronic low back pain, reducing pain and improving functional status [72].
- *Behavioral treatment:* Strong evidence that behavioral treatment has a moderate positive effect on pain intensity, and small positive effects on generic functional status and behavioral outcomes among patients with chronic low back pain. It often includes various components and is applied in combination with other therapies (e.g., medication or exercises; see there). It is unclear which type of behavioral treatment is the most effective, or what type of patients may benefit most [73].
- *Multidisciplinary return-to-work approaches:* All effective treatment programs for patients with non-specific musculoskeletal pain (mostly back pain) consist of multiple components [60]. Multidisciplinary treatment is effective in improving rates of return to work for chronic back pain patients [74].

b) Interventions addressing upper limb pain

There are fewer secondary and tertiary prevention studies related to upper limb pain and addressing the benefit for return to work compared to low back pain studies, and they are often of low quality. The authors report strategies stressing technical/mechanical and psychosocial approaches, exercises, and multidisciplinary treatment.

- *Technical or mechanical interventions:* Focusing on a) work environment/workstation adjustments for computer workers (lighting, new workstation, office layout, software applications): there is some evidence of positive health effects [56]; b) workstation equipment for computer workers: two reviews found limited [75] and moderate [56] evidence of the effectiveness of alternative keyboards. The effectiveness of certain mouse types can not be assessed because of low study quality and unclear results. The benefit of new chairs or desks can not be demonstrated [75]; c) ergonomic equipment for manufacturing workers (e.g. adjustable chairs, vibration-proof tools): no effectiveness is evident yet [56], also due to low quality of studies with positive health outcomes.

- *Psychosocial interventions*: Although a few studies showed a decrease in symptoms after using psychosocial interventions as secondary prevention, no strong evidence for positive effects on stress outcomes was found by *Pransky et al.* [76]. Insufficient evidence was found to support production systems or organisational intervention strategies as effective. These results are based on two studies of low quality that did not find improvements in health outcomes associated with organisational and work task design changes among office workers and manufacturing assembly workers [56].
- *Exercises*: No differences can yet be found between the various kinds of exercises [75] and overall, there is limited evidence for the effectiveness of exercises [56], [75]. In spite of the lack of strong scientific evidence, physiotherapy is anecdotally reported to be an effective treatment option for sufferers of upper limb disorders [77].
- *Multidisciplinary treatment:* Effective treatment programs to reduce musculoskeletal pain generally contain multiple components such as education, psychological conditioning, physical and work conditioning and relaxation exercises [60]. A Cochrane review found limited evidence for the effectiveness of multidisciplinary bio-psychosocial rehabilitation programs for neck and shoulder pain among working age adults [50]. Because those programs are often laborious, long and costly and relevant studies are sparse, the need for high-quality trials including cost-benefit relationships in this field is underlined. Even if no significant differences in cost-effectiveness are found between a multidisciplinary approach and usual care, the multidisciplinary treatment is indicated as having effects on intermediate individual outcomes (physical disability, kinesiophobia, pain intensity, physical functioning, coping with complaints) when compared to usual care, as reported in a randomised controlled study [78].

c) Interventions addressing lower limb pain

- Work-related hip or knee disorders and related risk factors have been reported considerably less often than back or upper limb pain. Accordingly, the authors found no review literature on the effectiveness of work-related interventions in the rehabilitation of workers. They extended their search to non-occupational inter-

ventions and found intensive exercises as a commonly described effective intervention for knee osteoarthritis (e.g. found among farmers).

3.2.2.1 Conclusions and recommendations

With regard to low back pain, the authors of the *OSHA- Prevention Report* conclude that most of the discussed intervention programs – excluding lumbar supports – are effective to decrease chronic low back pain rates, whereas interventions for acute back pain are less frequent effective. They attribute this inverse effect due to the frequent spontaneous recovery in the early phase of the back pain episode. Examined intervention effects are of short or intermediate term (no evidence of positive long-term effects on pain and function); a recurrent course of back pain has to be expected, despite of successful interventions.

Regarding neck and upper extremities disorders, there is – in contrast to back pain – a remarkable lack of randomised controlled trials and high quality evidence in the secondary and tertiary prevention field. Accordingly, most reviewed intervention types might have short-time effects, but the evidence is limited regarding technical/ mechanical workplace interventions, exercises and insufficient regarding psychosocial interventions. Multidisciplinary treatments seem to be promising, but the limited scientific evidence and the high costs require implicitly further investigations.

With regard to lower limb disorders, the lack of review literature of work-related interventions and the rehabilitation of workers indicate a new research field.

Overall, further research is needed to determine the cost-effectiveness of intensive multidisciplinary bio-psychosocial rehabilitation programs and their additional benefit when compared to less intensive measures.

The authors criticise the fact that – although many studies have been carried out – the evidence for the effectiveness of interventions is limited, in particular regarding those aimed at upper limb symptoms. They question the quality criteria level of evidence-based reviews as being appropriate to the complexity of workplace interventions, e.g. in terms of the feasibility of randomisation design. This might lead to an

underestimation of possible intervention effects, when non-RCT- studies with successful outcomes are not included in a review because of low quality. They suggest adopting different criteria on which to base evidence classification for interventions in the workplace sector as those used to evaluate medical treatment. Until now, these criteria are still lacking.

Remarks on the role of successful case management

In order to clarify the - in our view particularly important - question of the role of successful case management in the rehabilitation of chronically ill patients, the findings of the authors of a review from the Canadian *Work and Health Institute,* which specifically dealt with this aspect, shall be enlarged upon here [58]. The working group assessed ten studies, including four RCTs, but also five non-controlled studies on occupational interventions for employees unfit to work due to musculoskeletal, but also other, generally chronic pain. Some of the intervention concepts are comparable with those of the statutory German “Company Reintegration Management” (“*Betriebliches Wiedereingliederungsmanagement*“). In terms of content, the working group differentiates between six possible components:

1. early contact with the worker by the workplace
2. work accommodation,
3. involvement of occupational health physician in the process,
4. ergonomic work site visits by experts,
5. involvement of a case manager,
6. unscheduled replacement of patient with another person, using external financial support.

Strong evidence supports a significant reduction in the duration of unfitness for work when, on the one hand, the work can be modified for the return to work and, on the other, the occupational health physician is involved in the process. The evidence moderately supports – due to the number of studies – early contact with the worker by the workplace, involvement of a case manager or an expert-supported optimisation of the ergonomics in the workplace. For these five components, there is moderate evidence of effective cost reduction in connection with the duration of unfitness for work. Evidence of sustainable effects is insufficient or limited and requires further research. (The sixth aspect can not be evaluated due to the lack of studies). This

shows, that it is not only the type of intervention that plays an important role, but that aspects relating to the interaction between various players at managerial level also appear to be important predictors of positive effects. There is need for further research to gather more information on their interrelation.

Remarks on the economic benefit of work(place)-related multi-dimensional disability interventions

As also shown clearly by the expert report by Luehmann et al. [15] referred to in Chapter 3.1, economic benefits can and were clearly visible for preventive measures for high-risk groups/chronic patients as opposed to for other employees. *Tompa et al.* [66] looked at this material in particular depth. They found 17 studies about MSD disability management interventions with relation to the work site that included economic analyses. Their publication refers to a sub-set of a systematic literature review that included all types of OHS interventions [47]. Eight of these studies were of high or medium quality, mainly analysing cost-benefit relationships with the predominant outcomes “wage cost of the absence”, “workers’ compensation wage-replacement costs”, or “disability indemnity costs”, and health care expenses associated with the injury. The intervention elements and their closeness to the work site varied. Besides individual components (education, physiotherapy or behavioral therapy), different combinations were found covering the following elements:

1. early contact with the worker by the workplace (4 studies),
2. work accommodation offer (4 studies),
3. contact between health care provider and workplace (7 studies), ergonomic work site visits (4 studies), and
4. RTW coordination (3 studies).

Because two studies focused on the clinical treatment and included only one workplace element (contact between health care provider and workplace), only six studies are of interest to us. From these, four included work accommodation offers.

The authors found strong evidence supporting the financial merits of multi-disciplinary interventions and moderate evidence based on clusters of studies with the mentioned workplace components. However, no component surfaced as a dominant characteristic in the study. In general, there is a huge lack of economic studies and for those that do exist, predominantly low performance quality is stated. Nevertheless, confirming the findings of the scientific literature referred to in this Chapter, the key message is the high probability of saving costs by disability management with RTW programs.

4 Priority intervention and research strategies from the expert's point of view

The second part of this Work Package provides a compilation of the current evaluation of priority prevention strategies from the point of view of national and international experts. This is achieved by summarising the sources documented in Chapter 2.2.

4.1 Recommendations for innovative prevention approaches to reduce MSDs from the expert's point of view (expertises)

The German research institutes IGES and IAD (see below) were engaged as partners to propose innovative prevention approaches for the reduction of MSDs. The literature reviews and expert workshops were funded by the German *Bundesanstalt für Arbeitsschutz und Arbeitsmedizin* (BAuA; Federal Institute for Occupational Safety and Health).

4.1.1 BAuA-expert report no. 1 (IGES)

Nolting et al. [3] from the IGES Institute in Berlin cast doubt on the potential benefit of primary preventive interventions in preventing MSDs among the healthy working population. They justify this assessment with the limited amount of scientifically established proof of efficiency in systematic reviews. This applies primarily to genuine occupational and engineering concepts. The authors recommend an increased focus on secondary or tertiary preventive interventions, as more and better evidence of efficacy is available here, particularly with regard to cost effectiveness. Above all the importance of implementation of multidisciplinary programs and support of the necessary structures for effective co-operation of all actors in the reintegration of sick employees is emphasised.

As part of a survey of seven members of what is now the DGUV working group AK 1.7 ("Disorders of the musculoskeletal system") *Nolting et al*. summarise the experts' recommendations on the most important innovative strategies (particularly for small and medium-sized enterprises, SMEs) as seen on Table 4.1:

Table 4.1
BAuA-expertise no. 1 (*Nolting et al.* [3]): Further action needed for innovative prevention approaches to reduce MSDs – executive summary

a)	**Risk assessment of high-risk workplaces**
–	Further development of existent risk assessment instruments using, for example, a method inventory or registers of MSD risks for the possibility of modification of workplaces with high exposure rates, e.g. such as for the development of gonarthrosis.
–	Comparative trials of different instruments.
–	Extension of the German risk assessment instrument "*Leitmerkmalmethode*" (key indicator method) to apply to further physical disorders – the building industry as well as occupations requiring kneeling and squatting are specifically named.
–	Increased publicity and dissemination of knowledge, particularly with regard to SMEs. Closer cooperation between accident insurance companies and occupational health and safety agents as well as professional groups and associations.
b)	**Ergonomic product and work design**
–	Development, application and evaluation of instruments for ergonomically adapted design of products and processes (for example, the "New Production Worksheet" introduced by car manufacturer Opel, www.inqa.de/externalblob/dokumente/770).
–	Closing the gaps in the practical transfer of well-known ergonomic principles through user-friendly presentation of relevant content and its integration in training curricula and professional development strategies (additional qualification of trainers required!).
–	Offer of specific information relevant to risk groups on ergonomic work behavior.
–	Close involvement of works physicians in the dissemination of know-how, especially for the target group SME.
–	Ensuring transfer of successfully implemented industry-specific concepts to other businesses (e.g. back training for job starters or training and ergonomics programs on rehabilitation and avoidance of MSDs implemented by the professional association for construction, www.ergonomie-bau.de.
c)	**Integrated health management**
–	Extension of occupational health reporting systems with particular consideration of psychosocial working conditions, supported where appropriate using a reward system for companies
–	Ensure the transfer of successfully implemented, industry-specific concepts on the topic of stress (e.g. by the professional association BG Metall, www.bg-metall.de) for other industries and problem areas.
d)	**Occupational medical assessments to ensure appropriate use of personnel**
–	Occupational medical pre-placement screenings according to the *Guideline for Occupational Medical Examinations G 46* "*Disorders of the musculoskeletal system*" including physical performance tests where appropriate (recommended with caution, as corresponding advice or selection of employees can be misused as a labor policy).
–	Introduction of basic medical documentation of employees' health with initial and follow-up data.
–	Systematic designation of areas of activity where special aptitude tests would be useful and not have counterproductive effects. Development of minimum criteria for physical health on the basis of risk assessments as a pre-requisite for the activity concerned.
e)	**Occupational medical preventive care**
–	Systematic integration of preventive medical screenings of employees with pre-existing disorders or increased workplace exposure to MSD risks, e.g. through orthopedic functional diagnosis in the framework of G 46 screenings (see above) or other measures, e.g. structured self-checks, in the routine procedures of the works physician.
–	G 46 Medical examination as *compulsory* preventive screenings, in place of a voluntary screening program; in the case of special, as yet undefined conditions to be based on risk assessments (see point d).
–	A more strongly sector-based way of working and training of occupational health and safety experts who offer their guidance as external service providers. In order to improve networking, addresses of businesses and their occupational health and safety agents should be available to the accident insurance companies.

f) Return-to-Work programs for sub-acute/chronic MSD sufferers

- Improvement of the multi-disciplinary case management approach and the cooperation between players from the fields of occupational medicine, curative medicine and rehabilitation, in combination with work-related strategies (risk assessment, risk-elimination/modification) as well as individual preventive strategies (work hardening etc., cognitive behavioral therapy). The prospects for successful implementation in SMEs are currently seen as problematic in Germany due to the many-layered structural and procedural barriers (generally low level of networking of the various agents).
- Better involvement of works physicians in case management, supported by the availability and dissemination of address registers, particularly of external health and safety consultants which provide advice to small and medium-sized enterprises (see point e).
- Evaluation of the practicality of return-to-work cooperation (medical experts and company) with involvement of social partners, and of the prospects of success for across-the-board application.

On the basis of their literature research (which comes to comparable results to those put forward here), two expert workshops and the working group AK 1.7's expert survey, *Nolting et al*. suggest the prioritisation of three innovative model projects:

1. Regional programs for dissemination of practical ergonomic and preventive knowledge with particular consideration of the structures of SMEs and their targetability.
2. Programs for the advice and guidance of companies and employees in an occupational health setting; intensity of programs varying according to risk levels.
3. Regionally coordinated return-to-work programs.

4.1.2 BAuA-expertise no. 2 (IAD)

The feasibility study by *Bruder et al.* [6] which focuses on work science and ergonomics at the Institute of Ergonomics (Institut für Arbeitswissenschaft, IAD) at the Darmstadt University of Technology represents the second section of the BAuA expert report on the communication of innovative and integrative preventive approaches for the BAuA (for the first section see [3]). The authors conducted systematic research of the literature and organised additional workshops with German experts on work and health safety in order to collate the experiences of unpublished, practice-oriented prevention projects as well. They came to the conclusion, like their partners from IGES, that for a number of intervention approaches for the reduction of MSDs in the primary preventive domain there was insufficient scientific proof of their effectiveness, or even clear evidence of a lack of effectiveness – even though some of these intervention approaches had often been investigated and systematically reviewed. No statement could be made on measures aimed at a comprehensive ergonomic

adaptation of processes in production or in other services, as not enough studies could be evaluated in the overview. Alongside these gaps in research, the authors point primarily to deficits in interdisciplinary networks as well as in methods for quality assurance, for demonstrating effectiveness and for transfer and evaluation mechanisms. The need for action for innovative means of prevention on the basis of expert discussions is summed up in Table 4.2.

Table 4.2
BAuA-expertise no. 2 (Bruder et al. [6]): Further action needed for innovative prevention approaches to reduce MSDs) – executive summary

a) Optimisation of methods and instruments for risk assessment of the workplace
– Adaption of the existing method inventory to current developments (decrease in hard physical labor, increase in repetitive activities).
– (Further) development of instruments adaptable to person, job and company size with adaptable functions/modules.
b) Ensuring and optimizing the transfer of ergonomic knowledge
– Development of company and external “expert networks” for the transfer of know-how related to successful measures in large companies to the situation in small and medium sized enterprises (SMEs). Ensuring the transferability of the instruments and measures introduced and deemed successful to SMEs (“lighthouse effect”).
– Integration of politicians (economic and labor ministry) as those responsible for coordination and application of conditions for (cross) company prevention at all levels.
– Integration of basic ergonomic knowledge into vocational training.
– Avaiability of a guide to possibilities for integrating health promotion as a sustainable component of strategic company planning.
c) Optimisation of implementation strategies
– Creation of in-company and exterrnal incentives to take part in prevention strategies (monetary and non monetary).
– Involvement of process designers in the ergonomic design of workplaces.
d) Optimisation and evaluation strategies
– Development and testing of instruments to prove the effectiveness and efficiency of company-health promotion in connection with company organisational and staff development or with the efficiency of productive processes.
– Development and testing of instruments to prove the effectiveness and efficiency of preventive investments in connection with the efficiency of productive processes.

On the basis of the system-oriented recommendations, the authors suggest a pilot study on “Integration of preventive approaches to ergonomics into management tasks”, which builds on already successfully implemented ergonomic processes in the company and transfers the preventive approach into the processes of company management.

4.2 National strategies aiming the prevention of MSDs

4.2.1 Strategies in the United States of America

In the following, the goals of the *National Occupational Research Agenda* (NORA) will be discussed**.** NORA is a partnership program to stimulate innovative research and improved workplace practices as a framework for the NIOSH Institute (www.cdc.gov/niosh/nora). One of twenty priority research teams deals with musculoskeletal disorders. The team published the "National Occupational Research Agenda for Musculoskeletal Disorders" in 2001 with a short update five years later [79]. The aims of the experts are to evaluate the current status of scientific research, to identify gaps in the research base, to prioritise future research needs, and to facilitate research through development of partnerships with other government agencies and groups. Starting in 2006, NORA formed eight sector councils to develop recommendations for national prevention strategies covering several specific branches (services[8], agriculture/ forestry/ fishing, construction, health care/ social assistance, manufacturing, mining, transportation/ warehousing/ utilities[9], wholesale/ retail trade[10]). Actually, some working groups have published national sector agendas defining target groups, research and intervention strategies including intermediate and final goals (see Table 4.3).

8 Special focus on automotive repair, building, hotel, restaurant/ food, recreation/ entertainment, waste treatment/ disposal, telecommunications, and education/ schools services, public administration and temporary workers.

9 Special focus on employees working in the sector of baggage and material handling in air and ground passenger transportation, and trucking/ courier/ messenger.

10 Special focus on car dealers, floor covering stores, building material/garden equipment supply, furniture/ home furnishings stores, and office supply stores.

Table 4.3
Research and intervention goals in national sector agendas of the NORA group (status: July 2009, www.cdc.gov/niosh/nora/councils/)

Branches	Agenda publ. date	MSD-goals no.
Services	04/2009	Strategic goal no. 16, intermediate goals no. 6.1, 8.2, 12.1
Public safety (fire fighters, sub-sector of services)	03/2008	Strategic goal no. 4
Transportation, warehousing, utilities	07/2008	Strategic goal no. 2
Wholesale, retail trade	06/2008	Strategic goal no. 1
Mining	No agenda yet	Strategic goal no. 3 in the research plan[11]
Agriculture, forestry, fishing	12/2008	Intermediate goals no. 5.1, 7.1, 9.1
Construction	10/2008	Strategic goal no. 7
Manufacturing	A strategic plan will follow in the next time	–
Health care, social assistance	A strategic plan will follow in the next time	–

The most detailed goals and work plans at the moment are defined for the service, the construction, the wholesale/retail trade, and the transportation/warehousing/utilities sector. The action plans for some branches provide decidedly a 25-30% reduction of incidence/severity rates of MSDs or repetitive injury rate (mining) within the next 5-10 years; other councils do not specify time schedules.

For the health care services, no agenda is available at the moment. A report will be published soon (information of the NORA coordinator by email, May 2009, as well as for the manufacturing sector). *Waters et al.* [20] as members of the council conclude the following needs for further NIOSH research efforts to reduce MSDs in the health care sector: Further evaluation of

- risks of back and shoulder disorders due to patient handling and/or work in awkward postures across various work environments,
- the efficacy of safe patient handling and movement programs to reduce the risk of MSDs, and
- costs and benefits resulting from the implementation of those programs.

For the mining sector, no agenda is available, but the following intermediate goals are defined in the research plan:

- quantification of job demands and physical capabilities of miners to develop improved recommendations in detail for ten improved work designs, with special interest in the physical capabilities of older miners, and
- development and field test of ergonomic interventions to reduce exposure.

In general, all action plans formulated in detail (e.g. in the construction industry) cover

1. Comprehensive basic research on prevalence and incidence rates of MSDs and injuries by evaluating national surveillance data sources.
2. Basic research on risk factors in the development of MSDs.
3. Compilation/development and evaluation of exposure assessment instruments addressed for research and practice purposes.
4. Transfer of research knowledge (risk factors) and assessment instruments into practice (campaigns, dissemination of information material by modern communication methods, e.g. internet, network of occupational organisations etc.).
5. Compilation and dissemination of best practice models.
6. Identification of practical barriers as reason for missing dissemination and adoption of relevant instruments and workplace solutions.

Beyond these universally valid strategies, some particular messages of sector-related councils publishing detailed action plans are summarised as follows:

- *Service sector*: An action plan is published in general (all employees found with elevated risks/MSDs-prevalence rates) and additionally, four sectors are addressed expressly (hotel, public administration, telecommunications services, and fire fighters). Particularly, repeated or sustained exertions, followed by awkward postures in all occupations are addressed for further research and intervention.
- *Construction industry*: Comprehensive basic research is needed because of underreported MSDs-incidence/prevalence rates and related costs in the national injury and illness statistics, not well understood dose-response relationships, and psychosocial risk factors. Organisational aspects should be better integrated in prevention measures (e.g., design processes, project schedule development, site logistics, project communications, availability and appropriateness of equipment

[11] www.cdc.gov/niosh/nas/mining/whatis-miningresearchplan.htm

and tools). Barriers to dissemination and adoption of the plenty of available workplace solutions should be identified.

- *Agriculture/forestry/fishing*: Research and successful intervention projects have been initiated on a modest scale in some industry segments, e.g. tree nursery and wine industries; significantly more are needed.
- *Transportation/warehousing/utilities*: Research gaps and evidence for inclusion of physical, but also of non-physical risk factors (fatigue, work organisation, individual co-morbidities, and psychosocial metrics), related to specific body regions of MSDs (including upper and lower extremities) should be closed.
- *Wholesale/retail trade*: Developing and maintaining an annual database for updating an user oriented chart-book to identify jobs/tasks with high rates of MSD- injury data. Provision of biennial workshops and focus groups (representing companies, unions, associations, practitioners, and academics) to adopt 6-8 best work practices found from research studies. The launch of an employer sensitisation campaign.

In general, goals and action plans indicate a need for basic information about scope and nature of MSDs in some branches, especially in the wholesale/retail trade and the service sector, which is dominantly organised in small and medium sized companies. The main recommendations for further research related to MSD-aspects are concluded in a publication of *Marras et al.* [18] and documented in Table 4.4.

Table 4.4
National Occupational Research Agenda (NORA) – general recommendations for further research on MSD-risk factors – executive summary of Marras et al. [18]

a)	**Research of risk factors for MSDs: better understanding of…**
–	the interaction between low-level static exertions and mental demands (computer users),
–	tissue responding to repetitive, forceful loading and of their interaction,
–	the influence of low-level sustained or repetitive exertions on muscle recruitment patterns, resulting in soft tissue disruption, pain, and dysfunction,
–	the links between biomechanical loading, soft tissue tolerance, and psychosocial stressors,
–	the role of workplace factors in the development of fibromyalgia,
–	the magnitude of risk associated with shoulder loading in the workplace,
–	the impact of aging on work-related loading, tolerance, psychosocial stress, and their interactions,
–	the risk of secondary injury associated with return-to-work, integrating biomechanical exposures, soft tissue pathomechanics, and psychosocial factors into laboratory, epidemiological, and intervention studies.
b)	**Research quality**
–	More effectiveness in research methods, standardizing research metrics and designs to assess the impact of interventions on the risk of musculoskeletal injury (including randomised trials, wherever possible, and a quasi-experimental study design with control groups, at a minimum).

4.2.2 Strategies in Australia

At the internet page of *Work Safe Australia*, the goals of a *National Occupational Health and Safety Strategy (OHS) 2002-2012* are submitted [80]. The *Strategy* aims to provide the framework for collective efforts to improve Australia's OHS performance. National targets were set to reduce the overall incidence of workplace injury (dominantly musculoskeletal disorders) by at least 20% by the intermediate date of June 2007 and finally 40% by June 2012 (baseline date: 2001). Surveillance, communication and intervention goals and strategies cover nine general action fields – comparable to the goals of the NORA group. These fields are summarised in Table 4.5.

Table 4.5
National Occupational Health and Safety (OHS) Strategy, Australian Government: goals and areas of action fields – executive summary of NOHSC [80]

	Areas of action	Action fields
1.	Comprehensive OHS data collections	– Extension of data coverage. – Development of consistent definitions and measurement principles. – Extension systems to allow timely reporting and provision of information.
2.	Coordinated research efforts	– Establishment of research priorities, cooperative arrangements and networks. – Exploration of partnerships between areas concerned with public and occupational health. – Improvement of communication with national and international OHS research bodies.
3.	Nationally consistent regulatory framework	– Monitoring the adoption of national standards. – Review of national standards and codes. – Development of new national standards where need is demonstrated. – Repeal of superseded regulations.
4.	Strategic practical and consistent enforcement	– Benchmarking and sharing of best practice approaches. – Development of strategic approaches based on proactive targeting, risk assessment and innovative sanctions. – Publication of enforcement policies.
5.	Effective incentives for employers	– Examination of the effectiveness of current premium setting incentives. – Investigation of innovative non-financial incentives.
6.	Support of compliance to regulatory authorities, especially of small enterprises	– Development of hazard and industry specific guidance. – Support access to consistent compliance advice. – Development of OHS management systems guidance and auditing mechanisms.
7.	Practical guidance to assist company stakeholders to implement OHS and risk management principles in their workplaces	– Development of means for improved access to information and supporting development of guidance. – Facilitation of sharing.
8.	Community awareness programs and evaluation	– Maximizing gains from substantial investment in awareness campaigns by sharing experience and learning. – Development of evaluation approaches suitable for measuring the impact of awareness and information initiatives.
9.	OHS skills development	– Integration of health and safety into vocational, professional and inspectorate training arrangements. – Promotion of the integration of OHS competencies into management training, including for small business. – Encouragement of the development of suitable OHS training resources. – Research of improved methods of OHS skills development.

A number of industries have been selected to receive priority attention, based on a combination of high incidence rates and high employment: agriculture/ forestry/fishing, construction, health/community services, manufacturing, and transport/storage. In 2007, two national standards were declared by the Australian Safety and Compensation Council (ASCC): The *National Standard for Manual Tasks,* and the *National Code of Practice for the Prevention of Musculoskeletal Disorders from Performing Manual Tasks at Work* including risk assessment tools for purposes in the industrial setting (www.safeworkaustralia.gov.au, see OHS standards).
Short communication papers published a lowered overall MSD incidence rate of 16% from 2001-2007; the intermediate target size of 20% was narrowly missed [81]. The construction and transport/storage industries have recorded the greatest percentage improvement (23% and 21% respectively), the manufacturing industry a 6% decrease in incidence rates, agriculture/ forestry/ fishing industry a 10% decrease, and the health and community services industry 16%.

In one of the articles identified by the MEDLINE research, *Briggs and Buchbinder* [19] in a publication that appeared this year, deal with the question of whether back pain should become a “national health priority area” (NHPA) in Australia, given the high complaint and injury rate. NHPAs aim to engage the cooperation between government and non-government organisations to monitor report on and develop strategies to improve health outcomes. Given the advantages discussed, the authors come out in favor of such a classification.

4.3 Priorities drawn from MSD-conferences

This Chapter describes the state of the discussion with regard to the lack of intervention strategies and gaps in research from the point of view of experts who met at three congresses in the USA. No corresponding recommendations can be derived from two congresses that took place in a European setting (EU “Lighten the Load” campaign, Chapter 4.3.4); however, the most important points are summarised here.

4.3.1 Annapolis Conference 2005: Current State of Research on Work-related Upper Extremity Disorders (Annapolis, USA)

The working conference held in Annapolis, Maryland on September 23rd and 24th, 2005 joined experts from research and practice related to upper extremity disorders. The intent of the meeting was – on the base of the state of the art evidence in epidemiology and intervention research – to develop suggestions regarding next steps in workplace intervention research and application. A conference report was published in the Journal of Occupational Rehabilitation [82]. The conference covered secondary prevention issues (treatment), but had also a strong relationship with primary prevention aspects. The authors point out the gap between the knowledge of identified risk factors (ergonomic, workplace psychosocial and individual factors) and the development and practical implementation of comprehensive interventions related to upper extremity disorders. In particular, the aspects are documented in Table 4.6.

Table 4.6
Annapolis Conference 2005 of upper extremity disorders – executive summary of Feuerstein & Harrington [82]

a)	**Intervention strategies**
–	Interventions related to work organisational changes are needed, due to the increasing psychomental and psychosocial load in rapidly changing working environments (“dynamic workplace”), e.g., in the office setting. Since this has been well known for two decades, the implementation barriers in practice should be evaluated.
–	More multi-component strategies are required, covering physical and psychological demands; single intervention programs seem to have no or not strong evidence of being effective.
–	Methods need to be identified to help employers take office ergonomics more seriously, particularly when there is no regulatory support to motivate intervention.
–	Key strategies to convince employers of (multidimensional) prevention programs should be ensured to overcome current prevention barriers.
–	Interventions need to be more precise in terms of type of disorder (e.g., carpal tunnel syndrome, enthesiopathy), symptom severity or reported symptoms vs. disorders, because it is still unclear whether the same risk factors contribute to the severity or maintenance of symptoms, disorders and ultimately disability.
–	A better interdisciplinary collaboration of ergonomists with medical and behavioral health personnel should be promoted in the case of approaches in the secondary prevention field.
–	Ergonomics in practice need to consider also not only posture and forces, but also individual aspects, such as work styles and individual factors (weight: influence on postures? Gender: differences in worker’s recovery from stress).
b)	**Research issues**
–	The most efficient ways to measure or quantify productivity and productivity disruption associated with occupational upper limb problems have to be determined.
–	A system is needed to assess the effectiveness of ergonomic products (i.e. keyboards, chairs).
–	Confounders on effects (e.g., changing work demands during the intervention) should be evaluated.

In conclusion, the three working groups identified the following broad research topics:

- Clear need to create a set of holistic interventions covering the combined influence of biomechanical, biobehavioral, psychosocial, and organisational factors.
- Review of non-English studies and their applicability to the national setting.
- Comparative studies among different systems with variations in work climate, health care, and insurance policy aiming to identify best practices taken from each country/system.
- Need of economic analyses of interventions.

4.3.2 EUROFOUND Conference 2007: Musculoskeletal disorders and organisational change (Lisbon)

The conference of the *European Foundation for the Improvement of Living and Working Conditions* (EUROFOUND) was organised in the framework of the European MSD campaign (http://osha.europa.eu) and aimed to engage the discussion on European and national trends in the prevalence of MSDs, the economic and social impact, and good practice examples in prevention policies. Participants were experts, representatives from the EU and national authorities, social partners and practitioners, and members of the *European Working Conditions Observatory (EWCO) Network*. For conclusions concerning needs for intervention and research strategies gathered from the proceedings, see tables 4.7.

Table 4.7
EUROFOUND Conference 2007: Musculoskeletal disorders and organisational change – executive summary of EUROFOUND [83]

a)	**Intervention strategies**
–	Special attention to high risk groups: blue-collar workers, workers aged 40–54 years who are worst affected by MSDs, younger workers with high incidence rates of neck problems.
–	Tailored interventions considering gender as a risk factor.
–	More attention to increasing MSD-rates affecting neck and shoulders and associated with tendinitis, due to changes in the workforce composition (shift from a mechanised industry to a more knowledge-based economy). Exposures to vibrations are declining.
–	More emphasis on participatory ergonomics (“room to maneuver” for the worker), what in practice is far from current implementation actions at company level. Proposal: creation of an exchange network on the debate focusing on worker’s “room to maneuver”.
–	More emphasis on the development of structured impact assessment tools for employers prior to new prevention plans (cost-benefit-calculations).
–	Development of successful strategies for awareness and know-how increase of employers.
b)	**Research issues**
–	Sensitivity on the significant factors contributing to the reduction of risks at the workplace in multi-component interventions.
–	Evaluation of the balance between ergonomics and productivity.
–	Stronger integration of psychological factors (e.g., job intensification) into prevention strategies at the workplace.
–	Generation of guidelines for successful intervention.
–	Extension of secondary intervention measures.

4.3.3 PREMUS 2007: Prevention of Work-Related Musculoskeletal Disorders (Boston, USA)

PREMUS is an international scientific conference held every third year that serves as a forum with an emphasis on prevention of MSDs. The participants include international experts in research and practice, and policy makers. The goal of PREMUS is to present and discuss the latest research. As one of the main representatives of the congress, the presentation of the keynote speaker Riihimaeki from Finland [84] about workplace intervention studies is considered as presented in Table 4.8.

Table 4.8
PREMUS Conference 2007: Musculoskeletal disorders and organisational change – executive summary of Riihimaeki [84]

a)	**Intervention strategies**
–	Emphasis on holistic intervention approaches, covering work organisation, workstation and tools, physical work demands, psychosocial factors and individual characteristics, and especially on participatory ergonomics.
b)	**Research issues**
–	Critical consideration of the feasibility of randomised controlled trials (RCTs) in the workplace setting. Proposal for group or cluster RCT- design.
–	Emphasis on better evaluation designs (particularly process evaluation issues to control confounding variables, measurement of real reduction of loads by the intervention).
–	Emphasis on using a framework for design and evaluation of complex interventions, e.g., of the Medical Research Council of the U.K. [85] for phased approaches (theory development, modeling the intervention and its influence on health outcome, exploratory trial, definitive randomised trial and long term intervention).

4.3.4 European Week 2007: "Lighten the load" campaign (Berlin, Potsdam)

As part of the *European Week* (Organiser: European Agency for Safety and Health at Work, EU-OSHA) addressing the prevention of musculoskeletal disorders, two key events took place in Germany. In order to give non-German-speaking readers the possibility of gaining a picture not only of deficits, but also progress made, the reports will also be summarised in the following section, although not so comprehensive.

a) Berlin event

In the first event, various health and safety experts presented the progress made since the last *European Week* in 2000. The focus was on the ergonomic design of the workplace, rehabilitation measures and the manual handling of loads [86]. The conference documentation includes the following six points:

1. Information on the overarching objectives and strategies of the campaign: support for a) improved cooperation between employers, employees and the government, b) holistic prevention approaches taking into account all demands and risks, including psychosocial and psycho-mental ones and c) the retention, rehabilitation and reintegration of workers with chronic MSDs Secondly reference to the Europe-wide "*Good Practice*" competition as an important element of the campaign (won by two DGUV prevention projects on systematic risk assessment

and ergonomic redesign of workplaces in the sewing and metalworking industries).

2. Evidence of national activities by the DGUV and BAuA to fulfill eight strategic objectives, which were formulated at last *European Week* in 2000. The authors come to the conclusion that there are already well-established methodological guidelines in Germany, general and specialist prevention programs as well as exemplary industry-related practical solutions, and the current knowledge in companies has clearly expanded as a result of further training and publicity measures.
3. Reports on the European cooperation projects (SLIC campaign, see Table 4.7), *OSHA- Case Studies Report* on MSDs [31] with examples of best practice and on the "ERGO collection" a summary of ergonomic guidelines from engineering and metalworking accident insurance associations and the BAuA (Germany) as well as accident insurance companies from Austria and Switzerland[12].
4. Reports on strategies at national level: 1. INQA - Initiative Neue Qualität der Arbeit (Initiative for a new quality of work): themed initiative groups established in 2002 to network experts from research and practice for the generation of prevention concepts (www.inqa.de), including industry-specific ones - and 2. three pilot schemes from the BMAS 2007[13] funding priorities, with the goal of creating more guidance about the risks of disorders and strains for practice-oriented prevention concepts by 2010, for example, which could also be transferred to other areas, e.g. other industries, occupational groups or company sizes. [14]
5. Introduction of individual industry-specific prevention projects (e.g. multicomponent programs: back-protective patient transfer in the clinical setting, retention of older employees' ability to work in the construction industry).
6. Introduction of occupational interventions: 1. Assessment tools for experts and employers to evaluate MSD exposure in the application of production and planning processes at the Darmstadt Technical University. 2. A concept from the *Verband Deutscher Betriebs- und Werksärzte* (VDBW), (German Association of Company medical officers) focused on medium-sized enterprises, "Healthy backs cooperation model" for regional networking of occupational physicians with all

[12] www.ergo-sammlung.de/page_1192885021326.html
[13] BMAS – Bundesministerium für Arbeit und Soziales, Förderschwerpunkt 2007: „Belastungen des Muskel-Skelett-Systems bei der Arbeit – integrative Präventionsansätze praktisch umsetzen"

players involved in the primary prevention of work-related MSDs from medicine, rehabilitation and other social partners and for the initiation of prevention measures.

b) Potsdam event

At the second congress in the *European Week*, the prevention of vibration-induced MSDs took center-stage. The author of an unnamed manuscript on the OSHA [15] website provided a summary:

1. Since the introduction of the Noise and Vibration Safety Act in 2007, a new level has been achieved in the prevention of health risks due to vibration effects.
2. With the development of reduced-vibration machines and devices over the past ten years, the exposure limits for whole body vibration or hand-arm vibration need no longer be exceeded.
3. Numerous measurement results and written information as well as value-for-money vibration measuring devices are available for practical risk assessment of vibrations.
4. With the trade association´s Guideline for Occupational Medical Examinations G 46 “Disorders of the musculoskeletal system including vibration” (G 46), the basis for effective occupational health prevention has been set out.
5. Numerous guidelines are available for the practice of accident insurance companies, BAuA and federal safety authorities; and small and medium sized enterprises can be effectively advised by their accident insurance provider.

4.4 Conclusions and recommendations

Many future challenges for intervention areas and research priorities mentioned in the strategy papers have already been addressed in section 3. Target groups for prevention efforts are (and have been in the past) especially all those with occupations associated with high levels of physical strain. However, unfavorable working

[14] www.naprima-projekt.de, www.pakt-praevention.de, www.kobra-projekt.de
[15] http://bb.osha.de/docs/resuemee_hauptveranstaltpotsdam_ew2007.pdf

positions as well as shoulder exposure must be given more attention. In particular in the services sector and in principle in all small and medium enterprises, greater prevention efforts are required in order to close the transfer gap between theory or available tools and practice. The NORA working group emphasises the as yet incomplete research on the connection between occupational risk factors and MSDs in their strategy papers. On reading the Australian strategy papers, the time lag in the development of efforts on the national level in comparison to the USA becomes clear, but so also do the very promising improvements achieved in the sense of reduced incidence rates over the past years. The congress proceedings too, constantly repeat the need for holistic bio-psychosocial intervention approaches that take greater account of company organisational aspects and psychosocial risk factors, as well as for improved inter-professional cooperation. The main challenges in this context appear to be not only the development of strategies that can actually be put into practice, but also the task of convincing all stakeholders of the expected benefits and the appropriate strategy implementation. The issues arising from demographic change – which is happening on a global scale – i.e. the question of how older employees can also be effectively supported in order to maintain their fitness to work, was not specifically discussed in any of the papers examined.

In both of the BAuA expert reports, the need for inventarisation, standardisation, adaptation, testing and practical dissemination of risk assessment tools is emphasised. Ergonomic considerations should be an integral part of management. Furthermore, they discuss the extensive transfer of successful prevention programs offered by professional associations to other sectors, as well as the enhancement of the preventive role of occupational health physicians, for which a formalised and standardised instrument has existed for several years in the shape of the orthopedic risk assessment tool developed in the framework of the occupational health guideline G 46. Further areas that should be examined are the inclusion of preventive and health and safety topics in occupational training, the setting up of (further) regional prevention networks and the creation of prevention-related incentives for businesses. (With the German *Jahressteuergesetz* 2009 (Annual Tax Act 2009), another step has been taken towards fulfilling this requirement. The Act (§3, no. 34 EStG) grants tax exemptions of up to 500 euros per employee to employers who commit to occupational health promotion.

As to evaluation-related research gaps, the cited shortcomings are the same as the aspects already mentioned in section 3 (above all, more high-quality studies taking into account the effect of confounders, and high-quality cost-effectiveness analyses). They shall not be repeated here. (See also Section 5.)

5 Discussion and recommendations

Judging from the results established so far by Work Package 4 – that is from the point of view of review authors who apply the principles of evidence-based medicine – primary preventive measures for the reduction of musculoskeletal disorders in healthy or acutely ill patients seem to have astonishingly few proven and lasting positive effects, despite the many different approaches taken. From this point of view, there is a continuing need to evaluate high-quality studies that have not been published internationally and to carry out further studies with a primary preventive background. The area of secondary prevention for sub-acute patients in an occupational health context represents a challenge from both a practical and a research-based point of view. Tertiary preventive measures for chronically sick employees with the goal of reintegrating them into the workplace appear highly promising when certain conditions are met. To identify current challenges and recommendations for the prevention of musculoskeletal disorders, we studied evidence-based systematic reviews, expert reports and congress proceedings, as well as papers proclaiming national strategies in the USA and Australia. Derived solely from these sources, our conclusions and recommendations for priority areas of prevention are as listed below (summaries and detailed conclusions can be derived from the relevant sections). The areas mentioned are those in which increased efforts should be made, both now and in the future. This does not imply, however, that for aspects not addressed here activities should be reduced. We differentiate between

1. action fields for prevention and

2. evaluation strategies

and comment on these aspects with a particular view to the situation in Germany, sometimes with the inclusion of further (including gray) literature and own expert

knowledge. (For a priority list of most important prevention topics to be addressed in the future, see section 5.3.)

5.1 Specially recommended fields for encouraging preventive action

5.1.1 Target groups

a) Groups with high exposure to certain demands: focus on…

- forced postures in standing, bending, kneeling or overhead positions;
- high and/ or low level static exertions, especially combined with mental demands;
- psychosocial risk factors/stress;
- repetitive work with lack of recovery;
- manual work load.

There is a continuing need for research and action on the risks as well as the effects of preventive measures in manual handling of loads, in terms of the functional effects of this strain alone or in connection with awkward body position and taking into account, among others, disorders related to shoulders or knee joints. Given the growing importance of workplace-related psychosocial risk factors for MSDs, organisational approaches must be accorded a great deal more attention. In the same way, there is a need for research and action in the area of static work postures and repetitive activities.

b) Industry sectors: focus on…

- in general: small and medium sized enterprises;
- in general: services, esp. hotel/ gastronomy, retail trade;
- sectors with high physical load (e.g., construction, manufacture, transportation and distribution, agriculture/ forestry/ fishing, health services/nurses);
- sectors with static load (e.g., computer user).

There is a disproportionate amount of publications on preventive approaches for computer users, care professionals and some manufacturing industries in comparison to other industries. Experts emphasise the heavy focus on essentially all sectors in which small or medium enterprises dominate and which are less reachable in terms of prevention strategies than large companies. Transport/logistics and construction, but also agriculture, are highlighted as industries where employees are traditionally particularly exposed to loads that affect the spine. No plan currently exists that takes into account the exponential growth of subcontracted and temporary work, primarily in sectors characterised by unstable work relationships, e.g. for unskilled workers, but also in the service sector [87], [88]. This sector therefore represents a particular problem that is best addressed with preventive measures introduced via the main areas in which agency workers are employed. The service sector, which is also expanding and is characterised by extremely varying levels of MSD exposure, will require increased and differentiated attention in the future.

c) Target groups with individual risk predisposition: focus on…

- older workers, especially in highly demanding professions (high loads, long duration of forced postures, psychomental demands);
- employees with overweight and other important functional impairment risks that often correlate with MSDs, e.g. metabolic syndrome.

Current demographic change necessitates increased adaption of work requirements to older employees and vice versa, in order to ensure that employees are fit for work for the longest possible time. Future strategies and studies must take into account the age aspect in a much more focused way.

Obesity is a general problem in today's society and is a co-predictor for the development of intervertebral disk and knee disorders. Interventions to modify individual risk factors are poorly researched and should be followed up.

5.1.2 Disorders

a) MSD- localisation: focus on…

- lower extremity disorders, esp. knees;
- upper extremity disorders, esp. shoulder.

There is a gap in knowledge of which prevention strategies are successful in the area of upper extremities in comparison to the knowledge available on risk factors. This is on the one hand due to the diverse nature of the risk factors in combination with a number of psychosocial aspects whose degree of influence has to this day not been satisfactorily explained. On the other hand, in relation to the evidence of preventive effects there is a lack of high-quality intervention studies and holistic work-related approaches. This is also true of disorders caused by overexertion or overuse, e.g. work-related carpal tunnel syndrome or epicondylopathy, mainly of the elbow joints. Corresponding work-related intervention studies on prevention of disorders of the lower limb are very scarce to date (see for example the study of *Jensen and Friche* [89] on training methods for tasks that require kneeling). The fact that gonarthrosis has been included in the list of occupational diseases since July 2009 (no. 2112), leaves no more room for doubt as to the need for prevention-related action in the workplace.

b) MSD- severity: focus on…

- MSD- status of chronification.

To increase the impact it is recommended that target groups be defined and chosen with greater precision for certain interventions. This requires better differentiation between provisions for persons without complaints, with acute functional disorders caused by overexertion or overuse, long-term or lasting functional disorders, and with structural limitations (e.g. lumbar disk damage, arthrosis).

5.1.3 Interventions

a) Prevention type: focus on…

- secondary prevention, work-related (surveillance, occupational medicine);
- tertiary prevention, work-related (return to work programs).

The role of the occupational physician as a link in the chain of experts concerned with the prevention of MSDs must be strengthened. It would also be useful if the links between occupational and therapy medicine were strengthened in the statutory framework. To date, the implementation guidance for r*eturn-to-work management* in the German Social Security Code, Section IX, only provides on a non-compulsory basis for a remit of the occupational physician to actively support the reintegration process in the workplace.

One challenge for the occupational physician prior to this process is the systematic identification of persons at risk, taking into account individual risk exposure at work and personal predisposition. Then the chances of early intervention (see sub-paragraph b) would increase. In the case of multifactor and multidisciplinary return-to-work programs, the effects in terms of treatment and fitness to work, as well as their economic consequences, appear particularly auspicious. These programs, although costly, are worth implementing across the board. In the German health care system, there are structural obstacles that make networking of all health care systems difficult (e.g. general practitioners and specialist physicians often do not know - particularly in the case of employees of small and medium sized enterprises - who the patient's occupational physician is and do not find this out because of the limits on their capacity). These obstacles must be overcome by means of efficient case management.

b) Primary intervention type: focus on…

1. work re-organisation approaches and preventive organisational culture;

2. risk assessment (workplace): (further) development and dissemination of target group-oriented assessment tools, evaluation of obstacles of theory-practice transfer.

In view of the increasing prevalence of psychosocial risk factors linked to the development of MSDs, the great importance of a prevention-oriented corporate culture should be more strongly emphasised. For this, the willingness of the employer to implement innovative strategies in the framework of work organisation and personnel development is a fundamental requirement. The participatory approach, which has been widely researched but mainly with regard to ergonomics, seems to be a key factor for success. Furthermore, ergonomic solutions that make use of engineering tools to avoid excessive strain are essential components of an effective health and safety protection strategy. A suggestion for a pilot project addressing organisational aspects ("Integration of ergonomic preventive approaches in managerial tasks") made by *Bruder et al*. [6] in the framework of their BAuA expert report would also seem to be an interesting approach, but as far as we are aware, is still waiting to be put into practice.

Exercises and programs to improve fitness are to be recommended unequivocally – if carried out intensively and over a long enough period of time – and their requirements and framework for their use for individual target groups should be established. On the other hand, single knowledge building and training measures or the isolated provision of ergonomic work equipment do not seem advisable on the basis of evidence-based research findings as a way to achieve sustainable effects. (As to the role of multi-factor intervention strategies, see sub-paragraph e.)

Risk-assessment instruments and practical health and safety guidelines that relate to specific workplaces, exposures and target groups have become widely available in Germany and are of a high quality. [16] What is lacking, however, is comprehensive

[16] see www.dguv.de, www.bgia.de, www.inqua.de, www.baua.de, www.iga-info.de, see also the websites of all accident and sickness insurance organs etc.; overviews of methods can be found, for example, in in Hoehne-Hückstädt et al. [92], Caffier et al. [93], Steinberg et al. [94] Macdonald and Evans [95] or in the guideline published by the German Association for Occupational and Environmental Health (Deutsche Gesellschaft für Arbeitsmedizin und Umweltmedizin - DGAUM) "Bewertung körperlicher Belastungen des Rückens durch Lastenhandhabung und Zwangshaltungen im Arbeitsprozess" [96]

integration of these instruments in the methodological recommendations for risk assessment, and also the training of occupational health and safety specialists, given their important role as advisers for companies in this domain.

Above all, the extent of the actual transfer and roll-out in practice is unsatisfactory, particularly in small and medium sized enterprises. This could also be due to the inadequate provision of occupational physicians in this sector of the economy. The authors of a 2005 survey came to the conclusion that risk assessment was only carried out systematically in around one third of businesses with fewer than 100 employees surveyed, and not often in satisfactory quality [90]. It is therefore recommended that the practical suitability of existing assessment instruments should be reviewed and that they should be standardised and defined more precisely for the different target groups (experts or company users). In order to close the gap between theory and practice, further investigations are necessary, e.g. on the benefit of information material as a means of building expertise in the practical context and on alternative means of access particularly in small and medium enterprises (see for example the *Praetrans* project [91]).

c) Secondary intervention type: focus on…

- risk assessment (surveillance of worker's health and risk factors): Realisation of an applicable screening concept including identification of "yellow flags".

With the introduction of the occupational health guideline G 46 [97] and the availability of a multi-layered orthopedic investigation instrument, the technical requirements for an occupational early-warning system in Germany have been created. The new Occupational Health Provision Act *("Verordnung der Arbeitsmedizinischen Vorsorge"*) dated 24.12.2008 (ArbMedVV) does retain fitness to work as a goal, but, because of the classification of the G 46 as an investigation *to be offered,* does not create any corresponding mandatory requirements for the employer when particular levels of risk due to physical strain exist in the workplace [98]. An evaluation of the state of application and experience is also overdue. In principle, experts proceed on the assumption that early warning systems for avoidance of chronification of MSDs have only been established in isolated cases [99] – a fact that has to be seen in the light of

the described “on offer” character of the investigations in G 46. Early warning systems can be relatively easily established in larger companies (e.g., [45]). Current research is again lacking, as indicated both by international literature and the voices raised in favor of a *results-oriented* evaluation of the German “*JobReha*” project [17]. Even a two-tier screening instrument for disorders of the upper extremities developed in Italy for occupational physicians was not scientifically validated according to written information received by the author in July 2009 [100].

To date, a gap appears to exist between the offer of tools available and the extent of their use, partly also because of limited acceptance on account of the high cost, as revealed, for example, by an evaluation of use of the *BAPRO* instrument [101]. There is a general lack of instruments connecting musculoskeletal disorders with physical stress and able to be used in corporate practice [95]. Two such instruments found during the review are located more in the rehabilitation field, e.g. the *Orebro Musculoskeletal Pain Questionnaire* [102]. The instrument *FAGS amse* [103] is however also described as being of use in the cooperation between orthopedic surgeons and occupational physicians. (For a comprehensive summary of assessment instruments see the DGAUM guidelines [96]). There exists here a corresponding need for action and research. International recommendations for progressive diagnostics are already available for the upper extremities, for example [104].

c) Tertiary intervention type: focus on…

- early mobilisation, early return to work, modified work duties and work environment, work hardening/exercises, cognitive-behavioral treatment, appropriate diagnostics, treatment and advice.

The aspects mentioned are predictors identified as successful in the restoration of fitness to work of patients with chronic MSDs. Their combination in the framework of interdisciplinary cooperation increases the positive effects (see sub-paragraph c). Concepts also exist in Germany, e.g. the rehabilitation management by the Adminis-

[17] Early intervention program for employees in the automotive and postal sectors. Version: July 2009,

trative *Professional Association* or the *Professional Association of the Construction Industry* [105], [106]. With the *Company Reintegration Management* ("*Betriebliches Eingliederungsmanagement"),* legally stipulated in Germany as obligatory for employers since 2004 (§84, 2 Social Security Statute Book IX) and a standardised disability management audit by the *German Social Accident Insurance* (www.disability-manager.de), the necessary structures exist, and their use must be further monitored and researched. They currently focus mainly on rehabilitation following accidents at work and sometimes, in the case of specific threats from work-related disorders of the musculoskeletal system, are applied for their prevention.

d) Intervention dimensions: focus on…

- multi-faceted interventions in primary prevention;
- multidisciplinary interventions in tertiary prevention.

The current state of research points impressively to corporate intervention programs with holistic bio-psychosocial approaches as offering the best probability of having positive effects, e.g. in the integration of aspects of work organisation, organisational culture, individual behavior and (participatory) ergonomics. The early identification of functional disorders offers an approach for the improving the acceptance of preventive measures in connection with the change experienced.

For employees from small and medium enterprises with unfavorable working conditions, adequate structures to offer need to be designed and extended. [18] The providers of sector-specific prevention (accident insurance companies in the framework of their extended duty of prevention according the Social Security Statute Book VII) should work in an even more targeted way to provide the necessary knowledge and support for work-related prevention in SMEs and draw on the support of corporate

www.mh-hannover.de/14661.html

[18] A current example of efforts in the field is the model project "Gesunde Arbeit" ("Healthy Work"), being promoted by the Federal Ministry of Labor and Social Affairs (Bundesministerium für Arbeit und Soziales) and the Neue Qualität der Arbeit (INQA) initiative. The aim is the create contact points all over Germany for SMEs for issues related to work and health (www.gesunde-arbeit.net/)

consultants (works physicians, specialists in health and safety at the workplace) in transferring this.

The highly promising approach offered by interdisciplinary case management in tertiary prevention has already been emphasised several times. Scientific analyses of the effectiveness of the different components are recommended.

e) National prevention strategies: focus on…

- networking of social partners, particularly in the frame of return to work programs;
- organisation of regional prevention networks to address and integrate small enterprises in prevention issues;
- development and provision of information registers;
- creation of company and external incentives for taking part in preventive measures;
- guidelines for successful intervention strategies;
- creation of evaluation procedures for preventive measures in the corporate setting.

A range of projects has already been initiated and implemented in Germany in response to need for action on top-level strategies identified by international experts. Examples for this are the action guidelines for the implementation of musculoskeletal-related health promotion strategies at work [107] and the implementation of regional networks[19]. Registers in the form of DGUV exposure databases are currently being created on musculoskeletal disorders, including psychological disorders, as well as knee conditions (databases *OMEGA* and *GonKatast,* www.dguv.de). The address registers of consulting occupational physicians suggested by *Nolting et al. [3]*

[19] An overview can be found on the website of the *German Network for Workplace Health Promotion* (“*Deutsches Netzwerk für betriebliche Gesundheitsförderung, www.dnbgf.d)e* or the *Company and Rehabilitation Network (“Netzwerk Betrieb und Rehabilitation”*, www.netzwerk-betrieb-reha.de).

have to be disregarded on account of the lack of opportunities for putting into practice. [20]

5.2 Special recommended fields for research action

a) Design: focus on…

– high-quality studies.

The emphasis on “high quality” lies on randomised controlled studies (RCTs), cluster-randomisation in the case of barriers of individual randomisation, use of concurrent control groups without other intervention and long-time follow ups (> 12 months). Furthermore, experts insist on the use of good epidemiological practice (calculation of study power analysis and effect sizes). Critics of the evidence-based evaluation of studies in the field of corporate health promotion do not support the strict natural-science focus on RCTs. For a realistic appraisal of the evaluation of effects, they recommend the (additional) inclusion of “lower quality” types of studies (including experimental and case studies) as well as of high-quality gray literature and experiences published in languages other than English.

b) Outcomes: focus on…

– differentiated measurement of MSD stages;

– consideration of confounding predictors on the success of an intervention;

– measurement of “intermediate” variables;

– economic outcomes.

[20] An attempt made by the *Company and Rehabilitation Network (*www.netzwerk-betrieb-reha.de) turned out not to be feasible for various reasons.

As described in the sub-paragraph “MSD severity“, researchers should differentiate between pain outcomes such as acute, subacute, and chronic type of disorders. This is important to assess design and realistic effects of intervention strategies.

Evaluating confounding predictors is a main recommendation for research in the future. This means recording participation and drop out-rates, compliance with the intervention, commitment of stakeholders, changes of work load/exposure and relating the confounders to the final outcome of MSDs. If this is not done, effects are not truly assessable.

There are currently only slight indications of any positive cost-benefit relationships for certain interventions in the field of primary prevention, according to evaluations by evidence-oriented authors who have dealt with this subject more closely in controlled studies (e.g. [7], [15]). Little more can be concluded from the expert reports due to the problematic research situation – which points to a need for action. Positive case examples [31], [48] are thus a helpful approach, particular for practitioners, and greater attention should be paid to these in the future. The indications of economic effects for multidisciplinary programs for high-risk groups in the return-to-work area are clearer from an evidence-based point of view, but more high-quality research is needed here. Economic research should also include the introduction and operationalisation of productivity and productivity disruption categories.

We can conclude that in recent years the quality both of the prevention and, to some extent, the evaluation has notably improved from a conceptual point of view in many – although not all – fields. Some gaps in terms of appropriate prevention structures and statutory framework conditions have been markedly narrowed in Germany. But the reality of the currently weak position of occupational medicine in connection with the prevention of musculoskeletal disorders remains the area requiring the most work.

The most important deficits remain the problem of putting measures into practice, the lack of structures to ensure sustainability, the limitations of research methodology and a publication bias, primarily in Germany, towards the findings of intervention projects. These are combined with conceptional uncertainties and contradictions be-

tween the various medical, social, insurance and political partners involved in this field of action [108].

5.3 TOP TEN prevention priorities

By way of conclusion, ten fields of action to be prioritised for future preventive efforts are listed and briefly justified. It should of course be said that formal prioritisation by means of a ranking of contents is not entirely fair, as the points cannot be seen in isolation.

1. Interventions with a clear focus on interventions related to work organisation, on the one hand because exclusively ergonomic measures do not have a guaranteed impact and on the other hand in order to combat the growing number of psychosocial and mental disorders.

2. Interventions to reduce occupational disorders of the lower extremities, as this area has been neglected in prevention efforts to date.

3. Interventions with a clearer focus on the prevention of occupational disorders of the shoulders linked to static work postures, but also interventions to reduce disorders from manual handling of loads, as this aspect has to date been accorded too little consideration.

4. Interventions to reduce the number of disorders caused by unfavorable static work postures, with consideration of combined disorders in the case of occupations with high rates of psychomental disorders, as there is a lack of prevention in this area.

5. Standardisation and implementation of economic analyses in intervention studies, as this is frequently a field where no well-grounded scientific statements can yet be made, especially in Germany.

6. (Further) interventions, subject to especially close evaluation, in occupational groups with high exposure to manual load handling (e.g. in the construction industry or the healthcare professions).

7. Interventions focused on occupational groups and sectors that to date have not – or have only recently – become the focus of attention, above all in the services sector, as well as generally in all small and medium sized enterprises (SMEs). Intensification of efforts to find successful access and practical tools for SMEs, and monitoring of the use of available tools.

8. (Further) development and systematisation of the early warning systems in primary prevention (risk assessment tools) and secondary prevention (occupational health screening and surveillance).

9. Comprehensive development of effective case management with workplace-focused return-to-work programs, with measures taken to remedy current co-operation deficits within the medical provision system.

10. Support of high-quality evaluative research with appropriate intervention and measuring methods.

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