

# Occupational musculoskeletal and mental health: Significance of rationalization and opportunities to create sustainable production systems – A systematic review

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## ABSTRACT

This literature review aims to identify occupational musculoskeletal and mental health effects of production system rationalization as well as organizational-level measures that may improve health outcome (“modifiers” in this review). A short review of the effect of ergonomic interventions is included as background and rationalization is discussed as a theoretical concept. Indicator variables for occupational musculoskeletal and mental health and related risk factors are presented. Variables with a generalized format were allowed in the literature searches (e.g., job satisfaction and absenteeism were accepted as risk factor and health indicator, respectively), suitable for the research fields of work sociology, organization science, human resource management (HRM) and economics research.

One hundred and sixty-two studies of rationalization effects on health and risk factors and 72 organization-level modifier results were accepted into the final database. Entries were sorted by rationalization strategy and work life sector, and trends in outcome (positive, mixed, no effect, or negative effect on health and risk factors) were determined.

Rationalizations have a dominant negative effect on health and risk factors (57% negative, 19% positive); the most negative effects were found for downsizing and restructuring rationalizations in general (71 studies negative, 13 positive) and for the health care sector in particular (36 studies negative, 2 positive). The rationalization strategy High Performance Work System (HPWS) was associated with the highest fraction positive outcome studies (6 of 10 studies). Other rationalization strategies (lean practices, parallel vs. serial production and mechanization level) reported intermediate results, in part dependent on work life sector, but also on the year when studies were carried out. Worker participation, resonant management style, information, support, group autonomy and procedural justice were modifiers with favourable influence on outcome.

It is concluded that production system rationalization represents a pervasive work life intervention without a primary occupational health focus. It has considerable and mostly negative influence on worker health, but this can be reduced by attention to modifiers. The results create a basis for new priorities in ergonomic intervention research.

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## 1. Introduction

Medical conditions diagnosed as musculoskeletal or psychological/mental (hereafter “mental”) disorders are a major cause of sick leave, threatening the welfare of individuals and the economics of companies and the society. Swedish statistics show the two diagnostic categories accounting for more than 60% of certified work-related health complaints with sick leave longer than 90 days

(AFA report, 2009). The associated symptoms of muscular pain, headache, stress symptoms, and sleeping problems represent dominating health complaints among European workers (Parent-Thirion et al., 2007), often occurring as comorbid symptoms (Hagen et al., 2002; Svendsen et al., 2006). Alternative explanations for the high prevalence of these conditions have been advanced, including leisure time activities, ethnicity/cultural values, changed attitudes to health, and social security system (e.g., Coggon, 2005); however, European statistics and authoritative reviews (N.R.C, 1999, 2001) conclude that musculoskeletal and mental disorders to a considerable extent are related to work demands. Measures to reduce risk factors for musculoskeletal and mental disorders have

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been introduced in work place interventions, but sick leave and, presumably, health problems are not appreciably reduced.

Most ergonomic intervention studies are designed to observe the effects of reduction in relevant risk factors impacting the individual worker, while this literature typically ignores the potential health consequences of measures to improve competitiveness and productivity. The rising power of capital markets, globalization of financial and product markets thereby increasing the sphere of competition, and rapid technological change create pressures for high performance at both corporate and individual levels (“work intensification”; Burchell et al., 2002; Docherty et al., 2002; Green, 2004). This trend is all-embracing in contemporary work life, affecting both private enterprises and public organizations. Rationalization of production can be considered the primary intervention process, powered by the need to maintain competitive performance and therefore continuously adapting to a rapidly changing context. Rationalization interventions may contribute to the poor impact of traditional ergonomic interventions and explain the high prevalence of work-related health problems in industrialized countries (Winkel and Westgaard, 1996). This point is indirectly acknowledged in reports as a suggested explanation of the low effect of workplace interventions (e.g., Landsbergis and Vivona-Vaughan, 1995; Saksvik et al., 2002). Thus, there is a need to understand the health effects of rationalization to ensure “sustainable production systems”, here defined as the joint consideration of competitive performance and working conditions in a long term perspective.

Previous reviews examining the health effects of changes to production systems are restricted in the type of change considered, e.g., Lean Production (Landsbergis et al., 1999) or precarious employment (Quinlan et al., 2001). A comprehensive review of the effects of production system rationalizations on musculoskeletal and mental health and related risk factors is thus motivated. Operative issues to be considered are (1) rationalization influences on musculoskeletal and mental health, (2) contextual factors that modify the effects of rationalization on workers health. A key issue for this review is to create a basis for new priorities in ergonomic intervention research to improve musculoskeletal and mental health.

## 2. Reviews of ergonomic intervention studies

An overview of ergonomic intervention research that aims to improve musculoskeletal and mental health of workers through improved ergonomics and psychosocial work environment is included to substantiate the above assertion of minimal effect of ergonomic interventions (Table 1). Systematic reviews, published in scientific journals or by the EU system and with clear definitions of inclusion, exclusion and quality criteria are listed. Publications based on non-systematic literature surveys (e.g., Shain and Kramer, 2004; Semmer, 2006; Bongers et al., 2006) and reviews of measures without a primary intervention purpose (e.g., return-to-work; Linton and van Tulder, 2001) are excluded. A further complement of ergonomic intervention reviews exist (e.g., <http://www.iwh.on.ca/systematic-reviews>), presenting conclusions in line with the reviews in Table 1.

Most reviews in Table 1 focus on the interventions to improve physical and/or psychosocial working conditions for the individual worker, or strengthen resilience to negative factors in the work environment. Seven reviews examine the effects of rationalization interventions (Cummings and Estabrooks, 2003; Egan et al., 2007b; Quinlan et al., 2001; Landsbergis et al., 1999; Morris and Cook, 1991; Platt et al., 1999; Zacharatos et al., 2007). A review considering the effects of task restructuring (Bambra et al., 2007) does not distinguish work environment and rationalization interventions.

Most reviews build upon the dominant paradigm in occupational health research: health issues are remedied in isolation from ongoing business and organizational activities. However, Egan et al. (2009) make the point that rationalization (“business”) interventions seem more likely to result in negative health outcomes. Organization-type interventions are included in a majority of reviews, but mostly as the attempted redistribution of pauses or work tasks at the individual level and not organizational changes targeting production needs. On the contrary, such interventions (designated “natural interventions” in ergonomics terminology) are often viewed upon as disturbances in ergonomics intervention research (e.g., Olsen et al., 2008).

Most reviews report weak evidence of positive intervention effects. Sustainability of effects over longer time periods is rarely considered and seems difficult to maintain (e.g., Giga et al., 2003). The best chance of success for interventions dealing with physical risk factors is (1) measures focusing organizational culture, with high commitment of stakeholders and flexible strategies for the reduction of risk factors, and (2) measures directed towards the individual worker, focusing workers at risk and using measures that actively involve the worker (e.g., Silverstein and Clark, 2004; Podniece et al., 2008). It is not possible to be specific as to the nature or proportion of measures with the best chance of success. Reviews of occupational stress interventions recommend organizational measures, but referring to group practices and not organizational changes targeting production needs. These reviews are also cautious in their conclusions (e.g., Routsalainen et al., 2008). Basically, conclusions are similar to the early review by the present authors (Westgaard and Winkel, 1997), illustrating the slow progress despite large resources allocated to practical measures and research. The list of 59 reviews in Table 1 indicates that ergonomic intervention research is a mature research field at a standstill in combating a serious societal problem. This has opened up a debate about the best way forward. Wells (2009) argues for a thorough review of the premises for ergonomic intervention research, implying that current practices are not optimized for positive impact. An alternative explanation is that production system rationalizations have a dominant negative impact on risk factors and health.

## 3. Rationalization

Due to varied and sometimes inconsistent views on the history and meaning of production system rationalization, this is defined and elaborated based on key references.

### 3.1. The concept of “Rationalization”

The first international consensus on a conceptual definition of the term “rationalization” seems to date to the World Economic Conference in Geneva in 1927 (p. 38). It was understood by rationalization “... the methods of *technique* and of *organisation* designed to secure the minimum *waste* of either effort or material. ...”. “Waste” was defined by the American Engineering Council in 1921 as lost production attributable to “... faulty management ...” or “... idle material, plant, equipment and men ...”, “... intentionally caused by owners, management or labour ...” and “... ill health, physical defects and accidents”. Thus, human factors were considered at this early stage, but obviously from a rationalization point of view.

The original definition of waste still seems to be valid. Different aspects of waste have been highlighted over time, depending on context (e.g. Björkman, 1996; Liker, 2004), which partly explains the many rationalization strategies presented in the literature. To design, order, and make a specific product or deliver a specific service, two categories of actions are involved, waste and its

**Table 1**

(A) An overview of evidence of effects in systematic reviews on ergonomic intervention research aiming to improve musculoskeletal and/or mental health of workers. Results are presented according to job type and focus of interventions considered within each review (individual resilience; engineering; organization; implementation strategy). Abbreviations: *LBP*: Low back pain; *MSD*: Musculoskeletal disorders; *neg*: negative; *pos*: positive; *WE*: work environment).

Reference	Job type	Specific intervention review focus	Intervention				Evidence of effects
			Individual resilience	Engineering	Organization	Implementation strategy	
Ammendolia et al., 2005	Various	Back belt, LBP	X				No evidence for pos effects on preventing lost time from occupational LBP
Aust and Ducki, 2004	Various	Health circles	X	X	X		Weak evidence for pos effect
Bambra et al., 2007	Various	Task restructuring		X	X		Limited evidence for pos effect of decreased demand, increased control, neg effect of increased demand, decreased control
Boocock et al., 2007	Various	Neck/upper extremity musculoskeletal conditions	X	X	X		Some evidence for individual and engineering/WE interventions
Brewer et al., 2006	Computer users	Computer workplace; upper body MSD	X	X	X		Moderate evidence for alternative pointing devices
Burton et al., 2006	Various	LBP	X	X	X		Weak evidence for multidimensional interventions, some effect of exercise
Caulfield et al., 2004	Public sector workers in Australia	Occupational stress	X		X		Weak evidence for seminar-based stress management programs, some effect of organizational/WE interventions
Cole et al., 2006	Various	Implementation strategy				X	Various intervention strategies provide evidence for selection of best implementation
Cummings and Estabrooks, 2003	Nurses	Hospital downsizing and restructuring			X		Evidence for reduced job satisfaction, physical and emotional health
Denis et al., 2008	Various	Implementation strategy				X	No difference in effectiveness on MSD prevention of complete, shortened and turnkey interventions
Driessen et al., 2010	Various	Physical and organizational interventions with RCT design		X	X		Little or no effect of ergonomic interventions
Egan et al., 2007a	Various	Employee control (participation and decision making)	X	X	X	X	Some evidence for pos effect of participation interventions on mental health
Egan et al., 2007b	Public utility and industrial workers	Privatization of public utilities and industries			X		Some evidence of neg effects of privatization on psychosocial health
Egan et al., 2009	Various	Implementation strategy				X	Business interventions more likely to cause negative health outcomes; no association of outcome to quality of reporting
Gebhardt, 1994	Various	Training, LBP	X				Modest evidence for effect of training on low back pain
Giga et al., 2003	UK workers, mainly public sector	Stress management	X		X		Some evidence of pos effect; organizational-level interventions show best results
Hess and Hecker, 2003	Various	Stretching at work	X				No clear pos effects
Hignett, 2003	Health care providers	Patient handling	X	X	X		Multifactor interventions most likely to be successful
Jellema et al., 2001	Various	Lumbar supports	X				No clear pos effects
Karas and Conrad, 1996	Various	Back belt, back schools, exercise/flexibility training, education; back injury	X				Evidence for pos effects of all four interventions; back school and exercise/flexibility training most pos
Karsh et al., 2001	Various	Ergonomic interventions for control of MSD	X	X	X		Multiple component interventions most effective. Mixed results most common, neg results rare
Kennedy et al., 2010	Various	Upper extremity disorders and indicators	X	X	X	X	Moderate evidence for some positive effects of combined intervention measures, but also evidence for no effect of some intervention strategies.
Koes et al., 1994	Various	Back schools	X				Weak evidence for pos effect of back schools in occupational settings
Koppelaar et al., 2009	Nurses	Improved patient handling	X	X	X	X	Barriers and facilitators to intervention implementation identified.

(continued on next page)

Table 1 (continued)

Reference	Job type	Specific intervention review focus	Intervention				Evidence of effects
			Individual resilience	Engineering	Organization	Implementation strategy	
Lagerström et al., 1998	Nurses	LBP	X	X			No clear pos effects
Lamontagne et al., 2007	Various	Stress management	X		X		Both individual and organizational in et al., 2007 management interventions show pos effect
Landsbergis et al., 1999	Various (mainly manufacturing and health care industry)	Lean production			X		Some evidence for neg effect in manufacturing jobs with ergonomic stressors
Lang et al., 2004	Nurses	Nurse-patient ratio			X		Limited evidence of more burnout with low nurse-patient ratio
Leyshon et al., 2010	Office workers	Office workers with symptoms of MSDs	X	X	X		No strong levels of evidence were identified
Lincoln et al., 2000	Various	Carpal tunnel syndrome	X	X	X		Some evidence for pos effect of multiple component programs
Linton and van Tulder, 2001	Various	Back and neck pain					Exercise show moderate pos effect
Maher, 2000	Various	LBP	X				Evidence for pos effect of exercise
Martimo et al., 2008	Jobs with heavy lifting	Training on working techniques and lifting equipment to prevent LBP	X	X			No evidence for pos effects
Michie and Williams, 2003	Various	Psychological ill health	X				Stress management and physical training pos effect
Mimura and Griffiths, 2003	Nurses	Stress management	X		X		Personal support programs show some effect
Morris and Cook, 1991	Various	Factory closure			X		Short-term reduction in mental health, improvement with new employment
Murphy, 1996	Various	Stress management	X				Combination of techniques most effective
Murta et al., 2007	Various	Stress management				X	No evidence regarding preferred implementation strategy due to incomplete reporting in cases
Parkes and Sparkes, 1998	Various	Stress management			X		No clear pos effects
Peñalba et al., 2008	Law enforcement officers	Psychological disorders	X				Weak evidence of pos effects
Platt et al., 1999	Various	Labour market conditions		X	X		Evidence for neg effects of workplace reorganization and new technology
Podniece et al., 2008	Various	MSD	X	X	X	X	Moderate evidence for pos effect of multidisciplinary approach; also pos effect of technical ergonomic measures, training, participative approach
Proper et al., 2002	Various	Physical activity programs	X				Limited evidence for pos effect on absenteeism
Proper et al., 2003	Various	Physical activity programs	X				Strong evidence for pos effect on MSD
Quinlan et al., 2001	Various	Precarious employment			X		Strong evidence for neg effect on OHS of outsourcing and restructuring/downsizing, some evidence for temporary workers
Richardson and Rothstein, 2008	Various	Stress management	X		X		Medium overall effect in meta analysis. Largest effect of cognitive-behavioral interventions
Rivilis et al., 2008	Various	Participatory ergonomic interventions				X	Moderate evidence for pos effect on MSD and sickness absence
Routsalainen et al., 2008	Health care workers	Stress/burnout	X		X		Limited evidence for pos effect of all strategies
Silverstein and Clark, 2004	Various	Ergonomic interventions for control of MSD	X	X	X	X	Moderate evidence for pos effect of multicomponent interventions; some effect of exercise and participatory approaches
Tompa et al., 2010	Various	Ergonomic interventions with economic evaluations	X	X	X		Evidence for financial merit of ergonomic interventions in some industrial sectors
Tullar et al., 2010	Health care workers	OSH interventions for control of MSD	X	X	X	X	Moderate evidence for pos effect of exercise, no effect of ergonomic training.
Tveito et al., 2004	Various	LBP	X		X		Some evidence of pos effect of exercise on sick leave and of multidisciplinary interventions on pain
van der Hek and Plomp, 1997	Various	Stress management	X		X		Some evidence of pos effect of organization-wide approaches; most studies report some kind of effect



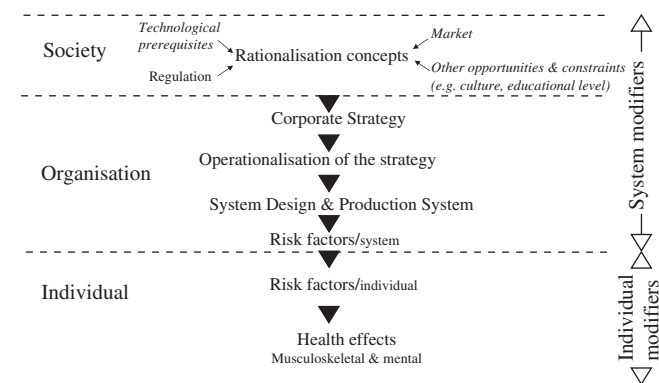
services are cut even though the perceived customer value deteriorates. This is by strict criteria a rationalization only if performance is not reduced to the same extent. However, studies that fulfil inclusion and exclusion criteria are retained in this review regardless of their effect on performance.

### 3.3. From rationalization strategy to health: a model

Fig. 1 conceptualizes the relation between rationalization and worker health effects. Other effects of rationalization (e.g., economics) are acknowledged, but are not considered here. At society level rationalization concepts are developed, driven by technological development and market conditions, as well as societal regulations and other opportunities and constraints. Rationalization concepts are a basis for corporate strategy. The strategy is adapted to a local context in the design of the production system. The choice of strategy may introduce risk factors at system level, i.e., independent of the individual worker. Each individual perceives risk factors that may cause musculoskeletal and mental health effects for some workers. Outcome along the main chain of events in the model may be modified at society, organization and individual level (shown on right side of Fig. 1). In this review there is a specific interest in modifiers at system level that influence risk factors and health effects at the individual level. Studies of societal aspects of this model in relation to risk factors, interpreting results in a rationalization perspective (e.g., the effect of recessions; Fenwick and Tausig, 1994), are excluded.

## 4. Musculoskeletal and mental disorders and associated risk factors

Traditional risk factors for musculoskeletal disorders relate to biomechanical and circulatory loads (N.R.C., 2001). Proposals for assessment of such risks include the NIOSH lifting equation (Waters et al., 1993) and limits to circulatory load (e.g., Jørgensen, 1985). Overexertion was in the early 1990s conceptually widened to include the time dimension of exposure, i.e., duration and time variation (“repetitiveness”) of the biomechanical load pattern, and the detrimental health effects of long duration, low amplitude exposure were recognized (Winkel and Westgaard, 1992; Westgaard and Winkel, 1996). Psychosocial exposures were indicated as risk factors for musculoskeletal complaints (Bongers et al., 1993), which is also current understanding (Bongers et al., 2006).



**Fig. 1.** Model conceptualizing the relation between rationalization concepts and worker musculoskeletal and mental health effects. Three levels of premise providers (society, company/public organization, and individual) are shown. Factors influencing the types of rationalization concepts developed are indicated. The relation between rationalization and health can be influenced both at system and individual level. The model is a further development of previously published models (Winkel and Westgaard, 1992; Westgaard and Winkel, 1997; Neumann et al., 2009).

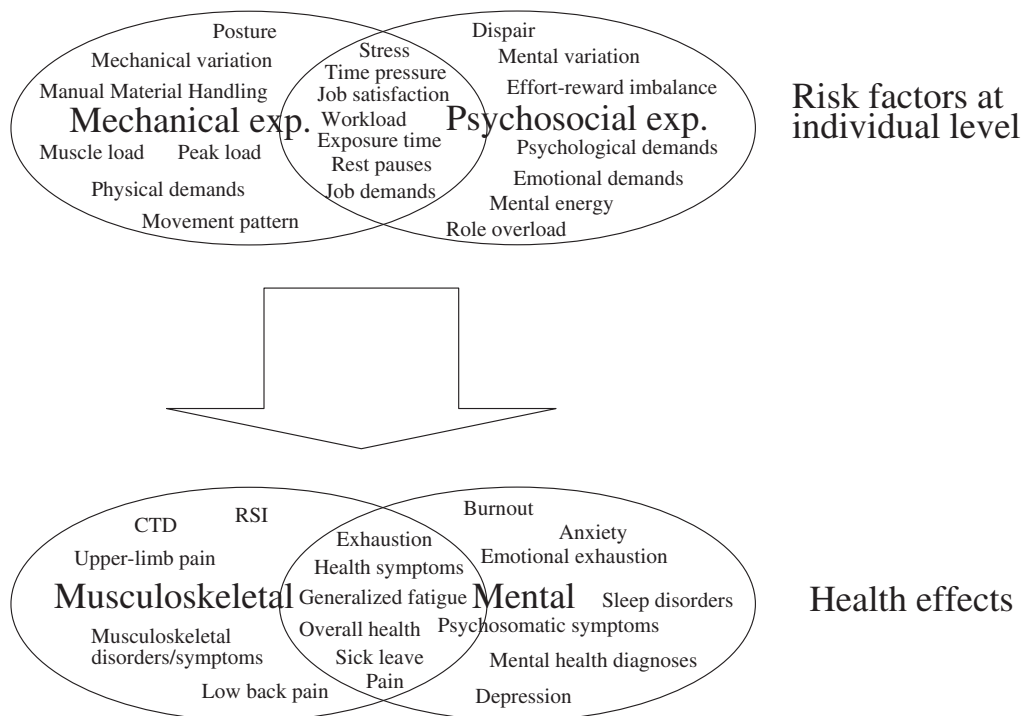
Longitudinal, population-based studies show the importance of individual psychosocial factors for the onset of localized pain (Macfarlane et al., 2000; Palmer et al., 2008). Conversely, persons free of musculoskeletal pain report absence of psychological distress factors (Jones et al., 2009). Specific injury mechanisms are not well understood for the most prevalent pain conditions in shoulder, neck and low back (e.g., Johansson et al., 2003; Visser and van Dieen, 2006), but it is accepted that multiple biological pathways to musculoskeletal complaints exist.

Mental disorders such as burnout, depression, and anxiety are recognized as potential occupational diseases (e.g., AFA report, 2009). Recent reviews show an association between working conditions and depression (Netterstrøm et al., 2008; Bonde, 2008). Stress due to task-related demands and social interactions at work seems important mediating factors (e.g., Holte and Westgaard, 2002; Bongers et al., 2006). Mental disorders (including somatization) and musculoskeletal complaints share symptoms such as pain, sleep disturbance, and fatigue (Nahit et al., 2003; Palmer et al., 2005). It is therefore difficult to differentiate between the two diagnostic categories and associated risk factors as occupational disorders. Classification of health outcome by medical diagnosis is not a concern in most studies relevant for this review. Inclusive risk indicators are therefore accepted, pointing to either musculoskeletal or mental conditions. In the discussion, “wellbeing” is used as an antonym for “negative musculoskeletal and mental health effects”.

Fig. 2 is a graphic illustration of this situation: musculoskeletal and mental disorders are intertwined as a medical condition (e.g., muscle pain and anxiety coexist), by health indicators (e.g., exhaustion), and by commonly used risk factors. Indicators are therefore treated as one entity in this review, ignoring that some clearly point at either musculoskeletal or mental conditions. Examples of non-specific indicators are time pressure and overall health. Indicators that point to health conditions or risk factors unrelated to musculoskeletal or mental illnesses (e.g., health effects due to exposure to chemicals) are excluded.

Only variables pointing directly to mechanical and/or psychosocial exposures or short-duration responses to such exposures are included as risk factors for musculoskeletal and mental disorders in this review. Variables pointing at a mental state that is influenced by conditions at work, but also by the individual (e.g., job insecurity, coping ability, negative affectivity), are considered individual-level risk factors. Such risk factors may be influenced by suitable intervention, but usually not as an integral part of a rationalization process. Individual risk factors are noted if investigated in an included study, but are not further discussed. Other variables recognized as risk factors for mental health (e.g., influence, meaningful work, predictability, social support, reward, trust, justice) describe conditions at work that influence psychosocial work demands. Such factors are treated as modifiers in this review; i.e., representing actions or targets of actions that in a rationalization process can influence health outcome. Modifiers are analyzed as independent variables that associate to primary risk factors or health effects in a rationalization process. Individual-level risk factors and modifiers are sometimes treated as dependent variables in studies; e.g., by determining conditions favourable for worker participation in a rationalization process or using job insecurity as a proxy for job stress. These studies are not part of the primary database unless the association to accepted outcome variables is analyzed.

Job satisfaction is accepted as a risk factor in this review, as an exception from the above rules. Job satisfaction associates strongly with both musculoskeletal and mental health (van Poppel et al., 1998; Hoogendoorn et al., 2002; Faragher et al., 2005; European Foundation for the Improvement of Living and Working



**Fig. 2.** Operational variables used in included studies to show risk factors or health effects of rationalizations. The figure illustrates how some variables are non-discriminative with respect to musculoskeletal and mental health conditions, and associated risk indicators. Note that health effects are rarely based on medical diagnoses, but usually on self-assessment of complaints.

Conditions, 2007) and is in many studies the only indicator of rationalization effects on workers. Effort-reward imbalance is equated with job stress (e.g., Dragano et al., 2005) and thus accepted as a risk factor. However, reward as part of effort-reward imbalance can be targeted in a rationalization process and is also a potential modifier (independent variable). Context determines how a study is assessed.

## 5. Material and methods

### 5.1. Establishing the literature base

The literature base is limited to studies published from 1990. Database searches aimed to identify studies that examined (1) the effect of rationalization on health or risk factors for musculoskeletal or mental illnesses, and (2) strategies or actions that influence such relations (“modifiers”). Included studies were identified in a multi-step process:

- Two database searches were carried out; (1) indicators of rationalization were combined with indicators of health effects or risk factors and (2) indicators of “organizational change process” were combined with indicators of “change management” (Table 2).
- Search criteria and procedures were adjusted to ensure that an initial pool of 20 papers from personal libraries, relevant for inclusion, was identified.
- Title and abstract of identified papers were read. Papers potentially satisfying inclusion criteria on the basis of title and abstract were read in full.
- Reference lists of included papers and relevant reviews were scrutinized.
- Authors publishing a significant number of relevant papers were targeted in supplementary searches.

- Titles of studies published the last 5 years in 20 journals within the subject areas of human and industrial relations, human resource management (HRM), and public management were examined. If a title indicated potential inclusion, abstract and (when necessary) the full paper were read.

Searches were performed in databases comprising biomedical, ergonomic, psychological, organization and business literature: Social Science Citation Index, Arts Citation Index, Medline, Sociological Abstracts, Social Services Abstracts, ERIC, EconLit, Arblin, PsycInfo, Ergonomic Abstracts, Business Source Elite, Academic Source Elite, RILOSH, CISDOC, HSELINE, and Nioshtic2. Initial searches were supplemented to cover the period until summer 2009.

Rationalization measures are mostly described by general terms such as rationalization, reorganization, restructuring, organizational change or downsizing. Searches that were reasonably specific in some databases identified unreasonably large amounts of literature (more than 10 000 papers) or no literature at all in other databases. As an example, “rationalization” has different meanings in business and psychology literature. In business literature, “health” is commonly used as in health of organizations. Database searches were therefore carried out in an iterative process. Occupational health effects of outsourcing as a rationalization strategy were recently covered by another review (Quinlan et al., 2001) and are therefore not included in this review.

About 4000 entries were identified in the initial searches, while the total number of studies assessed was more than double this number. Abstracts were independently reviewed by the authors. The full paper was read if either author judged a study potentially relevant. Inclusion with respect to rationalization or modifier effects was decided independently by the authors. In case of disagreement, the paper was discussed and discrepancies resolved.

**Table 2**

Search terms used to identify potential papers for inclusion in the present review. Search profile I combined indicators of health or risk factor (Boolean OR, 1st column) with indicators of rationalization (Boolean OR, 2nd column). Search profile II combined indicators of organizational change (Boolean OR, 3rd column) with indicators of change management (Boolean OR, 4th column). Terms were selected in trial searches for inclusive and specific results. \*-mark signifies additional letter(s) allowed.

Search profile I (Boolean AND)		Search profile II (Boolean AND)	
Health, risk factor	Rationalization	Organizational change process	Change management
Occupational health	Rationali*ation	Rationali*ation	Change management
Occupational disease*	Rationali*	Reengineering	Change management
Cumulative-trauma*	Downsizing	Re-engineering	Change strategy
Health effect*	Lean	Downsizing	Personnel management
Work environment	Lean production	Job change	Personnel*
Ergonomic*	Lean-production	Reorgani*ation	Best practice
Sick leave	Reorgani*ation	Reorgani*	Best-practice
Sickleave	Reorgani*	Organi* change*	Benchmarking
Absenteeism	Organi*ational change*	Organi*ational change	Employee participation
Workload	Organi*ational innovation	Organi*ational	Employee interaction
Work load	Organizational factors	Development	Employee*
Workload demands	Organizational design	Organi*ational	Participation
Work* condition*	Organi* change*	Innovation	Particip*
Wellbeing	Job change	Corporate reorganization	Communication
Well being	Job attitudes	Corporate turnaround*	Success factor*
Job satisfaction	Job sharing	Personnel change	Success*
Accident*	Reengineering	Employee-productivity	Positive*
Musculoskeletal	Re-engineering	Lean production	Failure*
Musculoskeletal disorders	Downsizing	Lean	Effort*
Musculoskeletal system	Outsourcing	Total quality Management	Strateg*
Muscl*	TQM		
Stress	Total quality		
Job attitudes	Total quality management		
Job autonomy	Employee-productivity		
Motor fatigue			
Postural fatigue			

### 5.1.1. Search for rationalization effects on health or risk factors

Inclusion criteria (one of the following):

- Studies of realized or intended rationalizations investigated by time-separated measurements.
- Studies reporting changes to health or risk factors of *past rationalizations* (historic prospective design).
- Comparison of production facilities or industries with organizational characteristics representing contrasts in rationalization philosophy, compared in a case-control manner or using correlational analyses in case of large data sets.
- Technological and/or organizational changes implemented to improve productivity and/or quality of products or services, studied by short-term comparison measurements of mechanical exposures at the work site.

Additional requirements (all required):

- Outcome variables interpretable as a health or risk factor effect.
- Papers published in English from 1990 in peer-reviewed scientific journals.
- The rationalization (“intended” if rationalization is not realized) at least summarily described (e.g., downsizing was accepted as a descriptor).

Upon reading the full paper, the following exclusion criteria were implemented:

- Changes to the production system or measures to improve physical and/or psychosocial exposures without the aim of rationalization (e.g., work stress interventions; Elo et al., 2008).
- Outcome variables not accepted as indicators of health or risk factors.
- Papers in a discussion format where empirical data is difficult to distinguish from secondary material or opinions (e.g., Chandler et al., 2002).

- Injuries due to accidents (except low back injuries).
- Laboratory or simulation studies of rationalization effects.
- Researcher-initiated, short-term changes to production system or worker reward structure.

Examples of excluded studies are D'Souza et al., 2006 and Elovainio et al., 2005 due to unclear significance of rationalization, Hårenstam and The MOA Research Group, 2005 due to primary data not reported, Kuipers et al., 2004 and Tyler and De Cremer, 2005 due to unclear interpretation of outcome variables in terms of health or risk factors, and Abst et al., 1994 and Doncevic et al., 1998 due to inadequate or missing control group in cross-sectional comparisons. Included studies were heterogeneous in research philosophy, design, variables, and size. Quality assessment of candidate studies was therefore individually based.

### 5.1.2. Search for modifier effects

The second search aimed to identify studies combining descriptions of a change process with descriptions of how this process is best managed. Indicators of health or risk factors were not part of the initial filter (Table 2), but papers judged not relevant were eliminated upon reading title, abstract and when necessary, the full paper.

Inclusion criteria:

- System level modifier: organizational measures, procedures or differences in organizational culture that influence health or risk factor outcome.

Exclusion criteria:

- Exclusion criteria similar to the above exclusion criteria.
- Worker characteristics susceptible to intervention at the individual level, e.g., coping strategy, unless the study otherwise qualified for inclusion.



## 5.2. Analysis

The analysis of included studies was based on two considerations, (1) epidemiological quality criteria and (2) workplace context. Epidemiological quality (e.g., Higgins and Green, 2008) is important in judging study quality, but important insight is lost if inclusion is based solely on such criteria. Studies of high epidemiological quality often lack detailed information on contextual factors that may explain outcome or serve as modifiers. In particular, qualitative studies often provide richer insights to supplement traditional quantitative study designs. Exclusion was therefore less strict than recommended for epidemiological based reviews. Instead, clusters of studies were identified and it was considered whether a dominant trend in results was supported by studies of good epidemiological quality.

It is intuitive that context (e.g., values, culture, history) influences the outcome of rationalizations. Work setting was categorized as health care, public, manufacturing or private service. A “mixed” category was added to include studies based on material covering several work life sectors.

Sometimes a series of papers is based on the same rationalization in the same study population. Such series are listed as one entry in the main table (Table 3), with results extracted from all publications. In a few cases independent rationalization studies are reported in the same paper, or clearly time-separated and different rationalizations are carried out on the same study group. These are noted in column 3 of Table 3 and treated as separate entries in Table 4.

Included studies were sorted according to context and rationalization strategy, and outcome trend (positive, zero, mixed, negative) determined. Quantitative assessment of outcome was considered, but the heterogeneity in reporting precluded such analyses. The “mixed” score designates studies where relevant outcome variables show both positive and negative effects. The dominant result was used in the summary tables, e.g., negative health outcome together with mixed or zero risk factor outcome was scored as negative. Rationalization strategy was classified according to the descriptors in the papers. Rationalization terminology is often imprecise, a point made in several studies. The category “lean practices” includes studies of contrasts in production systems that represent aspects of the lean production philosophy (e.g., JIT: Just-In-Time, TQM: total quality management, use of teams, standardization of work practices (Liker, 2004; Conti et al., 2006)). Three relatively well-defined strategies are presented separately: “parallel-serial” (i.e., line assembly vs. batch production where each worker or work group assembles a significant portion of a product) and “mechanization level” (assessed as manual, semi-automated and automated production systems) are predominantly studied in manufacturing production. A third strategy, High Performance Work Systems (HPWS), consists of a “bundle” of lean and human resource practices.

The differentiation of rationalization strategies “downsizing” and “restructuring” was a borderline decision for some studies: organizational restructuring may imply threat of or realized job loss while there will be restructuring following downsizing. A study was classified as downsizing if quantitative information on job loss was reported or a study considered the threat of job loss; otherwise a study was classified as restructuring.

The modifier format is explained in Section 4, but classification was sometimes a challenge; e.g., “control” was in some studies interpreted as participation (Karasek, 1990) or autonomy (Verhaeghe et al., 2008), in other studies control was an individual level modifier as in control coping (e.g., Armstrong-Stassen, 2004).

## 6. Results

### 6.1. Rationalization: association to health and risk factors

One Hundred and sixty-two studies presenting results on the association between rationalization and health or risk factors were included (Table 3). A summary of study outcome trends is presented in Table 4, sorted by rationalization strategy and occupational setting.

#### 6.1.1. Downsizing

This group ( $n = 34$ ) includes effects of anticipated downsizing, effects immediately following downsizing (i.e., effects relating to the downsizing process) and following longer-duration observation periods. Contextual descriptions range from situations with relatively bleak job prospects to situations where the downsizing process is carried out with concern for laid-off workers and good prospects for alternative employment. Downsizing is quantified as number of workers affected, percentage lay-offs, or type of downsizing (e.g., job loss vs. reduced working hours).

Results summary:

- *In general*, downsizing rationalizations are associated with a negative effect on health and risk factors for survivors.
- This trend is particularly strong for *health care*; all studies but one report negative outcome.
- Studies with *mixed or positive outcome* describe circumstances such as compensatory activities or individual preferences being met, potentially explaining a deviating outcome.
- *Anticipation of job loss or demotion* is associated with negative health and risk factor effects in the absence of material changes to the production system. The effect seems graded by severity (i.e., level or immediacy of threat).
- Effects of *realized downsizing* depend on the level of downsizing (worse health with more downsizing), exposure to repeated downsizing (worse health when exposed to several downsizing rationalizations) and immediacy (worse health for workers most affected).

**6.1.1.1. Studies of special interest.** The Finnish cohort study of municipal employees in the Raisio community (Kivimäki et al., 1997b and follow-up studies, see Table 3) and the expanded cohort study including three more communities (Vahtera et al., 2004, 2005) were carried out on the background of a crisis in the Finnish economy. There was an increase in musculoskeletal and mental disorders following downsizing. Main effects on risk factors were increased workload, more stress and reduced job satisfaction. An association between increased workload and musculoskeletal disorders is thereby indicated; however, psychosocial factors may also contribute to inferior health. Health effects and risk factors increased in a graded manner by level of downsizing.

Kalimo et al. (2003) and Moore et al. (2004) present examples of an increase in health complaints with anticipated or implemented downsizing, the increase graded by level and immediacy of threat to job.

Røed and Fevang (2007) provide a macro-perspective on responses of nurses to large-scale (more than 20%) downsizing, using economic-type modelling based on data from several Norwegian databases. Large-scale downsizing is associated with elevated risk of sick leave or retirement from work up to four years following the downsizing event. Downsizing in this study represents large-scale organizational change with transfer to new jobs, as unemployment remained low (0.2%).

One study of good epidemiological quality, based on survey material from the Stockholm region, showed reduced long-term sick

**Table 3**

Studies presenting results on the association between rationalization and health/risk factors and/or effect of modifiers on this association according to inclusion criteria. Job type in column 2 is categorized according to work life sector. Type of rationalization is in some cases described by two entries in column 3; first entry shows categorization in Table 4. This column also presents modifiers, shown by text in italics. Assessment of health effect, risk factor effect and modifier effect (pos, neg, mixed, or 0) are shown in parentheses in columns 6–8. Abbreviations: *HPWS*: High performance work system; *mths*: months; *N/A*: not applicable; *neg*: negative; *NPM*: New Public management; *pos*: positive; *yrs*: years; *0*: no effect.

Reference	Job type	Type of rationalization (+modifier information when studied)	Rationalization assessment (how and/or what)	Study design ●Design type ●Reference group ●N ●Study period	Main results: Health effect	Main results: Risk factor effect	Main results: Modifier effect
Adams et al 2000	Health care (nurses)	<u>Restructuring</u>	National Health Service organizational change. General description of changes to tasks: skill-mix, decision-making, managers' objectives	●Qualitative ●No ●100 ●N/A	N/A	Increased workload, limited increase in variation (neg)	N/A
Adler et al 1997	Study 1 and 2: <u>Manufacturing</u> (automotive workers)	Study 1: <u>Lean practices</u> Study 2: <u>Lean practices</u> ( <i>Participation - rationalization process</i> )	Description of production changes, management practices, health and safety issues	●Longitudinal (qualitative) ●Yes (by comparison with other plants) ●3700 ●3 yrs	●Yes Study 1: OSHA citations, more injuries in changeover period (neg) Study 2: Reduced injury rate (pos)	N/A	Study 2: Pos effect of attention to health and safety, worker involvement in rationalization (changeover) phase (pos)
Aiken et al 2002a, Sheward et al 2005 (UK data)	Health care (nurses)	<u>Downsizing</u> ( <i>Organizational support</i> )	Multi-national comparison of staffing levels, estimated by staffing level (patients per medical-surgical staff nurse)	●Crosssectional ●Yes (by staffing level) ●10319 (303 hospitals) ●N/A	Burnout associated with low staffing level (neg)	Job satisfaction worse with low staffing level (neg)	Organizational support reduces burnout and job dissatisfaction (pos)
Aiken et al 2002b	Health care (nurses)	<u>Downsizing</u>	Comparison of staffing levels in US hospitals, estimated by patients per nurse	●Crosssectional ●Yes (by staffing level) ●10184 (168 hospitals) ●N/A	Emotional exhaustion associated with low staffing level (neg)	More job dissatisfaction with low staffing level (neg)	N/A
Allen et al 2001	<u>Private service</u> (managers)	<u>Downsizing</u>	1/3 laid off	●Time-series ●No ●106 ●15 mths	N/A	Workload (role overload) increased (neg)	N/A
Amiot et al 2006	<u>Private service</u> (airline fleet workers)	<u>Restructuring</u> ( <i>Management style; Control coping; Escape coping</i> )	General description of airline merger	●Time series (2 post recordings) ●No ●220 ●2 yrs	N/A	N/A	Problem-focused coping related to higher job satisfaction (pos); good management favor problem-focused coping (pos), No effect of escape coping (0)
Armstrong-Stassen 2002	<u>Public</u> (government workers)	<u>Downsizing</u>	>20% reduction	●Time-series ●Yes ●49/118 ●3 yrs	N/A	Job satisfaction decreased, but recovering after period with active downsizing (mixed)	N/A
Armstrong-Stassen 2004	Study 1: <u>Health care</u> (nurses); Study 2: <u>Public</u> (government managers)	Study 1: <u>Downsizing</u> and restructuring ( <i>Organizational support; Control coping; Escape coping</i> ) Study 2: <u>Downsizing</u> ( <i>Control coping; Escape coping</i> )	Study 1: Hospital staff reduced by 400, original staff number not indicated; Study 2: >20% reduction	Study 1: ●Pre-post ●No ●179 ●2 yrs Study 2: ●Time series ●No ●154 ●2 yrs	Study 1: Burnout increased (neg) Study 2: Symptoms of poor health increased, burnout decreased (mixed)	Study 1: Job satisfaction decreased (neg) Study 2: N/A	Study 1: Org support associated with reduced burnout, higher job satisfaction (pos). Control coping associated with higher job satisfaction (pos), escape coping associated with burnout (neg). Study 2: Control and escape coping associated with more health symptoms, burnout (neg)
Armstrong-Stassen and Cameron 2003	Health care (nurses)	<u>Downsizing</u>	Staff in 4 hospitals reduced by 400 in 2 waves due to budget cutbacks	●Time series ●No ●111 ●6 yrs	N/A	Job satisfaction reduced (neg)	N/A
Babson 1993	<u>Manufacturing</u> (automotive workers)	<u>Lean practices</u>	Introduction of self-managed teams, but team leadership questioned by workers	●Historic prospective and qualitative ●No ●2380 ●Unclear	N/A	Workload increased following introduction of lean practices (neg)	N/A
Bacon and Blyton 2000	<u>Manufacturing</u> (steel industry workers)	<u>Lean practices</u> ( <i>Management style</i> )	Description of management motivation for introducing teams: variety of tasks, expertise, reward, power, decision	●Crosssectional ●Yes (by management motivation) ●22/20 (work sites) ●N/A	N/A	N/A	No effect of type of team (focus productivity vs. human concerns) on level of occupational ill health (0)

Balogh et al 2006	<u>Manufacturing</u> (production workers)	<u>Mechanization level</u> (2 comparisons: semi-automated vs. manual, automated vs. manual)	Description of work tasks at 3 mechanization levels (manual, semi-automated and automated lines)	●Crosssectional ●Yes ●31 ●N/A	N/A	Semi-automated vs. manual line: Reduced peak loads, more constrained postures (mixed) Automated vs. manual and semi-automated line: more variation in exposure (pos)	N/A
Bao et al 1996	<u>Manufacturing</u> (assembly workers)	<u>Parallel/serial</u>	Detailed description of two production systems. Cycle time 8 and 24 min	●Crosssectional ●Yes ●7/16 ●N/A	N/A	Minor differences between production systems in muscle load, body posture and movement patterns (mixed)	N/A
Bao et al 1997	<u>Manufacturing</u> (assembly workers)	<u>Lean practices</u>	Balancing of two serial production lines including work station layout	●Crosssectional ●Yes ●9,6 ●N/A	N/A	Improved line balancing reduced rest pauses (neg)	N/A
Batt 2004	<u>Private services</u> (telecommunication workers)	<u>Lean practices</u>	Detailed description of work organization with self-managed and problem-solving teams	●Crosssectional ●Yes ●554/637 ●N/A	N/A	Self-managed teams (workers) reported higher job satisfaction (pos)	N/A
Batt and Appelbaum 1995	Study 1: <u>Private service</u> (customer service and network craft workers); Study 2: <u>Manufacturing</u> (garment workers)	Study 1: <u>Lean practices</u> ( <i>Group autonomy, Social support at work</i> ) Study 2: <u>Parallel/serial</u>	Study 1: "Quality action teams" implemented. Details on group work and work setting, team autonomy Study 2: comparison of bundle, module, mini-line workers	●Crosssectional ●Yes ●466/322/462 ●N/A	N/A	Study 1: Higher job satisfaction in self-managed team when low interdependence to other teams (pos) Study 2: More workload and stress in parallel system, job satisfaction unchanged (neg)	Study 1: Social support at work: higher job satisfaction (pos). Self-managed groups: higher job satisfaction for teams with autonomy (pos)
Baumann et al 2001	<u>Health care</u> (nurses)	<u>Restructuring</u> ( <i>Job change</i> )	Downsizing in present job vs involuntary reallocation to job in another hospital	●Historic prospective and crosssectional ●Yes (with vs. without job change) ●1662 ●N/R	N/A	Workload increased for both groups (neg)	Group moved involuntary to another hospital neg affected relative to new job in same hospital (neg)
Bejerot et al 1999	<u>Health care</u> (dentists)	<u>Restructuring</u> ( <i>Management style</i> )	New control system implemented. Three management styles compared: objectives, dialogue, hierarchy	●Historic prospective ●Yes ●312/2659 ●N/R	N/A	Workload increased (neg)	Management by dialogue (best) and objectives pos compared to management by hierarchy (pos)
Berg et al 1994	<u>Health care</u> (nurses)	<u>Restructuring</u>	Patient-focused care: description of measures to care for demented patients	●Pre-post ●Yes ●19/20 ●1 yr	Reduced burnout in ward with patient-focused care (pos)	N/A	N/A
Bildt et al 2001; Fredriksson et al 2001	<u>Manufacturing</u> (automotive workers)	<u>Parallel/serial</u> ( <i>Participation - production</i> )	Description of two production systems. Cycle time 15-20 min and 15-90 s	●Pre-post (qualitative and quantitative) ●Yes ●43/33 and 57/45 ●1 yr	Less m-sk disorder in neck, shoulder and hand/wrist in parallel system (pos)	Reduced perceived exertion, worse posture, better psychosocial factors in parallel system (mixed)	Intended increase in worker participation not obtained (0)
Blythe et al 2001	<u>Health care</u> (nurses)	<u>Restructuring</u> and downsizing	Description of units closing and merging, lay-offs and relocation of staff in 3 hospitals	●Historic prospective, qualitative ●No ●59 ●N/R	N/A	Workload and stress increased (neg)	N/A
Bordia et al 2004	<u>Health care</u> (hospital workers)	<u>Restructuring</u> ( <i>Information</i> )	Description of job redefinitions, changes to organizational structure, new building	●Crosssectional ●No (contrast in quality of change communication) ●222 ●N/A	N/A	N/A	Good quality of change information increased job satisfaction; reduced psychological strain (pos)
Bordia et al 2006	<u>Health care</u> (hospital workers)	<u>Downsizing</u> (anticipated) ( <i>Information</i> )	Description of anticipated organizational and physical changes	●Crosssectional, qualitative ●Yes (contrast in exposure to rumors) ●1610 ●N/C	N/A	N/A	More change-related stress when exposed to negative rumors (neg)
Boumans and Landeweerd 1999	<u>Health care</u> (nurses)	<u>Restructuring</u>	Patient-focused care with team-based organization	●Time series ●Yes ●23/36 (time-staggered reorganization) ●14 mths	Perceived health improved in one (of two) groups; absenteeism unchanged (mixed)	Job satisfaction unchanged (0)	N/A
Bourbonnais et al 2005a, 2005b	<u>Health care</u> (nurses)	<u>Restructuring</u> ( <i>Social support at and outside work; Escape coping, Neg affectivity, Domestic load</i> )	Hospitals and community health care centers	●Time series and crosssectional/pre-post ●No (time series) and Yes ●1454 and 1437/961&2636 (2 control groups) ●6 yrs (sick leave); N/A and 4 yrs	Increased total sick leave (incl mental health diagnoses) during anticipation period and following restructuring; longer duration of sick leaves in anticipation period (neg)	Psychological demands increased (neg)	Social support at and outside work (pos), escape coping (neg), type A behavior (neg), high domestic load (neg) in relation to outcome variables.

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Table 3 (continued)

Brenner et al 2004; Fairis and Brenner 2001	Manufacturing (blue collar workers)	Lean practices (4 comparisons)	Survey reports from Bureau of Labor Statistics: TQM, QC, JIT, teams	•Crosssectional •Yes (by correlational analyses) •1848 establishments •1993	JIT and QC in manufacturing pos associated with CTD (neg x 2); TQM and teams not significantly associated with CTD (0 x 2)	N/A	N/A
Brenner and Östberg 1995	Public (office workers)	Restructuring	Description of changes to office environment and work tasks with introduction of office computers	•Time series •No •42 •18 mths	Unchanged, good health (0)	More demanding work tasks (pos stress), more job satisfaction, increase in cortisol (pos)	N/A
Brett and Tonges 1990	Health care (nurses)	Restructuring	Description of patient-focused care model	•Time series •No •42 •9 mths	N/A	Work load increased, job satisfaction unchanged (mixed)	N/A
Brown et al 2003	Health care (nurses and doctors)	Downsizing	Hospital staff reduction 20%	•Time series •No •1002 •5 yrs	N/A	Workload increased, mental energy reduced (neg)	N/A
Brown et al 2006	Health care (nurses)	Restructuring	Assessed by 16 restructuring events in health care organizations following merger	•Pre-post •Yes •71/188/92 •6 mths	N/A	Nurses most affected by restructuring reported higher job stress, job pressure, lower job satisfaction (neg)	N/A
Bryson 2004	Public (university academic workers)	Restructuring	Description of standardization and documentation demands in the UK university system	•Historic prospective •No •1168 •N/A	N/A	University restructuring associated with higher workload, more stress (neg)	N/A
Carayon et al 1999	Public (office workers)	Lean practices	Description of TQM activities introduced in 6 departments from 2 organizations	•Crosssectional (4 units)/ pre-post (2 units) •No •424; 70 •N/A/unknown	N/A	TQM showed pos impact on some psychosocial factors, neg impact on workload (mixed)	N/A
Cartwright et al 2007	Public (office workers)	Restructuring (anticipated) (Participation - rationalization process)	Description of merger initiatives involving 2 universities	•Crosssectional •No •333 •N/A	N/A	N/A	Consultation and influence on rationalization (merger) process assoc with less stress (pos)
Christmansson et al 1999	Manufacturing (blue collar workers)	Lean practices (Participation - production)	Description of manufacturing production organized in self-managed teams	•Pre-post •No •12 •3 yrs	Unchanged prevalence of m-sk symptoms (0)	More mechanical variation, more manual handling. Psychosocial climate both improved and impaired (mixed)	Team-based production did not achieve all goals (mixed)
Conti et al 2006	Manufacturing (assembly workers)	Lean practices (Participation - rationalization process; Participation - production; Social support at work)	Description of 11 lean practices, rationalization assessed by number of practices introduced	•Crosssectional •Yes (level of lean implementation) •1391(21 sites) •N/A	N/A	Inverted U-shaped association between no of lean practices and job stress; partial implementation most neg (mixed)	Less stress with worker participation in improvement programs (pos), teamwork (pos), social support at work (pos)
Cordery et al 1991	Manufacturing (process workers)	Restructuring	Detailed description of work organization and tasks for autonomous groups in existing and new factory	•Crosssectional •Yes •16+~110/~100? •N/A	Absenteeism reported; results not presented consistently in relation to study contrast (no result)	Autonomous work groups reported higher intrinsic and extrinsic job satisfaction (pos)	N/A
Corey-Lisle et al 1999	Health care (nurses)	Restructuring	Description of "managed competition" in health maintenance organizations	•Qualitative •No •375 •N/A	N/A	Increased workload and stress, reduced job satisfaction (neg)	N/A
Coury et al 2000	Manufacturing (assembly workers)	Mechanization level (2 comparisons: semi-automated vs. manual, automated vs. manual)	Description of work tasks at manual, semi-automated and automated lines	•Crosssectional •Yes •4 •N/R	N/A	Semi-automated vs. manual: more repetitive (neg). Automated vs. manual: less repetitive (pos)	N/A
Cummings et al 2005	Health care (nurses)	Restructuring (Management style)	No of restructuring events assessed	•Crosssectional •Yes •6526 •N/A	Increased emotional exhaustion following restructuring events (neg)	N/A	Resonant leaders assoc with less emotional exhaustion and psychosom symptoms, higher job satisfaction (pos)
Danford et al 2004	Manufacturing (aerospace workers)	HPWS	Detailed description of HPWS practices	•Historic prospective + qualitative data •No •604 •3 yrs	N/A	HPWS practices associated with increased demands on amount of work, no of hours, most pronounced for managers (neg)	N/A
Danford et al 2008	Mixed (aerospace, finance, insurance, local authority, hospital workers)	HPWS	Detailed description of HPWS practices	•Crosssectional •Yes (by correlational analyses) •2575 •N/A	N/A	HPWS practices pos associated with job satisfaction, neg assoc with job stress (mixed)	N/A

Davidson et al 1997	Health care (nurses)	Downsizing (Information)	Hospital operating budget cut by 7.5%. Description of restructuring initiatives	●Pre-post ●No ●358 ●2 yr	N/A	Increased time pressure, overload; reduced job satisfaction (neg)	Improved instrumental communication reduces time pressure and improves job satisfaction (pos)
Davy et al 1991	Manufacturing (research, development, manufacturing workers)	Restructuring (Participation-production; Procedural justice)	Downsizing implemented during study, but no quantitative information given	●Crosssectional ●Yes (by correlational analysis) ●88 ●N/A	N/A	N/A	Participation (assessed ahead of layoffs) (pos) and perceived fairness of layoffs associated with higher job satisfaction (pos)
Dekker and Schaufeli 1995	Public (transportation company workers)	Downsizing	Description of closure process with timing information, 2 of 4 departments closed	●Pre-post ●Yes ●32 leavers/63 stayers: control group continuously threatened ●2 mths	Anticipation of job loss associated with impaired psychological health (neg)	N/A	N/A
Denton et al 2002	Health care (home care workers)	Restructuring (Organizational support)	Description of NPM restructuring initiatives	●Crosssectional and qualitative ●Yes (by correlation to restructuring impact) ●892 respondents to survey, 16 focus groups ●N/A	N/A	Increased workload, work demands, emotional demands, job stress, reduced job satisfaction (neg)	Organizational support reduces neg effect of restructuring on job satisfaction (pos)
Desombre et al 2006	Health care (health care workers)	Restructuring	Description of initiatives to generate functional flexibility in health care services	●Qualitative ●No ●18 interviews ●N/A	N/A	More job variety, but increased stress and work intensification (mixed)	N/A
Devine et al 2003	Health care (health care workers)	Downsizing (Reemployed leavers)	Budgets reduced by 17% (14753 displaced). Description of cost-cutting measures in Canadian metropolitan area	●Crosssectional (stayers vs. reemployed leavers) ●Yes ●435/173 ●N/A	General health worse for stayers (neg)	Job stress higher, job satisfaction worse for stayers (neg)	Reemployed leavers have better general health and job satisfaction than stayers (pos)
Doyle et al 2000	Mixed (senior and mid-level managers in public and private sector)	Restructuring	Diverse mix of experiences with organizational changes. Description of 10 types of organizational change	●Crosssectional ●Yes (by public vs. private, senior vs. middle managers) ●92 ●N/A	N/A	Work intensification is generally occurring. Public sector most affected (neg)	N/A
Dragano et al 2005	Mixed (national survey of German workers)	Downsizing	Cross-national survey with question on staff reduction	●Crosssectional ●Yes ●22559 ●N/A	Neg health effect of downsizing, synergistic interaction with job stress (neg)	N/A	N/A
Evans et al 1999	Public (bus drivers)	Restructuring	Description of measures to improve bus operations	●Pre-post ●Yes ●10/31 ●18 mths	N/A	Reduced blood pressure, heart rate, perceived stress (pos)	N/A
Ferrie et al 1995, 1998, 2001, 2002, 2006	Public (office workers)	Restructuring (Procedural justice)	Description of restructuring initiatives with anticipated and realized introduction of NPM: job change, anticipating change, no change (3 groups)	●Time series, pre-post, crosssectional ●Yes ●526/7607; 7149; 6667; 509 ●8 yrs	Deterioration in self-reported health for men, but not women. Effect both for realized and anticipated restructuring (neg)	Increased job demand for females (neg)	Relational justice associated with good mental health (pos)
Foster and Hoggett 1999	Public (office workers)	Restructuring (Management style; setting)	Introduction of NPM in Benefits Agency. Description of implementation in different branches	●Historic prospective (qualitative) ●No ●>70 interviews + group discussions ●N/A	N/A	Stress level and workload increased (neg)	Effects of NPM depended on setting including org culture (mixed). Resonant management style had pos effect on wellbeing (pos)
Froese et al 2008	Manufacturing (automotive workers)	Restructuring (Management style)	Description of acquisition process (by multinational companies) and changes to management philosophy	●Crosssectional ●Yes ●89/60/27 ●N/A	N/A	N/A	Incremental introduction of new org culture in cooperation with employees associated to job satisfaction (pos)
Fuss et al 1998	Health care (hospital workers)	Restructuring	Description of changes to care paradigm: revamping of work processes, redesigned staff roles, multidisciplinary teams, improved functionality	●Pre-post ●No ●98 ●6 mths	N/A	Mixed outcome for job satisfaction items for nurses and physicians, pos for technical support (mixed)	N/A
Gillespie et al 2001	Public (university workers)	Restructuring (Management style)	Description of NPM changes to universities	●Historic prospective (qualitative) ●No ●22 focus groups from 15 universities ●N/A	N/A	Stress level and workload increased (neg)	Employee consultations, staff input and management transparency reduced stress (pos)

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Table 3 (continued)

Green 2004	Mixed (UK national survey)	Restructuring	Identify sources of work intensification: new technology, work organization, task flexibility, high-involvement policies, effort incentives in UK survey material	<ul style="list-style-type: none"> <li>•Prospective and cross-sectional</li> <li>•Yes (by correlational analyses)</li> <li>•1934 interviews of managers</li> <li>•5 yrs/N/A</li> </ul>	N/A	New technology, work organization and high-commitment policies important sources of work intensification. Effort intensification higher in public sector (neg)	N/A
Greenglass and Burke, 2000a,b; Burke and Greenglass, 2000a,b, 2001a,b; Burke, 2003	Health care (nurses)	Restructuring (Organizational support; Control coping, Escape coping)	Description of 16 hospital restructuring events, e.g., budget cuts, staff layoffs, beds closed,	<ul style="list-style-type: none"> <li>•Pre-post and cross-sectional</li> <li>•No (pre-post), yes (by correlational analyses) •1363; 393 •N/A</li> </ul>	Restructuring index associated with emotional exhaustion (neg)	Restructuring index associated with more work load, reduced job satisfaction, more anger (neg)	Hospital support associated with higher job satisfaction, less psychosomatic symptoms, burnout (pos). Control coping associated with higher job satisfaction and less psychosomatic symptoms (pos), opposite relations with escape coping (neg).
Guimaraes 1997	Manufacturing (line workers, managers)	Lean practices	TQM introduced, no details given	<ul style="list-style-type: none"> <li>•Pre-post •No •73 •2 yrs</li> </ul>	N/A	Job satisfaction higher following TQM introduction (pos)	N/A
Gulliver et al 2003	Health care (hospital workers)	Restructuring	Merging of mental health and social care organizations, new management, "shared culture" introduced	<ul style="list-style-type: none"> <li>•Time series •No •107 •32 mths</li> </ul>	Emotional exhaustion higher (neg)	Job satisfaction reduced (neg)	N/A
Gustafsson and Saksvik 2005	Public (refuse collectors)	Restructuring	Introduction of NPM with competitive tendering in refuse collection	<ul style="list-style-type: none"> <li>•Time series (qualitative) •Yes •27/19 •3 yrs</li> </ul>	Higher sick leave following restructuring (neg)	Higher workload (neg)	N/A
Guthrie et al 2009	Mixed (manufacturing and service workers)	HPWS	Detailed description of HPWS practices	<ul style="list-style-type: none"> <li>•Cross-sectional •Yes (by correlational analyses) •165 companies •N/A</li> </ul>	HPWS practices associated with reduced absenteeism (pos)	N/A	N/A
Hamilton et al 1990	Manufacturing (automotive workers)	Downsizing	Description of automotive plant closure (29 000 workers affected) and contextual factors, e.g., guaranteed benefits for workers	<ul style="list-style-type: none"> <li>•Cross-sectional •Yes •831/766 •N/A</li> </ul>	No effect on mental health for workers anticipating job loss (0)	N/A	N/A
Härenstam et al 2004	Mixed (workers in public organizations and private companies)	Restructuring (3 comparisons: market-adjusting, standardizing, centralizing); Lean practices	4 rationalization categories are described (market-adjusting, lean, standardizing, centralizing) work sites and are compared to stable organizations	<ul style="list-style-type: none"> <li>•Two-year historic organization) •Yes (stable organization) •208 from 72 work sites •N/A</li> </ul>		Worst working conditions in standardizing and market-adjusting organisations. Lean and centralizing organizations also neg relative to stable organizations. More deterioration for public sector vs. private employees (neg x4)	N/A
Harley 2001	Mixed (UK national industrial survey)	Lean practices	Degree of team membership assessed by working together, team-appointment of team leader, team discretion and team responsibility	<ul style="list-style-type: none"> <li>•Cross-sectional •Yes •2401/1502 •N/A</li> </ul>	N/A	No effect of team membership on work stress, job satisfaction (0)	N/A
Harley 2002	Mixed (Australian national industrial survey)	HPWS	Detailed description of items included in HPWS practices	<ul style="list-style-type: none"> <li>•Cross-sectional •Yes (by correlational analyses) •14067 •N/A</li> </ul>	N/A	HPWS practices show no or weak associations with job satisfaction, stress (0)	N/A
Harley et al 2007	Health care (nurses, personal care workers)	HPWS	Detailed description of variables included in HPWS practices	<ul style="list-style-type: none"> <li>•Cross-sectional •Yes (by correlational analyses) •1318 •N/A</li> </ul>	N/A	HPWS practices perceived dominant pos with respect to job satisfaction, reduced psychological strain (pos)	N/A
Hellgren et al 1999; Isaksson et al 2000	Private service (administrative workers in company headquarters)	Downsizing (Participation - rationalization process; Procedural justice; Neg affectivity)	42% overall reduction in repeated downsizing (2 waves)	<ul style="list-style-type: none"> <li>•Pre-post •Yes •395 (~50 % with change in work tasks) •1yr</li> </ul>	More distress symptoms for workers experiencing change in work tasks (neg)	Downsizing increased workload, reduced job satisfaction (neg)	Participation in rationalization process reduced distress (pos). Neg affectivity impaired physical and mental health (neg). No effect of perceived fairness of process (0)

Hertting et al 2004	Health care (nurses)	Downsizing	Hospital downsizing: 20 % reduction, 10 % relocation (also 43 % reduction in assistant nurses)	•Time series: qualitative •No •14 •3 yrs	N/A	Increased work demands (neg)	N/A
Heyes 1996	Manufacturing (process workers)	Restructuring	Description of restructuring initiatives, e.g., multi-skilling for increased flexibility, empowerment	•Qualitative •No •? •N/A	N/A	Work intensification generally occurring (neg)	N/A
Hinduan et al 2009	Private service (bank workers)	Restructuring (Management style)	Description of merger of 2 banks	•Qualitative •No •57 (leaders), 91 (followers) •N/A	N/A	N/A	Transformational leadership pos effect on job satisfaction when workers are open to change (pos)
Idel et al 2003	Health care (nurses)	Restructuring (Job change)	Description of merger of 2 hospitals	•Pre-post •Yes (transferring to new building vs. non-transferring) •37/56 •7.5 mths	N/A	N/A	Nurses transferring to new building had more emotional distress and higher threat perception (neg)
Ingersoll et al 2001	Health care (nurses)	Restructuring	Description of restructuring in 2 hospitals with introduction of patient-focused care	•Historic prospective (qualitative) •No •48 (12 focus groups) •N/A	N/A	Distress, despair, physical exhaustion reported by focus groups (neg)	N/A
Isaksson and Johansson 2000	Private service (office workers)	Downsizing (Participation - rationalization process)	Job loss through early retirement: stayers vs. leavers, forced vs voluntary choice compared	•Pre-post •Yes •226/144 •1.5 yrs	No effect for stayers (improved health for leavers) (0)	No change in wellbeing for stayers (0)	Voluntary (vs. forced) choice of staying pos for psychological wellbeing and health (pos)
Jackson and Martin 1996	Manufacturing (assembly workers)	Lean practices	Description of new JIT line	•Pre-post •Yes •21/23 •8 mths	N/A	Increased workload, reduced job satisfaction on JIT line (neg)	N/A
Jackson and Mullarkey 2000	Manufacturing (garment workers)	Lean practices	Description of conventional line and cell system (quick-response teamworking)	•Crossectional •Yes •242/314 •N/A	N/A	Job satisfaction and job-related strain similar between systems; no clear advantage to either system (mixed)	
Jimmieson et al 2004	Public (government workers)	Restructuring (Information; Neg affectivity; Self-efficacy)	Description of organizational change to improve services in government department	•Pre-post •Yes (by correlation analysis) •213 •N/A	N/A	N/A	Change-related information increased psychological wellbeing and job satisfaction (pos). High early self-efficacy related to later high job satisfaction (pos). Neg affectivity neg related to psychol wellbeing (neg)
Johansson et al 1993	Manufacturing (automotive workers)	Parallel/serial	Description of serial and parallel systems. Cycle time 6-12 min and 20-45 min	•Crossectional •Yes •17/28 •N/A	No difference in m-sk disorders (0)	Improved posture, more manual handling, impaired psychosocial environment in parallel system (mixed)	N/A
Johnson et al 1996	Private service (insurance company workers)	Downsizing (Organizational support)	Two events of downsizing; in total 16.4 %.	•Time series •Yes (contrast by level of support) •37 •about 3 mths	N/A	N/A	Manager communication support associated with higher job satisfaction (pos)
Johnson et al 2006	Health care (health care workers)	Restructuring (Participation - rationalization process)	Quantification of direct and indirect changes experienced by workers in health care org	•Crossectional •Yes (by correlation analysis and by type of change experienced) •919 •N/A	N/A	More stress with both direct and indirect org change (neg)	Increased influence over restructuring rationalization reduced stress (pos)
Jones et al 1997	Health care (hospital workers)	Restructuring	Description of multidisciplinary collaboration for patient-focused care	•Pre-post •No •54 •1 yr	N/A	Job satisfaction increased and decreased, depending on professional group (mixed)	N/A
Kadefors et al 1996	Manufacturing (automotive workers)	Parallel/serial	Description of serial and parallel (with car tilting device) systems. Cycle time 2 min and 1.5-6 hr	•Crossectional •Yes •5/? •N/A	N/A	More upright posture in parallel system, consequent reduction in muscle load (pos)	N/A

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Table 3 (continued)

Kalimo et al 2003	Mixed (Finnish national survey)	Downsizing	Past and future downsizing measures (anticipated, realized, lay-offs, reduced working hours, delayed rehiring) assessed by questionnaire	•Crosssectional •Yes (comparing downsizing event with non-event) •1297 •N/A	Increase in health complaints, exhaustion with implemented or anticipated downsizing; graded by type of downsizing (neg)	N/A	N/A
Kalmi and Kauhanen 2008	Mixed (Finnish national survey)	HPWS	HPWS characterized as self-managed teams, information sharing, incentive pay, training	•Crosssectional •Yes (by correlational analysis) •4104 •N/A	N/A	HPWS practices pos associated with higher job satisfaction and lower stress. Reduced effect with fewer HPWS practices. (pos)	N/A
Karasek 1990	Mixed (office workers)	Restructuring (Participation - rationalization process)	Organizational change assessed by questionnaire	•Crosssectional •Yes (subjects without change) •1937/6567 •N/A	Impaired physical health (m-sk, stomach, respiration) with restructuring (neg)	Increased depression, exhaustion, job dissatisfaction with restructuring (neg)	Influence over restructuring rationalization associated with less impairment of health and risk factors (pos)
Karia and Asaari 2006	Mixed (public and private workers)	Lean practices	Questionnaire on TQM practices: customer focus, training, empowerment and teamwork, continuous improvement	•Crosssectional •Yes (different TQM practices) •104 •N/A	N/A	Higher job satisfaction with training, teamwork, empowerment, continuous improvement (pos)	N/A
Kazmierczak et al 2005, 2007	Manufacturing (automotive workers)	Parallel/serial	Description of serial and parallel systems. Cycle time 7-17 min and 0.5-8 hrs	•Crosssectional •Yes (comparing separate studies) •10/10 •N/A	N/A	Higher peak back loads, more variation in parallel production (mixed)	N/A
Kinneman et al 1997	Health care (nurses)	Restructuring	Description of restructuring measures in patient-focused care including physical and organizational changes	•Pre-post •No •54 •3 yr	N/A	Job satisfaction higher with patient-focused care (pos)	N/A
Kivimäki et al. 1997, 1998, 2000, 2001, 2003; Vahtera et al 1997, 2000	Public (local authority workers)	Downsizing (Social support at work; Social support outside work; Reemployed leavers; Neg affectivity)	Register data on working hours by occupational group and levels of downsizing (<8, 8-13, 13-18, >18%); comparing stayers and leavers	•Time series •Yes (level of downsizing) •757-981 •2-5 yrs	Certified sick leave (total and m-sk) and m-sk pain increased by amount of downsizing (neg)	Physical demands increased by amount of downsizing, psychological demands unchanged (neg)	Social support at and outside work had no effect on sick leave (0). Female leavers reemployed have better health (pos). Neg affectivity associated with higher sick leave (neg).
Kivimäki et al 1997	Health care (hospital workers)	Lean practices	TQM introduced in clinic. Description of new measures (skill training, teams)	•Pre-post •Yes •72/126 •1 yr	N/A	Job satisfaction unchanged (0)	N/A
Korunka et al 1995	Mixed (private and public sector workers)	Mechanization level (Participation - rationalization process)	First-time implementation of VDUs with description of job contents (CAD, clerical work, "relatively monotonous", "extremely monotonous")	•Pre-post •Yes (by comparison of job content) •28/25/18/29 •14 mths	Increased psychosomatic complaints, mainly for extremely monotonous work. Increased shoulder complaints with clerical work (mixed)	Job satisfaction increased with CAD, decreased for extremely monotonous work (mixed)	Participation in implementation process pos associated with reduced psychosomatic complaints, greater job satisfaction (pos)
Korunka and Vitouch 1999	Mixed (private and public sector workers)	Mechanization level (Participation - rationalization process; Learning)	Implementation of new office IT systems. Description of implementation characteristics	•Time series •Yes •212/119 •22 mths	N/A	N/A	Participation and learning new procedures are associated with reduced strain and increased job satisfaction (pos)
Korunka et al 2003	Public (managers, administrative workers, customer service workers, technicians)	Restructuring (Group autonomy)	NPM introduced. Description of restructuring effects for the different worker categories	•Time series •No •183 •1yr	N/A	Job strain and perceived stress increased; job satisfaction higher in all categories except customer service (mixed)	Customer service workers (lowest autonomy) experienced restructuring more neg than the other groups (pos)
Kramer et al 2004	Private service (pilots)	Restructuring (Information)	Description of merger of two airlines and plans for integration process	•Time series •Yes (by correlational analyses) •104 •7 mths	N/A	N/A	Information from officials, peers, and union increased satisfaction and reduces stress (pos)
Kruglanski et al 2007	Study 1-3: Not relevant Study 4: Public (postal workers)	Restructuring	NPM implemented. Description of restructuring and training initiatives	•Pre-post •No •47 •2 mths	N/A	Job satisfaction increased following restructuring and training (pos)	N/A
Krugman et al 1999	Health care (nurses)	Restructuring	Two successive interventions, 1) professional development and autonomy, 2) skill-mix with reduction in resources	•Time series •Yes •162/100 •5 yrs	N/A	Job satisfaction unchanged through both interventions (0)	N/A



Lam 1995	Private service (front-line supervisors)	Lean practices	TQM introduced, no details given	•Historic prospective •No •211 •N/A	Workload increased; job satisfaction decreased (neg)	N/A
Laschinger and Leiter 2006	Health care (nurses)	Restructuring (Management style; Participation - production)	Staff and resource adequacy assessed by questionnaire; also participation, leadership	•Crosssectional •Yes (by correlation to restructuring assessment scores) •8597 •N/A	Adequacy of staffing negatively related to emotional exhaustion (neg)	N/A Leadership and participation (policy involvement) neg related to emotional exhaustion (pos)
Lee and Teo 2005	Health care (medical service company workers)	Restructuring (Social support at work)	Description of new management, changes to work processes and work flow	•Pre-post •No •72/71 •3 mths •N/A	Job satisfaction reduced; largest effect with most change (neg)	Social support at work improved job satisfaction (pos)
Leroyer et al 2006	Manufacturing (automotive workers)	Lean practices	TQM introduced. Description of changes (more tasks per operator, standardization, training)	•Time series •No •64 •1 yr	General health reduced, infirmatory visits increased (neg)	Psychological and physical job demands increased (neg) N/A
Lewchuk and Robertson 1996	Manufacturing (automotive workers)	Lean practices	Site visits of 16 companies assessing production systems as lean, changing towards lean, exploitative, Fordist	•Crosssectional •Yes •1670 •N/A	Perceived health reduced last 2 yrs, similar for all 4 groups (neg)	Workload, work pace high and increasing for all 4 groups. Worse effects for lean and exploitative companies (neg) N/A
Lewchuk and Robertson 1997	Manufacturing (automotive workers)	Lean practices	Expert judgement of level of lean implementation (4 plants with variable implementation of lean practices)	•Crosssectional •Yes •2424 •N/A	N/A	Work pace high, difficult to take unscheduled breaks. Highest job demand in plants with highest level of lean implementation (neg) N/A
Lindberg and Rosenqvist 2005	Health care (hospital workers)	Restructuring	Description of downsizing, merger, change in leadership and TQM implementation in intensive care unit	•Time series •No •36 •3 yrs	Sick leave increased (neg)	Workload increased, stress symptoms unchanged (neg) N/A
Lloyd and James 2008	Manufacturing (food processing workers)	Lean practices	Description of customer-controlled just-in-time system, integrated in supply chain	•Historic prospective (qualitative) •No •34 •N/A	Supply-chain requirements associated with high prevalence of upper limb disorders (neg)	Supply-chain requirements associated with increased work pressure (neg) N/A
Löck and Arnetz 2000	Health care (nurses)	Restructuring	Description of change in care paradigm and work culture, controls to group receiving stress intervention relevant	•Time series •Yes •14/12 •30 wks	N/A	No change in work demand for controls (0) N/A
Luthans and Sommer 1999	Health care (hospital workers)	Downsizing	>8% job loss, lay-offs, pay period reduced from 80 to 70 hrs per 2 wks	•Time series •Yes (time-staggered implementation) •261 •3 yrs	N/A	Job satisfaction reduced. Marginal difference in responses of managers and front-line personnel (neg) N/A
Macky and Boxall 2007	Mixed (New Zealand working population postal survey)	HPWS	Detailed description of HPWS practices	•Crosssectional •Yes (by correlational analyses) •424 •N/A	N/A	HPWS practices associated with increased job satisfaction (pos) N/A
Macky and Boxall 2008	Mixed (New Zealand working population telephone interview survey)	HPWS	Detailed description of HPWS practices	•Crosssectional •Yes (by correlational analyses) •775 •N/A	N/A	HPWS practices associated with increased job satisfaction, reduced stress and fatigue (pos). Work intensification associated with reduced job satisfaction, higher stress and fatigue, but not with HPWS N/A
Maynard et al 2007	Private service (customer service engineers)	Restructuring (Participation - production)	Description of introduction of self-managed teams of service engineers, with empowerment	•Crosssectional •No •637 •N/A N/A	N/A	Effect of participation in production on job satisfaction depended on team and individual resistance (mixed)
Mehri 2005	Manufacturing (automotive workers)	Lean practices	Detailed description of lean practices in a Toyota plant	•Qualitative •No •>75 interviews •N/A	Occupational illnesses and injury reported to be high (neg)	Workload high (neg) N/A
Mikkelsen and Saksvik 1999	Study 1 and 2: Public (post office workers)	Downsizing Study 1 and 2: NPM in postal service (2 independent locations)	NPM introduced, total job loss 4000 (control group in intervention study relevant)	•Time series •No (only control groups included) •Study 1: 23, study 2: 30 •1 yr	Study 1 and 2: Health complaints unchanged (0 x2)	Study 1 and 2: Job stress, job demand unchanged (0 x2) N/A

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Table 3 (continued)

Mohr 2000	Manufacturing (steel workers)	Restructuring (Social support at work; Social support outside work)	Description of threat of plant closure (anticipation effects)	•Pre-post •No •110 •7 yrs	N/A	N/A	Social support at and outside work reduced the neg effect of job insecurity on mental health (pos)
Mohr and Zoghi 2008	Mixed (Canadian national survey)	HPWS	Description of variables used to characterize HPWS: Quality circles, task teams, information, self-directed work group, feedback, suggestion programs	•Crosssectional and Pre-post •Yes (by correlation analyses) •-25000 •1 yr	N/A	HPWS practices progressively associated with job satisfaction. Job satisfaction promoted HPWS involvement (pos)	N/A
Moore et al 2004	Mixed (blue and white color workers in manufacturing organization)	Downsizing	No. of direct, indirect layoff experiences recorded (0-2); overall reduction >27%	•Pre-post •Yes •1244 •3 yrs	More depression, health problems with multiple layoff events (neg)	Job demand higher with 2 vs 1 layoff events (neg)	N/A
Morrow 1997	Public (transportation agency workers)	Lean practices	3 TQM practices compared: teamwork, customer focus, continuous improvement	•Crosssectional •Yes (different TQM practices) •2249 •N/A	N/A	Job satisfaction higher with all 3 TQM practices (pos)	N/A
Moyle and Parkes 1999	Private service (supermarket workers)	Restructuring (Social support at work)	Description of features in old and new shop upon relocation to upgraded shop	•Time series •Yes •27/58 •7 mths	Psychological distress increased for workers moving to new shop (neg)	N/A	Manager support reduced psychological distress (pos)
Mullarkey et al 1995	Manufacturing (electronics manufacturing workers)	Lean practices	Description of 2-stage introduction of TQM and JIT practices. 1: TQM training and product responsibility; 2: JIT, changed physical layout	•Time series •No •32 •34 mths	N/A	Stage 1: Increased job demands; Stage 2: Increased job satisfaction (mixed)	N/A
Nelson et al 1995	Study 1: Public Study 2: Private service (water authority workers)	Restructuring Study 1: Restructuring (privatization) Study 2: Restructuring (subsequent reorganization)	Description of privatization and restructuring initiatives, mostly centralization of support services	•Time series •No •397 •20 mths	Study 1: Reduced physical and mental health (neg) Study 2: No health effect (0)	Study 1: Reduced job satisfaction (neg) Study 2: Increased job satisfaction (pos)	N/A
Nemanich and Keller 2007	Private service (administrative workers)	Restructuring (Management style)	Acquisition and integration of companies; many settings with variation in leadership style	•Crosssectional •Yes (by correlational analysis) •447 •N/A	N/A	N/A	Transformational leadership, focusing goal clarity and support for creative thinking, assoc to job satisfaction (pos)
Neumann et al 2002	Manufacturing (electronics assembly workers)	Parallel/serial and mechanization level	Description of parallel and serial systems. Cycle time 141 s and 121 s. Partial automation of transport and assembly	•Pre-post •No •4/1 •2 yrs	N/A	Less repetitiveness, mixed posture, more physical variation in parallel system. Overall repetitive work for system is increased (mixed)	N/A
Neumann et al 2006	Manufacturing (automotive workers)	Parallel/serial	Description of parallel and serial production systems. Cycle time 1.2 hrs and <5 min.	Pre-post •No •54 (7 for pre-post technical measurements) •6 mths	Sick leave and pain unchanged (0)	More task variation, fewer pauses in parallel system, mixed effect on psychosocial conditions (mixed)	N/A
Newman and Krzystofiak 1993	Private service (bank workers)	Restructuring and downsizing	Description of bank acquisition and subsequent downsizing	•Pre-post •No •49 •9 mths	N/A	Overall job satisfaction reduced (neg)	N/A
Niedhammer et al 2006	Private service (publication distribution workers)	Restructuring and downsizing (Social support at work; Job commitment)	Description of situation with job uncertainty	•Crosssectional •No (contrast by variables in model) •680 •N/A	N/A	N/A	Social support at work (female), associated with improved mental health (pos); high commitment associated with depressive symptoms, psychiatric disorders (neg)
Noblet et al 2006a	Public (public sector workers)	Restructuring (Social support at work; Social support outside work; Control coping; Escape coping)	NPM introduced. Description of "managerialism" in public sector restructuring	•Crosssectional •No •207 •N/A	N/A	N/A	Social support at work related to psychological health and job satisfaction (pos); control (pos) and escape (neg) coping related to psychological health; no effect of non-work support (0)

Noblet et al 2006b	Public (public sector workers)	Restructuring (Management style, Social support at work, Control coping; Escape coping)	NPM introduced. Description of "managerialism" in public sector restructuring	•Crosssectional •No •1155 •N/A	N/A	N/A	Rewarding management (pos), work support (pos) related to psychological health and job satisfaction; control (pos) and escape (neg) coping related to psychological health
Novek 1992	Manufacturing (meatpacking production workers)	Lean practices	Description of restructuring, standardization, mechanization, line speed	•Time series •Yes •450-650/750 •5 yrs	Increase in RSI injury rate for line with thightest scheduling (neg)	N/A	N/A
Olafsdottir and Rafnsson 1998	Manufacturing (fish filleting workers)	Parallel/serial	Introduction of flow line with improved workstation design, task simplification	•Pre-post •No •229/415 •6 yrs	Upper limb pain increased with serial line for women (neg)	N/A	N/A
Østhus 2007	Mixed (Norwegian national survey)	Study 1: Downsizing Study 2: Restructuring	Comparison of rationalization measures in different companies (separate data for downsizing and restructuring effects)	•Crosssectional •Yes (by contrasts in reported rationalizations) •1944 •N/A	Reorganization (neg), but not downsizing (0) associated with high level of health problems	Reorganization, but not downsizing is associated with lower job satisfaction. Reorganization and downsizing associated with higher work demands (neg x2)	N/A
Ostry et al 2000	Manufacturing (sawmill workers)	Downsizing	Downsizing (60%) and mechanization, elimination of job categories	•Pre-post •No •4 expert raters •22 yrs	N/A	Psychological and physical job demands reduced (pos)	N/A
Ostry et al 2002	Manufacturing (sawmill workers)	Downsizing (Reemployed leavers)	Downsizing (60%), concurrent change in technology and organization	•Crosssectional •Yes (stayers vs. leavers) •600/570 •N/A	N/A	N/A	Leavers reemployed have better health than workers remaining (pos)
Parentmark et al 1993	Manufacturing (assembly workers)	Parallel/serial	Description of the two production systems	•Time series •Yes •275/255 •1 yr	Reduced sick leave and turnover in parallel system (pos)	N/A	N/A
Parker 2003	Manufacturing (automotive workers)	Lean practices (Participation - production)	Description of 3 lean practices: team, assembly line, standardization	•Pre-post •Yes •77, 31, 231/29 •3 yrs	More job depression with assembly line and standardization, no effect for teams (neg)	N/A	Reduced participation in production accounts for increased job depression (pos)
Parker et al 1997	Manufacturing (process workers)	Downsizing (Participation - production)	Description of downsizing (40%) and retraining, mostly on voluntary basis (early retirement), 5% compulsory	•Pre-post •Yes •139 (48/27/64) •4 yrs	N/A	Increased job demands and job satisfaction, unchanged strain (mixed)	Participation associated with decrease in strain, increase in job satisfaction (pos)
Paulsen et al 2005	Health care (hospital workers)	Downsizing	Intended staff reduction >50%, new service model introduced	•Time series •No •142 •18 mths	No effect on emotional exhaustion (0)	Job satisfaction lowest during anticipation phase, increasing during implementation and post-implementation phases (mixed)	N/A
Petterson and Arnetz 1998	Health care (hospital workers)	Downsizing (Participation - rationalization)	Downsizing (20%), description of intervention program to increase staff participation for work efficiency, quality and work environment	•Pre-post •Yes (high vs. low participatory activity) •2617 •2 yrs	Psychosomatic symptoms and exhaustion increased (neg)	Job demands and work pressure increased (neg)	Departments with more involvement in participatory efforts show less neg effect of downsizing (pos)
Petterson et al 2005	Health care (hospital workers)	Downsizing	Description of downsizing (22%) and relocation (10%) process	•Time series •No •1697 •8 yrs	Increase in sick leave, reduction in mental health over time (neg)	Increase in work demands, reduction in job satisfaction over time (neg)	N/A
Pillar and Jarjoura 1999	Health care (nurses)	Restructuring	Description of restruction in terms of patient-focused care	•Time series •Yes (time-staggered restructuring) •210 and 43 (panel) •1 yr	N/A	Job satisfaction unchanged (0)	N/A
Pollard 2001	Public (local authority workers)	Restructuring	Description of old and new local authority structure; workers required to apply for new job	•Time series •No •184 •18 mths	N/A	Tense arousal and systolic blood pressure highest shortly before reorganization, thereafter recovery (neg)	N/A

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Table 3 (continued)

Probst 2000	Public (government workers)	<u>Restructuring</u> ( <i>Job commitment</i> )	Merger, implying moving offices, new supervisor and work tasks, possibly reduced work status	●Crosssectional ●No (compare groups with different job involvement) ●283 ●N/A	N/A	N/A	High job commitment in combination with low perceived job security associated with impaired health (neg)
Probst 2003	Public (government workers)	<u>Restructuring</u>	Description of restructuring in merger process, including rumors of downsizing	●Pre-post ●Yes (pre-post/affected-not affected; 4 groups) ●64/62 (83/104) ●6 mths	Reduced mental health and physical health (neg)	Time pressure higher for groups affected by restructuring (neg)	N/A
Ramsay et al 2000	Mixed (UK national survey)	HPWS	Detailed description of HPWS practices	●Crosssectional ●Yes (by correlational analyses) ●13242 ●N/A	HPWS practices not associated with absenteeism (0)	HPWS practices associated with job strain (neg)	N/A
Rioli and Savicki 2006	<u>Private service</u> (engineering workers)	<u>Restructuring</u> ( <i>Procedural justice; Management style</i> )	Introduction of new computer system, details described emphasizing procedural justice	●Pre-post ●Yes ●56/47 ●1 yr	Reduced emotional exhaustion (pos)	Reduced strain (pos)	Procedural justice (pos) and resonant supervisory style (pos) associated with low stress and burnout
Røed and Fevang 2007	<u>Health care</u> (Norwegian national survey of nurses, capital excluded)	<u>Downsizing</u> ( <i>Reemployed leavers</i> )	Description of organizational change with downsizing, level estimated by employment records	●Time series ●Yes (by level of downsizing) ●43167 ●8 yrs	Sick leave increased by level of downsizing, effect sustained for 4 yrs following event (neg)	N/A	Reemployed leavers have lower sick leave, despite higher past sick leave (pos)
Rosenthal et al 1997	<u>Private service</u> (supermarket workers)	<u>Restructuring</u>	Description of aims and elements of a customer service program with empowerment of workers	●Time series and qualitative ●No ●72 interviews, 696 questionnaire responses ●6 mths	N/A	Workload unchanged (0)	N/A
Sagie and Koslowsky 1994	Public (tax authority, educational workers)	<u>Restructuring</u> ( <i>Participation - rationalization process</i> )	Detailed description of strategic and tactical (close to individual workers) changes for improved performance	●Crosssectional ●Yes (by correlational analysis) ●55/50/44/60/40 ●N/A	N/A	N/A	Higher job satisfaction with participation (pos); higher job satisfaction with tactical vs. strategic decisions
Sagie and Koslowsky 1996	Public (government clerical workers)	<u>Restructuring</u> ( <i>Participation - rationalization process</i> )	Describes elements of an incentive system introduced to improve performance	●Crosssectional ●Yes (by correlational analysis) ●232 ●N/A	N/A	N/A	Participation in decision making increases job satisfaction (pos)
Saurin and Ferreira 2009	<u>Manufacturing</u> (assembly workers)	<u>Lean practices</u> (multiple practices introduced)	Description of several lean-type changes introduced, but only partly implemented in practice	●Historic prospective ●No ●67 ●N/A	N/A	Increased work pace, workload, work pressure from superiors; but general working conditions improved (mixed)	N/A
Schnall et al 1992	<u>Private service</u> (financial services workers)	<u>Downsizing</u> (anticipated)	Description of threat of downsizing with 1/3 of workers anticipated laid off	●Pre-post (blood pressure), crosssectional (distress) ●Yes (correlational analysis by lay-off status) ●139 ●3 yrs	Unchanged blood pressure upon threat of job loss (no effect)	Higher psychological distress for those with uncertain job future (neg)	N/A
Schweiger and Denisi 1991	<u>Manufacturing</u> (production workers)	<u>Restructuring</u> (anticipated) ( <i>Information</i> )	Description of anticipated merger effects (no implementation during study)	●Time series ●Yes ●75/72 ●5 mths	Increased absenteeism following merger announcement (neg)	Increased stress level, reduced job satisfaction following merger announcement (neg)	Merger preview reduced neg effects of merger announcement (lower global stress, less neg job satisfaction) (pos)
Seppälä and Klemola 2004	<u>Manufacturing</u> (blue and white color workers)	<u>Lean practices</u> ( <i>Management style</i> )	Description of similarities and differences in the production process of 4 companies (11 lean principles outlined, realized to different degrees)	●Historic prospective ●No ●525 ●N/A	N/A	Increased workload, improved control; most stress for white collar workers (mixed)	Good change management associated with less stress (pos)
Shanley 2007	<u>Health care</u> (managers in aged care residential homes)	<u>Restructuring</u>	Description of restructuring of residential aged care homes with emphasis on managing the change process	●Qualitative ●No ●39 ●N/A	N/A	Managing change process associated with stress (neg)	N/A
Shaw et al 1993	<u>Private service</u> (office workers)	<u>Restructuring</u> ( <i>Social support at work; Control coping</i> )	Description of restructuring process with introduction of market mechanism	●Pre-post ●No ●110 ●1 yr	N/A	Job satisfaction reduced (neg)	Social support at work (pos), control coping (pos) inversely correlated to work stress

Sinclair et al 1996	Public (teachers)	Restructuring	Detailed description of NPM in schools with restructuring of financial system (budget restraints) and introduction of market mechanism	•Qualitative and quantitative •No •Interviews of 5 stakeholder groups in 17 case study schools; questionnaire: 595 •N/A	N/A	Almost all teachers report increased workload, work hours, stress last few years (neg)	N/A
Sprigg and Jackson 2006	Private service (call center workers)	Lean practices	Description of two lean practices (performance monitoring, dialog scripting)	•Crossectional •Yes (contrast in lean practices) •823 •N/A	N/A	Higher job strain with dialog scripting (standardization) and performance monitoring (neg)	N/A
Sprigg et al 2000	Manufacturing (blue color workers)	Lean practices (Group autonomy)	Introduction of teamwork with high and low work process interdependence	•Crossectional •Yes •93/138 •N/A	N/A	N/A	Collective (group) autonomy increased job satisfaction (pos)
Stål et al 1999, 2000	Manufacturing (machine milking workers)	Mechanization level	Description of two mechanization levels for machine milking (tethering and loose-house systems)	•Crossectional •Yes (within-subject comparison) •11 •N/A	N/A	More static load and repetitiveness, higher velocity, lower peak load with more mechanized system (mixed)	N/A
Sutherland 1995; Sutherland and Cooper 1992	Health care (general practitioners)	Restructuring	Description of new health care system with increased responsibility for general practitioners	•Pre-post •No •917/1817 •3 yrs	Higher depression and somatic anxiety, reduced mental health in new health care system (neg)	Increase in most listed stress factors (25 of 31); reduced job satisfaction in new health care system (neg)	N/A
Swaan et al 2004	Public (government workers)	Downsizing (anticipated)	Description of closure threat	•Time series •Yes •574/1096 •2 yrs	N/A	Increased relative risk of psychological distress for workers threatened by job loss, also elevated 1 yr after withdrawal of closure announcement (neg)	N/A
Swanson and Power 2001	Public (public utility workers)	Restructuring (Social support at work)	Detailed data on restructuring changes in public utility company	•Historic prospective •No •174 •N/A (1 yr post restructuring)	N/A	Workload increased for managers and graded staff, not for non-office staff (mixed)	Support from manager reduces stress for non-manager staff (pos)
Terry and Jimmieson 2003	A: Private service (pilots); B: Public (government workers); C: Public (senior managers in utility company)	Restructuring (A: Information; B: Information; C: Participation - rationalization process)	Description of restructuring (A: merger; B: relocation and partial abolition of mid management; C: introduction of new pay scheme)	•A, B, C: crossectional •A, B, C: Yes (correlational analysis), •A: 662, B: 213, C: 162 •A, B, C: N/A	N/A	N/A	A: Information reduces stress (pos); B: Information increases wellbeing and job satisfaction (pos); C: Participation increases job satisfaction and psychological wellbeing (pos)
Theorell et al 2003	Mixed (working population in Stockholm)	Downsizing (Social support at work)	Register data on change in staffing level (downsizing, expansion >8%) in 12-mth period. Sick leave in following 12 mth period	•Crossectional •Yes (<-8% and >+8%, no change) •4903 •N/A	Less long sick leaves with both downsizing and expansion for females, males show no effect (pos)	Long sick leaves not influenced by quantitative job demands (0)	Level of social support does not influence level of sick leave (0)
Väänänen et al 2004	Manufacturing (white and blue collar workers)	Restructuring (Organizational support, Social support at work)	Description of merger, causing changes to work roles and procedures mainly for white collar workers	•Time series •Yes (by correlational analysis) •2225 •4 yrs	N/A	N/A	Organizational support associated with improved subjective health (pos). Support at work has no main effect, but together with decline in job position is associated with worse health (neg)
Vahtera et al 2004, 2005	Public (local authority workers)	Downsizing (Employment status)	Register data on working hours by occupational group (different downsizing levels: <8, 8-18, >18%)	•Time series •Yes (level of downsizing) •range: 19273-22430 •range: 5-7.5 yrs	Certified sick leave and disability pension due to m-sk disorder increased by level of downsizing (neg)	N/A	Less effect of downsizing on sick leave for temporary vs. permanent workers (neg)
van Dick et al 2006	Health care (hospital workers)	Restructuring (Information)	Merger plans for two hospitals described. Intention not to cut jobs, most effects on internal services	•Crossectional •Yes (contrasts by information to workers and job content continuity) •459 •N/A	N/A	N/A	Information to workers improves job satisfaction (pos)

(continued on next page)

Table 3 (continued)

Verhaeghe et al 2006	Health care (nurses)	Restructuring	Changes in operations of 10 hospitals to improve productivity (change of supervisor, colleagues, tasks, hours, location last 6 mths)	•Crosssectional + follow-up •Yes (contrast in organizational changes) •2094 •N/A + 1 yr (follow-up on sick leave)	Changes perceived as threatening increase sickness absence, challenging changes has no effect on sickness absence (neg)	Reduced job satisfaction and increased distress for changes perceived threatening, increased job satisfaction and eustress for challenging changes (mixed)	N/A
Verhaeghe et al 2008	Health care (nurses)	Restructuring (Organizational support; Individual autonomy)	Changes in operations to improve productivity of selected units in 10 hospitals (change of supervisor, colleagues, tasks, hours, location last 6 mths)	•Crosssectional •Yes •416/678 •N/A	N/A	Increased distress with neg appraisal of changes ("threat") (neg)	Supportive management style associated with lower distress in situations where restructuring is perceived threatening (pos). Individual autonomy (control) reduced stress in non-intensive care units (pos)
Vickers and Parris 2007	Mixed (managers)	Downsizing	Description of redundancy process for middle- and senior level executives in different companies and work settings	•Qualitative •No •10 •N/A	N/A	Process of being made redundant is a large burden affecting health and wellbeing (neg)	N/A
Wagar and Rondeau 2000	Health care (health care workers)	Downsizing	"Permanent workforce reduction" (dichotomized). Questionnaire to senior executives (1 in each organization) in survey of 151 health care organizations	•Crosssectional and historic prospective •Yes (with vs. without downsizing) •151 organizations •N/A	N/A	Lower current job satisfaction and more neg change in job satisfaction in organizations with downsizing experience (neg)	N/A
Wahstedt and Edling 1997	Public (postal workers)	Restructuring	Detailed description of organizational changes in postal service	•Time series •No •100 •1 yr	Sick leave reduced (pos)	N/A	N/A
Wahstedt et al 2000	Public (letter carriers)	Restructuring	Description of organizational changes for letter carriers	•Pre-post •Yes •27/55 •1 yr	Reduced shoulder and thoracic pain (pos)	Reduced psychological work demands, unchanged physical demands (pos)	N/A
Wall et al 1990	Manufacturing (blue collar workers)	Restructuring	Description of restructuring with introduction of new technology to expand operator tasks and responsibilities	•Pre-post •No •19 •4 mths	N/A	Intrinsic job satisfaction improved, reduced job pressure (pos)	N/A
Waluyo et al 1996	Manufacturing (assembly workers)	Mechanization level (semi-automatic vs. manual)	Different mechanization levels (manual assembly vs. higher mechanized system) in vehicle assembly	•Crosssectional •Yes •326/136 •N/A	Higher mechanization level associated with more m-sk symptoms (neg)	Higher mechanization level associated with more stress and physical job demands, less job satisfaction (neg)	N/A
Weekes 2002	Health care (medical scientists)	Restructuring	Description of organizational changes and technology change for medical scientists	•Qualitative •No •23 •N/A	N/A	Increased work demands and stress (neg)	N/A
Westerlund et al 2004a	Mixed (Swedish national survey)	Downsizing	Workforce changes (<-18, -18--8, -8-+8, +8-+18, >+18%) estimated by tax registry data	•Time series •Yes (by downsizing or expansion level) •24036 •9 yrs	Increase in sick leave with large expansion (especially females in public sector) and moderate downsizing (neg)	N/A	N/A
Westerlund et al 2004b	Mixed (white collar working population in Stockholm)	Restructuring	Workplaces categorized as changing/growing, threatened-private, questioned-public, and stable	•Crosssectional •Yes (comparison to stable group) •1445, 639, 587, 674 •N/A	N/A	Changing/growing and threatened-private organizations associated with higher job strain (neg)	N/A
Womack et al 2009	Manufacturing (automotive workers)	Lean practices	Detailed description of differences in production characteristics, lean vs. traditional plant	•Crosssectional •Yes •56 matched jobs, no data on no. of subjects •N/A	N/A	More repetitive jobs, lower peak hand force ratings, same postural demands; no difference in risk index (mixed)	N/A
Woodward et al 1999	Health care (hospital workers)	Restructuring	Timeline of hospital merger, restructuring and downsizing initiatives	•Time series •No •400 •2 yrs	Increased exhaustion, depression, anxiety (neg)	Increased job demands (neg)	N/A
Zeytinoglu et al 2007	Health care (nurses)	Restructuring (Organizational support)	Description of restructuring of 3 teaching hospitals	•Historic prospective and crosssectional •No (yes by correlational analysis for modifier information) •949 •About 10 yrs	N/A	Work intensification following restructuring associated with increased stress, decreased job satisfaction (neg)	Organizational support associated with lower stress level (pos)

leave following downsizing (Theorell et al., 2003), in contrast to the main pool of studies reporting negative health effects. The authors speculate that a general downturn in the economy during the study period promoted “sickness presence”, citing other studies and national statistics.

### 6.1.2. Restructuring

This category ( $n = 67$ ) includes a variety of rationalizations. Restructuring may imply job loss, new work practices or the introduction of new technology. Worker responses to restructuring rationalizations are often uncertainty, but perceptions of future production systems range from rather negative to quite positive.

#### Results summary:

- In general, restructuring studies tend to report negative outcome on health and risk factors. Positive outcome studies in *public and manufacturing sectors* describe restructuring with integrated work environment emphasis and worker participation.
- Restructuring in *health care* often describes a process with manifest or potential downsizing; negative outcome dominates, consistent with the results of the downsizing studies in this sector. Mixed and positive outcome studies relate to restructuring with quality focus (i.e., “patient-focused care”).
- Restructuring studies in *public sector* often present the effects of the “New Public Management” paradigm (Hoggett, 1994), emphasizing customer orientation, market mechanisms and privatization of services. Negative outcome studies describe restructuring without participation, with lack of resources and top-down reorganizations without work environment concerns. Mixed outcome studies report effects according to job type; workers most affected show negative responses, unaffected workers show no change.
- Comparative studies indicate more deterioration of working conditions for public sector employees, relative to private sector ( $n = 3$ ).
- Studies performing large surveys of *mixed populations* report negative association of organizational change with health or risk factors ( $n = 7$ ).

6.1.2.1. *Studies of special interest.* The Whitehall II study series (Ferrie et al., 1995 and follow-up papers, cf. Table 3) examines the effects of restructuring of public service in the UK, including privatization of some services. It is based on a large material and a comprehensive study protocol, has good epidemiological quality, and covers a long observation period. Negative effects on health and risk factors were observed before material restructuring took place.

Härenstam et al. (2004) distinguished four rationalization strategies (market-adjusting, lean, standardizing, and centralizing). The study presents independent data on these strategies based on clusters of companies, and compares outcome with a control group of “stable” companies. All four strategies were associated with worse working conditions than for stable organizations, but organizations with market-adjusting (extensive market competition) and standardizing (hard control systems) strategies did worse than organizations with lean and centralizing strategies.

Østhus (2007), using Norwegian national survey data, found more negative health effects of restructuring than downsizing rationalizations. The author speculates that labour market regulations in Norway offer some protection against the negative effects of job loss, while restructuring have a dominant work intensification effect.

Green (2004), using UK national survey data, found that new technology and work organization, and high-commitment policies were major sources of work intensification, particularly noticeable for public sector employees.

Two studies by Verhaeghe and coworkers (Verhaeghe et al., 2006, 2008) found that the perceived quality of changes to working conditions of nurses (challenging vs. threatening) influenced job satisfaction and sick leave accordingly (positive vs. negative outcome).

The qualitative study by Foster and Hoggett (1999) showed that contextual factors (location, physical environment, clients, management attitude, training, and aspects of service delivery) differentiated outcome of restructuring in public sector. Deteriorating working conditions were described following a “savings” approach to restructuring.

**Table 4**

A summary of results presented in Table 3 regarding association between rationalization and health/risk factors. Results are sorted by type of rationalization (rows) and occupational setting (columns). Each cell shows number of studies and the distribution of health/risk factor outcome: predominant positive (+), mixed or no effect ( $\pm$ ), or predominant negative (–). Further details are given in text.

Occupational setting												
Type of rationalization	Health care		Public		Mixed		Private service		Manufacturing		Total	
Downsizing	14	+: 0 ±: 1 –: 13	6	+: 0 ±: 2 –: 4	7	+: 1 ±: 0 –: 6	4	+: 0 ±: 1 –: 3	3	+: 1 ±: 2 –: 0	<b>34</b>	+: 2 ±: 6 –: 26
Restructuring	33	+: 2 ±: 8 –: 23	16	+: 5 ±: 2 –: 9	8	+: 0 ±: 0 –: 8	6	+: 2 ±: 1 –: 3	4	+: 2 ±: 0 –: 2	<b>67</b>	+: 11 ±: 11 –: 45
Lean practices	1	+: 0 ±: 1 –: 0	2	+: 1 ±: 1 –: 0	3	+: 1 ±: 1 –: 1	4	+: 2 ±: 0 –: 2	24	+: 2 ±: 9 –: 13	<b>34</b>	+: 6 ±: 12 –: 16
HPWS	1	+: 1 ±: 0 –: 0	0		8	+: 5 ±: 2 –: 1	0		1	+: 0 ±: 0 –: 1	<b>10</b>	+: 6 ±: 2 –: 2
Parallel vs. serial <sup>a</sup>	0		0		0		0		10	+: 3 ±: 5 –: 2	<b>10</b>	+: 3 ±: 5 –: 2
Mechanization level <sup>b</sup>	0		0		1	+: 0 ±: 1 –: 0	0		6	+: 2 ±: 2 –: 2	<b>7</b>	+: 2 ±: 3 –: 2
Total	<b>49</b>	+: 3 ±: 10 –: 36	<b>24</b>	+: 6 ±: 5 –: 13	<b>27</b>	+: 7 ±: 4 –: 16	<b>14</b>	+: 4 ±: 2 –: 8	<b>48</b>	+: 10 ±: 18 –: 20	<b>162</b>	+: 30 ±: 39 –: 93

<sup>a</sup> Positive when parallel production shows better health or reduced risk.

<sup>b</sup> Comparison of manual, semi-automated and fully automated assembly. Positive when higher mechanization level in a comparison shows better health or reduced risk.

### 6.1.3. Lean practices

This group of rationalization strategies ( $n = 34$ ) was initially introduced in the automotive industry, but has migrated to all work life sectors. Consequently, measures and contextual factors in lean practice rationalizations vary much between studies.

#### Results summary:

- About half the lean practice studies report negative outcome for health and risk factors, including a cluster of studies ( $n = 7$ ) carried out in the North American automotive industry in the 1990s. The studies describe increased production volume and work intensification. Rationalizations were carried out with neither work environment considerations, nor participatory involvement of workers.
- Positive outcome studies describe worker involvement in the rationalization process, focusing quality (training, customer orientation, job enlargement or enrichment, teams).
- Several studies (e.g., Carayon et al., 1999; Christmansson et al., 1999) report new work situations with positive qualities (improved control, job enlargement, etc.), but also negative effects (increased workload, stress), possibly due to poor match between work demands and resources.
- Partial implementation of rationalization strategy (Conti et al., 2006), unfavourable work setting (Sprigg et al., 2000) or mismatch between responsibility and resources (Morrow, 1997; Parker, 2003; Karia and Asaari, 2006) are associated with negative outcome.
- Studies with different worker populations show workers with routine jobs most at risk of negative outcome (Parker, 2003; Seppälä and Klemola, 2004).

**6.1.3.1. Studies of special interest.** Conti et al. (2006) identified 11 lean practices and related the level of implementation of lean practices to outcome. An inverted U-shaped association was found (highest risk with partial implementation of lean practices). However, implementation level was also related to time; those with few implemented practices may be in an early stage of transition to lean production systems. A contrasting result was reported by Lewchuk and Robertson (1996) who found highest job demands in plants with full, compared to partial implementation of lean systems. The latter study was carried out in the Canadian automotive industry in the 1990s, potentially reflecting “hard” implementation strategies. A recent US study found that overall work demands in an automotive plant with lean implementation was not different to a plant with traditional production system (Womack et al., 2009).

The study of Brenner et al. (2004), based on US survey material from 1993, reported more musculoskeletal problems with JIT and quality circle rationalizations than with TQM rationalizations. The study has no detailed information on rationalizations; a possible explanation of the finding is emphasis on quality with TQM and on production efficiency with JIT. The negative result for quality circle rationalizations is not accounted for, but quality circles modelled on Japanese practices have been criticized to be of limited scope and fostering difficult employee relations (Hill, 1991).

Seppälä and Klemola (2004) examined the impact of rationalization by lean principles in four companies in Finland. The authors report more positive work environment changes, but also more stress for white vs. blue collar workers. There were differences between groups of blue collar workers, with the most negative changes for groups performing routine (repetitive) work tasks.

### 6.1.4. High Performance Work Systems (HPWS)

HPWS studies are a recent addition to rationalization models. The concept provides little new in terms of distinct rationalization

measures, but is conceived as a “bundle” approach, by applying a comprehensive combination of lean and Human Resource Management (HRM) practices (Godard, 2004). Nine HPWS studies are based on large (often national) surveys; one case study is included (Harley et al., 2007).

#### Results summary:

- HPWS studies tend to report more positive outcome than for other rationalization strategies.
- Negative outcome studies and subgroup analyses of positive and mixed studies show threats to positive outcome through job intensification (by management pressure to perform) and lack of coherent system for implementation of listed HRM practices (e.g., low worker participation, provocative management style).

**6.1.4.1. Studies of special interest.** Ramsay et al. (2000) tested three models for the association between HPWS practices and organizational performance; a direct model with discretion and management relations as mediating variables and two indirect models assuming improved performance through high-commitment management and work intensification, respectively. Work intensification related significantly to labour productivity, HPWS score to job strain.

Kalmi and Kauhanen (2008) reported beneficial effects (reduced stress, higher job satisfaction) of HPWS practices (in their study: self-managed teams, information sharing, incentive pay, training) for employees, with more positive outcome for increasing number of HPWS practices introduced. The authors speculate that institutional features of the Finnish labour market, such as a high degree of trust and low perceived conflict between managers and workers, mediate the positive outcome.

Mohr and Zoghi (2008), in the only HWPS study with pre-post design, found that job satisfaction of Canadian workers was positively associated with high-involvement practices, also for subsets of data. However, self-selection was indicated since satisfied workers were more likely to participate in high-involvement practices, while participation was not associated with future increase in job satisfaction.

### 6.1.5. Parallel vs. serial

Parallel production favours job enlargement, potentially eliminating short-cycle work tasks (Wells et al., 2007). Parallel production rationalizations are mostly studied in manufacturing, with the Volvo Uddevala factory a famous example (Kadefors et al., 1996).

#### Results summary:

- Most studies report mixed outcome ( $n = 5$ ), determined by contextual factors. Serial systems are short-cycle repetitive, but difficulties in balancing the production line cause more pauses. Parallel production offers longer cycle times and more varied work tasks, but a self-paced work pattern tends to result in fewer interspersed pauses as workers prefer long pauses for recreational purposes at the end of the workday.

**6.1.5.1. Studies of special interest.** Parenmark et al. (1993) described a new assembly plant with parallel production system, designed with considerable concern for working conditions and showed positive outcome for health and risk factors.

Neumann et al. (2006, 2009) showed mixed effects of a change from parallel to serial production on risk factors. Production was reorganized from isolated workstations to line-based teamwork. The serial system presented less variation and



more repetitiveness in workload, but also more pauses due to inadequate line balancing.

### 6.1.6. Mechanization level

This rationalization strategy aims to transfer work tasks from operator to machines. Comparisons of manual (low), semi-automated (medium) and automated (high mechanization level) production lines are presented, including the introduction of computers for office workers.

#### Results summary:

- Mechanization from low to medium level in manufacturing results in reduced exposure amplitude, but more repetitive work and higher movement velocity ( $n = 2$ ).
- High mechanization level in manufacturing results in reduced exposure amplitude and less repetitive work, but more cognitive demands ( $n = 3$ ).

**6.1.6.1. Studies of special interest.** Balogh et al. (2006), Stål et al. (1999) and Coury et al. (2000) performed technical measurements of workload, documenting highest level of repetitive movement in semi-automated production systems.

Bao et al. (1997) and Waluyo et al. (1996) compared assembly work in Asia and Sweden. Health risk for Swedish assembly workers may be higher, despite superior work station design, due to low porosity from better balancing of production lines.

## 6.2. Modifiers

Altogether, 72 modifier entries, representing actions or conditions at work, were accepted into the material. Modifier categories and outcome by work setting are summarized in Table 5. Results can be positively or negatively presented in the original publication (e.g., participation is positively or lack of participation negatively associated with positive outcome). A statement of modifier effect is therefore formulated, and the number of studies supporting, negating, and reporting unclear or no effect (“mixed”) is listed.

- Worker participation in the rationalization process is associated with improved health or risk factor outcome (13 supporting studies).

These studies describe consultation and/or collaboration initiatives prior to and/or during the rationalization process. Parker et al. (1997) described a downsizing process with worker participation and positive outcome. Downsizing in this study was to a considerable extent achieved by natural wastage and early retirement.

- Information about the rationalization process and the anticipated end result is associated with improved outcome (8 supporting, 1 negative study)

These studies describe the effects of workers receiving information about forthcoming rationalization events, but without influence over the process, contrasting a situation with worker participation in the rationalization. A positive effect of information was found also in the anticipation phase (Schweiger and Denisi, 1991). The study listed as a negative outcome result is consistent with the supporting studies by reporting negative outcome of negative information (i.e., rumours; Bordia et al., 2006).

- Worker participation in the production process is associated with improved outcome (5 supporting, 3 mixed studies)

These studies examine effects of worker participation in new work situations, following a rationalization. Studies reporting mixed results did not succeed in achieving participation or identified factors that hindered a positive effect of participation (e.g., Maynard et al., 2007). Such factors include team responsibility poorly matched to available resources and worker resistance to accept such responsibility.

- Group autonomy is positive when there is low work process interdependence between groups (3 supporting studies).

Self-managed teams were associated with positive outcome when the production system allowed independent group working (Batt and Appelbaum, 1995; Sprigg et al., 2000). Supervisors may experience negative effects of group autonomy, causing implementation problems (Batt, 2004).

- Inclusive management style is associated with improved outcome (12 supporting, 1 mixed study).

**Table 5**

A summary of results presented in Table 3 regarding factors modifying health/risk factors due to rationalization. Only modifiers that potentially can be influenced by actions at organizational level are shown. Results are sorted by occupational setting (columns) and type of modifier (rows). Each cell shows number of studies and the distribution of outcomes: predominant positive (+), mixed or no effect ( $\pm$ ), or predominant negative (–). Further details are given in text.

Occupational setting												
Type of modifier	Health care		Public		Mixed		Private service		Manufacturing		Total	
Participation (rat. process)	2	2+	4	4+	3	3+	2	2+	2	2+	<b>13</b>	13+
Participation (production)	1	1+					1	1±	6	4+	<b>8</b>	5+
Information	4	3+	2	2+			2	2+	1	1+	<b>9</b>	8+
Management style (resonant: +)	3	3+	3	3+			4	4+	3	2+	<b>13</b>	12+
Organizational support	6	6+					1	1+	1	1+	<b>8</b>	8+
Social support at work	2	2+	4	3+	1	1±	4	4+	3	2+	<b>14</b>	11+
Procedural justice			1	1+			2	1+	1	1+	<b>4</b>	3+
Group autonomy			1	1+			1	1+	1	1+	<b>3</b>	3+
Total	<b>18</b>	17+	<b>15</b>	14+	<b>4</b>	3+	<b>17</b>	15+	<b>18</b>	14+	<b>72</b>	63+
		1–		1±		1±		2±		3±		7±
										1–		2–

A positive effect of inclusive management practices (goal clarity and transparency, dialogue, concern for workers) on health and risk factors is supported by studies from all work sectors. A mixed outcome study found that management motivation for the introduction of teams (emphasis on productivity vs. human concerns) did not influence occupational ill health, but emphasis on human concerns was associated with positive outcome on motivation, communication, and interest in job (Bacon and Blyton, 2000).

- Organizational support is associated with improved outcome (8 supporting studies).

“Organizational support” is defined according to the criteria of Eisenberger et al. (1986) in several studies. The items listed may alternatively be interpreted as good management practice. Alternative scales include items such as information to workers.

- Procedural justice is associated with improved outcome (3 supporting, 1 mixed study).

Procedural justice implies fair treatment at work. Scales for procedural justice have similarities to organizational support scales.

- Social support at work is associated with improved outcome (11 supporting, 2 mixed, 1 negative study).

Social support at work implies informal or non-specific measures of support from coworkers, superiors and subordinates. The study with negative outcome describes an interaction effect: support at work together with a decline in job position is associated with worse health (Väänänen et al., 2004). Possibly, those with much support do worse overall in a restructuring rationalization.

- Miscellaneous system-level modifiers:
  - New environment (transfer to new organization or location; negative;  $n = 2$ ).
  - Employment status (temporary to permanent employed; negative effect in downsizing;  $n = 1$ ).
  - Reemployment in new job after being dismissed in downsizing (positive;  $n = 3$ ).
  - Job changes perceived challenging (positive effect) vs. threatening (negative) ( $n = 2$ ).
  - Learning in job (positive;  $n = 1$ ).
  - Individual autonomy in job (positive;  $n = 1$ ).

Some studies listed in Table 3 also consider outcomes relating to worker characteristics (control and escape coping, negative affectivity, self-efficacy), values (collectivist cultural values), job attitudes (job commitment, role ambiguity, job insecurity), and personal network (home situation, social support outside work). Such modifiers were classified as individual-level modifiers, and are not further considered in this review.

## 7. Discussion

### 7.1. Methodological considerations

#### 7.1.1. Study inclusion and classification

A “best evidence synthesis” approach (Slavin, 1995; Mindell et al., 2004; Ogilvie et al., 2005) was adopted for this review, in preference to applying strict epidemiological quality criteria (e.g., Higgins and Green, 2008), due to the heterogeneous nature of the relevant studies. This review can be described as systematic (by

well-defined inclusion and exclusion criteria) and explorative (by accepting studies with relevant results, although epidemiologically flawed study design). Systematic reviews with strict selection criteria and consequent data loss may end up with conclusions of low utility. As an example, Brewer et al. (2006) describe a rigorous procedure that pruned more than 7000 articles from the initial search to 31 articles, to draw conclusions on workplace interventions for computer users. Their conclusion of a positive health effect of alternative pointing devices among computer users is based on only two studies: testing a mouse design that has not been successful in practice, and substituting computer mouse with trackball. A reader may wonder whether this is sufficient evidence to support the generalized formulation of their conclusion, and whether supplementary, useful information can be found in some of the excluded studies.

The list of included papers is unlikely to be exhaustive. Many studies were identified by reading reference lists, including studies focusing health and risk factor effects of job insecurity and work intensification, with material collected in a rationalization setting. Studies of HPWS practices were identified by reading of management journals. This literature, which is of considerable relevance for occupational health practitioners, is rarely referenced in occupational medicine and ergonomics scientific journals. Searches of key authors and citation searches of seminal journal papers identified a few more studies. Recent included studies tended to present results consistent with early inclusions; omitted studies are therefore not expected to alter the conclusions of this review.

Studies were classified as restructuring rationalizations if not clearly belonging to other categories. Introduction of teams was classified as lean practices except for a few studies specifying a sociotechnical context. These were designated restructuring rationalizations. Rationalization content was often poorly described and the circumstances causing health or risk factor effects therefore difficult to identify, beyond generalized effects such as heightened job insecurity. Most studies did not report rationalization effects on production system performance.

#### 7.1.2. Sources of bias

*Evaluation of outcome:* Study outcome is in part dependent on the protocol; inclusion of many outcome variables increases the chance of recording mixed responses. Anticipation effects may exist at the first measurement in longitudinal studies (e.g. Shaw et al., 1993). Indicator variables for musculoskeletal and mental health complaints (e.g., total sick leave, job satisfaction) are wider than commonly allowed in ergonomics and occupational medicine literature, but the impetus for this review is worker health, with production system rationalization juxtaposed to ergonomic interventions.

*Method bias:* Psychosocial work conditions, worker characteristics, and health effects are scored by subjective reporting in most studies, making common method variance through attribution a particular risk (Theorell and Hasselhorn, 2005). This error source is discussed in some of the included studies (e.g., Bacon and Blyton, 2000; Macky and Boxall, 2008).

*Weak study design:* Causality of associations cannot be inferred in cross-sectional studies. Longitudinal studies without a control group cannot exclude alternative explanations of time-dependent effects that are independent of rationalization. The trustworthiness of studies was assessed as described in Section 5.2.

*Applied instruments:* Similar instruments are used to quantify differently named variables and *vice versa*. e.g., “organizational support” and “resonant management” share many descriptive items. Commonalities between variables were noted on the basis of information given in studies.

*Study period and location:* Time period and work life cultures are important contextual factors. Sociotechnical rationalizations were

mainly studied in the post-world war II period up to the 1980s (Pasmore et al., 1982). Downsizing in health care and the effects of New Public Management received attention in the 1990s. Global production, with increased competition and production transfer to low-cost countries, is an issue in many recent studies. Work culture varies between regions, influencing rationalization procedures and management style. Analyses in this review are constrained by the time period and setting of the published research.

## 7.2. General discussion

This review has documented mostly negative effects of rationalization on musculoskeletal and mental health and the corresponding risk factors. This provides an empirical basis to state that the potential of rationalizations to cause health problems is large, contrasting the overall assessment of ergonomic interventions that seem to have limited health effects in a long-range perspective. Thus, a contributing factor to the persistent problem of musculoskeletal and mental disorders is identified. Modifier results point to positive effects of good leadership and fair treatment, focusing those aspects that favour worker participation and dialogue between workers and management.

### 7.2.1. Rationalization effects on risk factors and health

Work intensification, as a consequence of rationalization, was pointed out already by Karl Marx (1867) and is regularly brought up as a phenomenon until the present time (e.g., Green, 2004). This broad perspective on factors determining work demands has received less attention from ergonomics and occupational medicine researchers. These research fields have instead focused mechanisms of disorders from a biomechanical and psychosocial perspective, risk factor detection, and intervention strategies to remove or reduce risk factors at the individual level (cf. Table 1). Three effects of rationalization with respect to risk factors are indicated:

- Physical workload may increase *following* rationalization (i.e., workload intensification by increase in *mechanical exposure*).
- The work situation may be more stressful *following* rationalization, independent of a change in mechanical exposure (i.e., increased *psychosocial exposure*).
- Increase in stress during periods of *uncertainty about the consequences of a future rationalization*.

Harmful physical and psychosocial work demands cause negative work-related health effects; descriptive terms in the ergonomic literature are “mechanical exposure” (distinguishing from the effects of, e.g., noise and draught) and “psychosocial exposure”. Work sociologists use the term “work intensification” to indicate increase in either or both exposures. Mechanical exposure is conceptually quantified by amplitude, repetitiveness, and duration (Winkel and Westgaard, 1992).

Changes to the organization of work activities mainly influence the two time dimensions of mechanical exposure, while technical rationalizations may reduce amplitude (cf. Section 6.1.6). Porosity, as first described by Marx (1867), correspond to rest pauses in work activities (“waste” in rationalization terms). Engineering analysis of manufacturing work aims to identify and eliminate periods of waste. Studies of mechanical exposure in manual work have shown less riskfull exposure during periods corresponding to waste (e.g., Kazmierczak et al., 2005; Østenvik et al., 2008). Successful rationalization would in such examples reduce porosity and increase health risk.

Relatively few studies report mechanical exposure effects of rationalizations. Technical measurements are used in comparisons

of parallel and serial production systems or comparing contrasts in technology level. Some studies have distinguished mechanical from psychosocial exposures by use of questionnaires, and have shown mechanical work intensification (e.g., Kivimäki et al., 1997b).

Psychosocial exposures can be broadly categorized in task (performance demands) and emotional exposures (e.g., Holte and Westgaard, 2002). Performance demands include task-related time pressure and problem-solving activities, emotional exposures include social relations to peers, superiors and clients, and job insecurity. Negative health effects are mediated through stress responses, which can be of different level (amplitude), repetitiveness and duration, similar to mechanical exposure. However, stress level and other indicators of psychosocial exposures (psychological job demands, psychological distress, or emotional demands) are predominantly quantified on one-dimensional scales.

Most studies in this review describe risk factors for impaired health in terms of workload, job demands or job satisfaction, variables not easily categorized as mechanical or psychosocial exposure. This provides little direction as to what exposure condition is critical in causing negative health effects of rationalizations, although job satisfaction is more strongly related to mental or psychological problems than physical illness (Faragher et al., 2005). Psychosocial exposures are clearly important to explain health effects in early stages of downsizing and restructuring rationalizations, when there is no change in mechanical exposure. It may be posited that psychosocial exposure effects of rationalizations dominate as a risk factor when mechanical exposure is low (as in most office jobs), while work intensification by increased mechanical exposure is more important in jobs with clear physical work demands. The health care sector presents good examples of job situations where both physical and psychosocial exposures are important.

Health effects were mainly considered in downsizing and restructuring studies, usually in terms of non-specific variables such as sick leave, health complaints, or using the General Health Questionnaire which is weighted towards mental disorders (Goldberg and Hillier, 1979). Seventy-one studies report on health effects of rationalizations; study designs range from analyses based on large-scale national surveys to small case studies. Most studies with elements of diagnostic information focus mental disorders (mental health diagnoses, emotional exhaustion, depression, burnout, etc.), often studying downsizing in health care or the introduction of New Public Management in public sector. Negative mental health effects were associated with the related risk factors of reduced job satisfaction, increased stress and higher psychological job demands.

Sixteen studies provided information on health effects in terms of musculoskeletal complaints. Negative musculoskeletal health effects were associated to the corresponding risk factors of mechanical and/or psychosocial work intensification. Two studies that reported positive health effects, emphasized good process and focus on working conditions as integral to the rationalization (Adler et al., 1997 2nd study; Wahlstedt et al., 2000).

### 7.2.2. Modifier effects

The second aim of this review is to identify factors that modify rationalization effects on workers health. Three classes of such factors were identified in the material:

- Measures to alleviate negative effects on health of any rationalization (“modifiers” in this review).
- Rationalization strategy selected to provide the best mix of production system performance and worker health concerns.
- Contextual factors other than choice of modifier and rationalization strategy.

**7.2.2.1. Modifier actions.** Most modifiers point at management style or actions relating to management style. Predominant positive effects are shown for worker participation in the rationalization process and in production planning, change-information to workers, and organizational support. Perceived fairness of the rationalization process is important. These aspects are elaborated in the management literature, e.g., leadership quality as in transformational leadership (Bass and Riggio, 2006) and resonant leadership (Boyatzis and McKee, 2005), touching upon charismatic leadership (“leader and followers”) and leadership using emotional intelligence (e.g., Coleman, 2006). Change management focuses good processes in organizational change (By, 2005). This is also a theme in macroergonomics (Holden et al., 2008; Zink et al., 2008). Considerations of worker wellbeing in a change management perspective were researched by Saksvik et al. (2007). HRM can be viewed as a systematic approach to good management style, acting as a supplement to other rationalization strategies, or as a rationalization strategy in its own right. Aspects of HRM are particularly favourable for human wellbeing (Guest, 2002), but a “hard” version of HRM can be used to coerce workers in performing beyond a sustainable level (e.g., Harley, 1999; Green, 2004).

**7.2.2.2. Rationalization strategy.** Differences in outcome relating to work life sector and disparity in the contents of similar categorized rationalization strategies make comparisons based on the included material challenging. Within study comparisons of different rationalization strategies are presented as “special interest” studies in results (Brenner et al., 2004; Härenstam et al., 2004; Conti et al., 2006; Østhus, 2007). Most studies with positive outcome describe elements of concern for worker wellbeing, or rationalization focus on quality rather than quantity (e.g., studies of patient-focused care and TQM compared to JIT rationalizations).

The rationalization strategy “High Performance Work Systems” (HPWS) is explicit in targeting both performance and wellbeing (“mutual gains”). Early surveys in England (Ramsay et al., 2000) and Australia (Harley, 1999, 2002) showed performance gain associated with work intensification. More recent national surveys and case studies indicate mutual gains, but also pointing to limitations to this approach; possibly due to a coercive management style that may be more apparent in liberal market economies (Godard, 2004). Implementation issues pose challenges (McBride, 2008). Organizational justice and trust in superiors at company and national level (included in the concept of social capital) have been suggested as positive mediating factors (Godard, 2004; Elovainio et al., 2005; Kalmi and Kauhanen, 2008).

**7.2.2.3. Other contextual factors.** Several studies show more severe outcomes for workers most immediately affected by rationalizations within the same organization (e.g., Schnall et al., 1992; van Dick et al., 2006). Constraints on resources are a problem: if resources do not match performance requirements, the production system is not sustainable. Working to budget is a particular concern in public sector and health care. This, together with management techniques transposed from the private sector (e.g., performance monitoring), may contribute to a dominant negative effect on health and risk factors of rationalization in these work life sectors.

Health and wellbeing effects of rationalizations also depend on factors beyond the individual organization. Differences in the social and organizational conditions of employment systems distinguish rationalization effort by work life sector (Härenstam and The MOA Research Group, 2005). Public sector rationalizations vary between countries (Bach and Della Rocca, 2000). Worker autonomy is more developed in the Nordic countries than in North America and Australia, possibly due to differences in social capital and trust (Dobbin and Boychuk, 1999). Job insecurity is associated with stress

in general, but more stress is reported for collectivist cultures (Probst and Lawler, 2006). These examples are from a further large literature base on societal-level contextual factors excluded from this review by not complying with inclusion criteria, e.g., outcomes not accepted as health or risk factors.

### 7.2.3. Rationalization as a work life phenomenon

Production system performance and worker wellbeing have been the major considerations for the rationalization movement all the way back to the Scientific Management tradition. In their book “Applied Motion Study”, Gilbreth and Gilbreth (1919) stated (p.17) “...the length and periodicity of intervals to be allowed for overcoming fatigue, and the best devices for eliminating unnecessary fatigue and for overcoming necessary fatigue, are determined...”, basically stating the first principles of physical ergonomics, although with the primary aim of improved performance. Barley and Kunda (1992) describe how the balance between production system performance and human wellbeing has shifted between the two opposites. However, their time line has a clear North American perspective as the sociotechnical movement, prominent as a managerial ideology in the Scandinavian countries in the 1970s and 1980s is not mentioned. A famous example is the Volvo Uddevalla factory, designed as a parallel production system inspired by sociotechnical principles. The factory closed in 1993 because of strategic considerations during a downturn in world economy. Productivity in this plant was higher than for the main Volvo plant with traditional serial line production (Kadefors et al., 1996). The favourable comparison of productivity in dedicated studies of parallel vs. serial production systems (Engstrom et al., 1996) is based on the assumption that the parallel system is operating at maximum efficiency, which was not achieved in practice in other Volvo plants (Neumann et al., 2006; Kuipers et al., 2004; Wallace, 2008). It can be argued that the Volvo implementation of the sociotechnical model erred on the side of human wellbeing, not sufficiently concerned with production demands. Consequently, the return from parallel to serial system design in Swedish industry during the 1990s was motivated by “... managerial attempts to regain control of the shop floor ...” (Wallace, 2008).

This is an example of unsuccessful rationalization through lack of regulation of performance at company level, in a situation with empowerment of workers. From a performance perspective, especially with transfer of responsibility and introduction of worker autonomy, there is a need to regulate performance. Regulation can have different formats; by standardizing (e.g., Mehri, 2005; Leroyer et al., 2006), monitoring (documentation demands), performance incentives, or management by objectives (i.e., responsibility for execution of work tasks transferred to workers).

Conversely, human wellbeing aspects are increasingly included in rationalization strategies that focus performance. Organizational flattening of work systems by removal of supervisors and middle management, more responsibility to workers (or teams), and the development of performance feedback and control systems is common to virtually all current rationalization strategies. Worker’s commitment and satisfaction is a prerequisite for good system performance. Liker (2004) strongly advocates the utilization of worker creativity in lean practices, softening the regimented lean systems of the 1990s (Delbridge et al., 1992; Sewell and Wilkinson, 1992). This is also a basis for the HPWS strategy and a multitude of rationalization “fads” introduced in recent years (some listed by Johansson and Abrahamsson, 2009), combining “good” aspects of HRM, such as worker participation, empowerment and presenting opportunities for learning and personal development, with performance-enhancing features. It appears that significant portions of the evidence-based recommendations to achieve

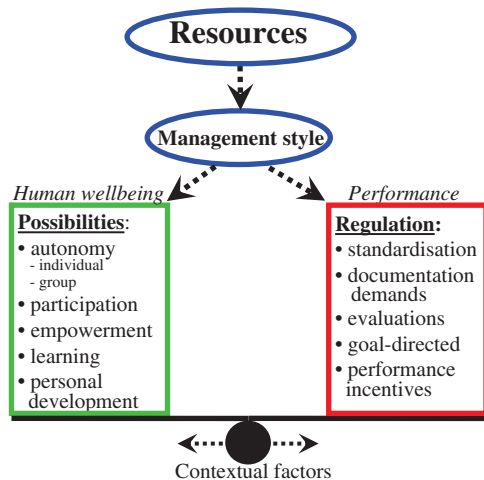
human wellbeing in working life, presented in this review, have been incorporated in many current rationalization strategies.

#### 7.2.4. From science to action

Despite the intentions of including measures considered to support human wellbeing in recent rationalization strategies, it appears that working conditions have not showed an overall positive development (e.g., EU working conditions surveys 1990–2005). The basic tenet of this review is that rationalization contributes to reduced worker wellbeing and health, but it is also a necessary aspect of work life. The joint consideration of system performance and worker wellbeing is needed, conceptually illustrated in Fig. 3 as a seesaw in balance. Measures enhancing performance and wellbeing, respectively, are listed in the two weights. A sustainable production system is a moving target; the right mix of measures is local, dependent on context and is continuously changing, as indicated by lateral shifts of the pivot. None of the listed measures has intrinsic superior value when performance and wellbeing carry equal weight. Proper management style and sufficient resources help maintain the balance. Organizational justice in rationalization may influence the balancing of the seesaw: workers more readily accept actions that are not optimal in a wellbeing perspective if they are perceived necessary to maintain a viable production system and the process is perceived to be fair. The challenge, regardless of rationalization strategy, is to establish the right balance between performance incentives and human wellbeing concerns.

It can be argued that Fig. 3 represents established management insight. Numerous studies have aimed to clarify aspects of the model (e.g., Cunningham and Hyman, 1999; Bateman and Rich, 2003). A pertinent question is why such insight has not led to more sustainable production systems. An answer may be formulated as hypotheses:

- Dissemination of relevant knowledge has not reached *key stakeholders*.
- Evidence-based knowledge exists at the general level and needs to be operationalized to be applicable in a *local context*.
- *Fragmentation* of responsibilities; strategic decisions are made by top management who may be less concerned with, or lack of understanding of wellbeing aspects (delegated to human resource personnel).



**Fig. 3.** An illustration of key factors and their interaction as a basis for a sustainable production system, based on the insights extracted from this review. The seesaw emphasizes that practical solutions at the individual organization is a dynamic and continuous process that must be monitored with specific attention to local, contextual factors. Management style and available resources are key factors in this interplay.

- Mismatch between performance demands and wellbeing considerations due to *insufficient resources*.
- Management and worker *cultural barriers* (lack of participation, communication, support, etc.).
- Stressful jobs may not be sustainable in a *lifelong career perspective*; opportunities for job change are limited.
- The *joint consideration of system performance and human wellbeing* as depicted in Fig. 3 is inherently difficult to optimize, also because it is a moving target.

The above hypotheses must be substantiated, but would act as barriers to overcome in order to reverse the trend of work intensification and high level of musculoskeletal and mental disorders. Solutions at the level of the individual organization will vary by time and by numerous contextual factors. Thus, practical solutions cannot be specified in general terms, but will emerge as outcome of locally driven processes.

Ergonomic interventions as generally practiced remain relevant (e.g., [http://osha.europa.eu/en/good\\_practice/](http://osha.europa.eu/en/good_practice/)). However, it appears that work intensification due to rationalization is best described by organizational variables such as control systems, management style, resources and incentives, and dealt with in those terms. Occupational medicine and ergonomics personnel should develop a good understanding of work organization relevant for production system performance and collaborate with stakeholders responsible for the planning and management of such systems (e.g., Neumann et al., 2009).

#### 7.3. Future research priorities to achieve sustainable production systems

What is the best use of research resources to minimize occupational musculoskeletal and mental disorders? A recent research agenda, presenting future directions in occupational musculoskeletal disorder research, argues for more research on tissue tolerance limits and improved quantification of risk factors and their interaction (Marras et al., 2009), representing a continuation of classic ergonomics research. Important insight may surface, but the track record of this research in terms of solving worker health problems is debatable; research supporting a more holistic intervention approach should be encouraged.

In present work life, performance is a prerequisite for the survival of organizations, making rationalizations a continuous and all-embracing process. This review shows wide-ranging impact of rationalizations on worker wellbeing, but also that means to counteract such effects exist. Future occupational health and ergonomics intervention research may have a better chance of success by focusing on insights that help balancing production performance and worker wellbeing, thereby moving towards more sustainable production systems. Practical applications of such research become proactive and act at system level (cf. Fig. 1), contrasting traditional ergonomic interventions that mostly target the individual worker. This reasoning may be operationalized into the following research issues:

- The hypotheses in Section 7.2.4 to explain inadequate implementation of means to achieve sustainable production systems are all relevant study targets.
- Tools and methodologies should be developed that allow concurrent tuning of performance and wellbeing considerations in a rationalization process.
- Case studies should investigate interactions between performance demands and worker wellbeing considerations (cf. Fig. 3), to supplement large-scale surveys that show mutual gains

Insights presented by this review are to a considerable extent based on literature from the research fields of work sociology, organization science, HRM management, and economics; all fields providing knowledge about work life factors important for the development of sustainable production systems. This literature base is not well utilized by occupational medicine and ergonomics researchers. Attempts in this direction are made within the macroergonomics and ODAM (Organizational Design and Management; a technical group in the International Ergonomics Association) framework (e.g., Imada and Carayon, 2008), but appears to have had limited impact. There is a need for better recognition of the above listed research areas, to provide a more comprehensive basis for ergonomics intervention research aiming for (and understanding the prerequisites of) sustainable production systems. A particular research challenge is that rationalization intervention is a never-ending process that adapt to continuously changing contextual factors to maintain competitive production systems.

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