

**The psychosocial and health effects of workplace reorganisation Paper 2: A systematic review of task restructuring interventions.**

Clare Bamba<sup>1</sup>, Matt Egan<sup>2</sup>, Sian Thomas<sup>2</sup>, Mark Petticrew<sup>2</sup>, Margaret Whitehead<sup>3</sup>

<sup>1</sup>Centre for Public Policy and Health, Wolfson Research Institute, Durham University

<sup>2</sup>Medical Research Council Social and Public Health Sciences Unit, University of Glasgow

<sup>3</sup>Division of Public Health, University of Liverpool

Corresponding author: Clare Bamba, Centre for Public Policy and Health, Wolfson Research Institute, Durham University Queen's Campus, Stockton on Tees, TS17 6BH.

Email: [clare.bamba@durham.ac.uk](mailto:clare.bamba@durham.ac.uk)

Sources of Support: Economic and Social Research Council and the Chief Scientist Office of the Scottish Executive Health Department.

Word count: 3873.

**Keywords**

1. Systematic review
2. Health inequalities
3. Psychosocial work environment

## **Abstract**

**Objective** To systematically review the health and psychosocial effects (with reference to the demand-control-support model) of changes to the work environment brought about by task structure work reorganisation, and whether those effects differ for different socio-economic groups.

**Design** Systematic review (QUORUM) of experimental and quasi-experimental studies (any language) reporting health and psychosocial effects of such interventions.

**Data sources:** 17 electronic databases (medical, social science and economic), bibliographies, and expert contacts.

**Results** 19 studies were reviewed. Some task restructuring interventions failed to alter the psychosocial work environment significantly, and so could not be expected to have a measurable effect on health. In those which increased demand and decreased control, health tended to get worse, and vice versa, though some effects were minimal. Increases in workplace support did not appear to mediate this relationship.

**Conclusion** This systematic review suggests that task-restructuring interventions which increase demand or decrease control adversely affect the health of employees, in line with observational research. It lends support to policy initiatives such as the recently enforced EU directive on participation at work, which aims to increase job control and autonomy.

Abstract: 182 words

## INTRODUCTION

The workplace, particularly the psychosocial work environment, is increasingly being considered by policymakers as an important intervention point at which health can be improved and health inequalities reduced.[1] [2] The demand-control-support model of the role of stressful psychosocial work environments on the health of employees has dominated the research literature [3] [4] (although it has not been without criticism not least from advocates of the effort-reward imbalance model)[5]. Karasek initially developed a two-dimensional concept of work-related stress in which the culmination of high psychological work demands and low job task control (low level of decision authority and low level of skill utilisation) increased work-related stress, subsequently producing higher rates of psychological and physical morbidity.[4] Support from colleagues and supervisors has been suggested as a possible mediating factor in the relationship between high work demands, low job control and work-related stress.[6]

Epidemiological research, especially from the Whitehall studies, has suggested a relationship between the psychosocial work environment, work related stress and inequalities in health status.[7] [8] Adverse health outcomes, including increased risk of heart disease,[7] [9] [10] [11] musculoskeletal pain,[12] poor mental health,[13] and sickness absence,[14] have been associated with high work demands and low job control. It has also been suggested that enhanced social support in the workplace may reduce these negative consequences.[6] [15] Although empirical research has generally confirmed the demand-control-support model's basic assumptions, some researchers prioritise specific parts of the model (e.g. suggesting that control may have stronger associations with health than demands).[16] [17] [18] Furthermore, concerns remain as to whether other factors (most notably income) may override the influence of psychosocial factors on health.[19] [20] [21] [22] Similarly, further investigation is necessary to examine the inter-relationship between demand, control and support.[21] The model is therefore usually considered to be descriptive rather than prescriptive. However, the potential clearly exists for interventions that modify the psychosocial work environment (by increasing or decreasing levels of demand, control or support) to also have positive or negative impacts on employee

health.

### Box 1: Descriptions of the task restructuring interventions located by the review

#### **Task Variety**

Interventions of this type increase the skills utilised by workers by increasing the variety of work tasks which are required as part of their jobs.

##### *Primary nursing* [33] [34] [35] [36]

Primary nursing and personal caregiving are patient orientated care systems in which each patient is assigned to an individual nurse/carer, the nurse/carer takes 24 hour responsibility for the care of that patient including the planning and quality of the care provided. Care is therefore based on patient need rather than the needs of the nursing ward. It aims to increase the variety of tasks undertaken by the nurses/carers and, according to the literature; it indirectly increases the decision latitude, autonomy and control of the nurse.

##### *Production line* [32] [37] [38] [39] [40]

Production line interventions increase the variety of tasks performed by a worker, increase the skills utilised and place more responsibility on individual workers. **Typically, individual workers were encouraged to be involved in a set of tasks requiring a wider variety of skills, instead of being responsible for a single task and reliant on a small range of skills.**

##### **Team working** [32] [37] [40] [41] [42] [43] [44] [45] [46] [47]

Workers are given more collective responsibility and decision making power. However, workers are still individualised, responsibility is not shared and supervisory structures remain in place. This intervention type is also designed to enhance collective coping and provide support within the workplace. Team working interventions can occur in any work environment.

##### **Autonomous groups**

This intervention type is specific to mass production environments where it is often used to reduce the prevalence of traditional production line characteristics (such as individualised, repetitive tasks) by increasing skill variety and collective involvement. It combines aspects of job enrichment and team working as well as increased worker participation (within group democracy).

##### *'Lean production' and 'Just in time'* [48] [49] [50] [51]

Lean production originated in Japan. It is intended to improve efficiency, quality and responsiveness. Employee workloads are maximised (tasks and responsibilities), wasted time is reduced, tasks are distributed within the team, and work standards are determined by the employees themselves rather than solely by management. Group responsibility also extends beyond production, to the maintenance and running of the production machines so that employees are also involved in problem solving and quality.

'Just in time' requires that products are made 'just in time' to be sold – no stockpiling of products. This ethos dominates each level of the production process and every work task: each aspect of the product is to be finished just in time for the next. Each stage is triggered by demand from the next; it is therefore a pull system compared to the traditional push system in which production is determined by the availability of labour or materials. Work groups, not individuals, are given autonomy and responsibility for specific tasks in order to achieve the required production flow.

##### *Autonomous work groups* [31] [52]

Autonomous workgroups are characterised by employee self-determination and involvement in the management of day to day work (including control over pace, task distribution, and training and recruitment). Work place democracy is also a factor as supervisors are usually replaced by elected 'team champions' or 'contact people', accountable to the groups.

Potential intervention points centre either on the individual (e.g. enhancing personal coping mechanisms) or on the reorganisation of the workplace at the macro or micro level.[23] Macro interventions change the levels of participation in decision making,[24] whilst micro-environment interventions change the structure of work tasks. Karasek identified three types of task structure interventions (Box 1): job enrichment and enlargement (task variety), collective coping and decision making (team working), and the use of autonomous production groups (autonomous groups).

In our companion paper,[24] we found that macro level work reorganisation interventions which increased control had positive health effects. However, Karasek suggested that macro and micro workplace interventions may have differing psychosocial, and therefore health, outcomes.[23] In this paper then, we extend our analysis of the psychosocial work environment by presenting the results of a systematic review of the health impacts of reorganisation interventions that alter the micro, task structure, environment. Based on Karasek, it is hypothesised that the task restructuring interventions will improve levels of control and support although, in line with the characteristics of more active jobs, demands may also be high.[23] Interventions which improve the psychosocial work environment in this way are predicted to have a beneficial effect on health, particularly mental health, while, conversely, interventions that result in higher demand and lower control are predicted to have an adverse effect on health outcomes.

Although previous literature reviews exist in this area, these often cover only specific occupations or one type of task restructuring intervention, and have not been conducted using the systematic review methodology.[25] This is therefore the first systematic review of the health effects of changes to the psychosocial work environment brought about by reorganisation of the work task structure. It offers the opportunity to examine the health effects of changes to the psychosocial work environment brought about by task structure work reorganisation, and whether those effects differ for different socio-economic groups. It also facilitates contrasts with the effects of macro level reorganisation interventions.[24]

## **METHODS**

### **Inclusion and Exclusion**

The review sought to identify all experimental and quasi-experimental studies that examined the effects on health of interventions which reorganised work task structures. The review included all task structure interventions that fell into one of Karasek's three clusters: Task variety, Team working and Autonomous groups.[23] Work reorganisation interventions based on the demand-control (support) model and those motivated by economic or managerial reasons were all included. Only studies which included measures of both the psychosocial work environment (demand, control, or support) and health were included in the review. Health outcomes included specific diseases as well as more general measures of physical health and psychological well-being. Impacts on health inequalities were also considered as outcomes. Studies which only focused on workplace injuries or accidents were excluded, as were those which did not report on the psychosocial work environment beyond job satisfaction measures.

### **Search strategy**

We searched electronic databases, bibliographies, and websites for documents of any type and in any language (full search strategy available from protocol at [http://www.msoc-mrc.gla.ac.uk/Evidence/Research/Research\\_MAIN.html](http://www.msoc-mrc.gla.ac.uk/Evidence/Research/Research_MAIN.html)). We searched the following 17 databases from start date to December 2006 (hosts given in parentheses): ASSIA (CSA), Conference Papers Index (CSA), Business Source Premier, Dissertation abstracts, Econlit (Dialog), Embase (Dialog/Ovid), ERIC Firstsearch/CSA), Electronic Collections Online (OCLC firstsearch), Index to theses, Medline (Ovid/Dialog), NTIS (free version), PAIS (Dialog), Psycinfo (Dialog/Ovid), SIGLE, Sociological abstracts (CSA), Social Sciences Citation Index (MIMAS), Zetoc, and various internet sources. We also hand searched bibliographies and contacted experts.

We initially located 68737 titles and abstracts, of which 734 were retrieved for full analysis. All

papers reporting the results of an empirical study of the effects on health of interventions which changed the structure of work tasks were independently assessed by two reviewers (CB and ME) for relevance and methodological quality.

### **Critical appraisal and data extraction**

Critical appraisal criteria were adapted from previous systematic reviews of public health interventions and existing guidance for the evaluation of non-randomised studies.[26] [27] [28] [29] [30] Two reviewers independently appraised the included studies according to these criteria (Box 2). Data were abstracted by one reviewer (ST) and checked by a second (CB). We included percentages, confidence intervals (CIs), *P* values, and effect sizes when they were reported in the original study or calculated these statistics (using final sample sizes) if sufficient information was available.

#### **Box 2: Critical appraisal criteria for assessing study quality [26] [27] [28] [29] [30]**

1. Is the study prospective?
2. Is there a representative sample?
3. Is there an appropriate control group?
4. Is the baseline response greater than 60%?
5. Is the follow-up greater than 80% in a cohort study, or greater than 60% in a cross-sectional study?
6. Have the authors adjusted for non-response and drop-out?
7. Are the authors' conclusions substantiated by the data presented?
8. Is there adjustment for confounders?
9. Were the entire intervention group exposed to the intervention?  
Was there any contamination between the intervention and control groups?
10. Were appropriate statistical tests used?

## RESULTS

Nineteen different studies were located, the earliest dated from 1986.[31] Thirteen studies were located from electronic databases and the other six were identified from citation follow-ups. Eight studies examined task variety,[32] [33] [34] [35] [36] [37] [38] [39] [40] seven examined team working,[41] [42] [43] [44] [45] [46] [47] and six examined autonomous groups.[31] [48] [49] [50] [51] [52] Two of the studies examined interventions which entailed both changes to task variety and increased team working,[32] [37] [40] and many of the other studies were conducted in the context of macro-environment work reorganisations.[24] Health was measured on a self-reported basis in all but two of the studies.[41] [52] The psychosocial outcome measures were also self-reported with employees asked to rate their sense of demand, control or support, or other similar psychosocial characteristics (e.g. work autonomy for control). In all but six of the studies,[31] [32] [35] [37] [41] [42] [43] [52]) the work reorganisation was motivated by economic or managerial reasons. Fourteen prospective cohorts, and five repeat cross-sectional studies were found. Ten of the studies used a comparison group (workers from a different department in the same workplace, or from a similar worksite) and two of the studies also had qualitative elements.[40] [44] Results are presented by intervention type in tables 1 to 3.

### Task variety

Eight studies [32] [33] [34] [35] [36] [37] [38] [39] [40] examined changes to task variety (Table 1), four in healthcare settings [33] [34] [35] [36] and four in production line settings.[32] [37] [38] [39] [40]



**Table 1: Summary of evidence of the psychosocial and health effects of task variety interventions**

Study	Design & Methods Appraisal <sup>A</sup>	Setting & Participants	Intervention & Implementation <sup>B</sup>	Psychosocial Outcomes (P<0.05) <sup>C,D</sup>	Health Outcomes (P<0.05) <sup>D</sup>
Boumans and Landerweerd (1999)[33]	Prospective cohort with comparison group  8 and 14 month follow-up  Final sample n=59  Methods appraisal: 1 3 5 7 10	Hospital, Netherlands.  Nurses.	Primary Nursing.  Introduced as result of a change in hospital policy. Workers were trained for the new roles. Few reported details on effectiveness of implementation or commitment of employees.	Satisfaction with head nurse (S) ↔ Satisfaction with contacts with colleagues (S) ↔	Health complaints ( <i>Dutch VOG scale</i> )  Sickness absence
Boumans and Berg (2000)[34]	Prospective cohort with comparison group  12 month follow-up  Final sample n=248  Methods appraisal: 1 2 4 7 8 10	Hospital, Netherlands.  Professional caregivers.	Primary Nursing.  Initiated by the hospital. An advisory group of caregivers, managers and researchers over saw implementation. Workers were trained for the new roles. No other details on effectiveness of implementation or commitment of employees.	Job complexity (D) ↔ Job clarity (C) ↑ Satisfaction with job clarity (C) ↔ Job autonomy (C) ↔ Satisfaction with management (S) ↑ Satisfaction with contacts with colleagues (S) ↔	Emotional exhaustion ( <i>Maslach Burnout Inventory</i> )
Melchior et al (1996)[35]	Prospective cohort with comparison group  12 month follow-up  Final sample n=161  Methods appraisal: 1 2 4 6 7 8 10	Hospitals, Netherlands.  Nurses.	Primary Nursing.  Introduced out of managerial concerns about staff burnout. A support group oversaw the work intervention and implementation was evaluated on a monthly basis. Workers were trained for the new roles. Few other details reported on the effectiveness of implementation or commitment of employees.	Depersonalisation (S) ↔	Emotional exhaustion ( <i>Maslach Burnout Inventory</i> )
Berkhout et al (2004)[36]	Prospective cohort with comparison group  3 and 10 month follow-up  Final sample n=147  Methods appraisal: 1 2 7 8 9 10	Nursing homes, Netherlands  Professional caregivers.	Primary Nursing.  Few reported details on effectiveness of implementation or commitment of employees. Authors did comment though that implementation of the intervention was partial in some cases.	Job demands (D) ↔ Job autonomy (C) ↔ Social support (S) ↔	Health complaints ( <i>Dirken Questionnaire for the st of experienced health</i> ) Sickness absence
Wahlstedt et al (2000, 2001)[32] [37]	Prospective cohort with comparison group  1 month follow-up  Final sample n=82	Postal sorting office, Sweden.  Manual workers and shop floor supervisors.	Increased task variety, more teamwork, more personnel, more time to plan work, bonus scheme.  Intervention(s) introduced by employers to improve the psychosocial work environment and	Psychological work demands (D) ↑ Authority over decisions (C) ↑ Skill discretion (C) ↔ Social support (S) ↑ Contact with superior (S) ↔ Contact with team mates (S) ↔	Shoulder and thoracic symptoms ( <i>Nordic questionnaire on Musculoskeletal Complaints</i> )  Neck and low back symptoms ( <i>Nordic questionnaire on</i>

	Methods appraisal: 1 3 4 5 7 10		to reduce sickness absence and staff turnover. Employees volunteered to be involved in the intervention.		<i>Musculoskeletal Complaints)</i>
Fredriksson et al (2001)[40]	Prospective cohort. Some qualitative components.  9 month follow-up  Final sample n=102  Methods appraisal: 1 2 4 9 10	Factory floor, Sweden.  Manual workers.	Production line introduced, decreased task variety, team working  Introduced to increase productivity, reduce the need for skilled labour and reduce sick leave. Few reported details on effectiveness of implementation or commitment of employees.	High job demands (D) ↔ Possibilities to influence work (C) ↓ Poor social support at work (S) ↔	Musculoskeletal disorders  Visits to health centre  Sickness absence
Wall et al (1990)[38]	Prospective cohort  50 day follow-up  Final sample n=19  Methods appraisal: 1 2 4 5 7 9 10	Factory floor, UK.  Manual workers.	Increased operator control on production line.  Introduced to increase staff performance. Training was provided. Representative of employees of all grades and the researchers were involved in a working party overseeing the implementation of the intervention. Some employees were resistant to the intervention.	Job pressure ↓	General strain (GHQ-12)  Job related strain (Warr Job Related Anxiety Scale)
Majchrzak and Cotton (1988)[39]	Prospective cohort  1 month follow-up  Final sample n=31  Methods appraisal: 1 2 4 7 8 9 10	Factory floor, USA.  Manual workers.	Computerisation of production line.  Intervention introduced to increase productivity after the company split up. Employees volunteered to be involved in the intervention but the authors suggest that this was because they were worried about keeping their jobs. No training was provided. Few reported details on effectiveness of implementation	Input and output unpredictability ↓ Degree of coordination needed ↔ Process unpredictability ↔ Control over input and output quality ↑ Control over process quality ↓ Informal communication opportunities ↑	Psychological problems (Brett Scale)  Perceived quality life (Brett Scale)

<sup>A</sup> Methods appraisal (Box 2): 1= prospective; 2= representative sample; 3= appropriate comparison group; 4= baseline response >60%; 5= follow-up >80% in cohort, >60% in cross-section; 6= adjustment for non-response and drop-out; 7= conclusions substantiated by data; 8=adjustment for confounders; 9= all intervention group exposed, non-contaminated comparison group; 10= appropriate statistical tests.

<sup>B</sup> See Box 1.

<sup>C</sup> D = Demand; C = Control; S = Support.

<sup>D</sup> ↑ = improvement ↓ = worsening ↔ = little change

### *Healthcare*

Four cohort studies,[33] [34] [35] [36] one of which was motivated out of concern for employee health,[35] reported on increased task variety amongst Dutch nurses. All of the studies were prospective and had comparison groups, although the quality of the comparison groups was a cause of concern. For example, in one study the comparison group became a second intervention group after six months.[33] In contrast to the stated aims, the interventions did not significantly alter the psychosocial working environment: in three studies[33] [35] [36] there were no changes in support (as assessed by the Boumans Questionnaire,[33], de Jonge scale [36] and the Maslach Burnout Inventory[35]), and in the Berkhout et al study, job autonomy (control) and work demands were also unchanged.(36) In the other study,<sup>(34)</sup> only clarity (control) and satisfaction with management (support) were higher in the intervention group (Boumans Questionnaire). There were few health effects: in the Boumans and Landerweerd study(33) and the Berkhout et al study,[36] reported health complaints (assessed by the Dutch VOG scale[33] and the Dirkin Questionnaire[36]) decreased slightly; while emotional exhaustion (Maslach Burnout Inventory) did not change significantly in either the Boumans and Berg[34] or the Melchor[35] studies.

### *Production line*

Four production line studies were located,[32] [37] [38] [39] [40] one of which reported on an intervention which intended to decrease, rather than increase, task variety.[40] Two of the studies[32] [37] [40] also involved team work (see next section). Only one intervention[32] [37] was designed to improve the psychosocial work environment, the others were initiated to increase productivity.[38] [39] [40]

In the prospective cohort study (with comparison group) of Swedish postal workers,[32] [37] demands decreased, job control was unchanged, and social support increased (as assessed by the Job Content Questionnaire). The study found a decrease in reports of shoulder and thoracic

musculoskeletal symptoms (Nordic questionnaire on Musculoskeletal Complaints). Two other prospective cohort studies examined increased task variety created by computerising the production system.[38] [39] The UK study reported a significant decrease in self-reported job pressure (Warr et al Attitudes to Work Scale) and a non-significant increase in general and job related strain (measured with Warr Job Related Anxiety Scale and GHQ-12).[38] The USA study reported some increases in demand (unpredictability increased), mixed effects on job control (control over input and output quality increased but control over process quality decreased), and increased social support (assessed by Majchrzak and Cotton Questionnaire).[39] However, there were no significant changes in terms of Brett Scale measurements of psychological problems or quality of life.[39]

A prospective cohort study of the automation of a Swedish production line was the only one in which task variety decreased (the opposite of job enrichment).[40] In this study, job control decreased (reports of lack of influence over work as measured by Fredriksson et al rose) but there were no significant changes in terms of demand or support. The study found that musculoskeletal disorders (measured as experience of musculoskeletal disorders in past seven days and twelve months) of the neck, shoulder and hand increased as did health centre visits. The qualitative element of this study found that workers had reduced occupational pride and felt 'robotised'.

### **Team working**

Table 2 summarises the results of seven studies which examined the effects of increased team work.[32] [37] [40] [41] [42] [43] [44] [45] [46] [47] Four studies were of manual employees,[32] [37] [40] [41] [42] [43] one was of a mixed occupational workplace,[44] and two were of professional employees.[45] [46] [47] In three studies, the motivation for the intervention was employee health,[32] [37] [41] [42] [43] in the others, it was productivity,[38] [39] [40] [44] reducing the need for skilled labour,[40] and a new employment contract.[45] [46] [47]

**Table 2: Summary of evidence of the psychosocial and health effects of team working interventions**

Study	Design & Methods Appraisal <sup>A</sup>	Setting & Participants	Intervention & Implementation <sup>B</sup>	Psychosocial Outcomes (P<0.05) <sup>C,D</sup>	Health Outcomes (P<0.05) <sup>D</sup>
Kawakami et al (1997)[41]	Prospective cohort with comparison group  1 and 2 year follow-ups  Final sample n=187  Methods appraisal: 1 2 3 4 5 7 8 9 10	Factory floor, Japan.  Manual workers.	More and smaller teams with sub-supervisors; participatory committee; more on the job training; and ergonomic improvements.  Introduced to reduce stress as the intervention site had the highest levels within the company. Authors report that employers supported the intervention although one aspect (on the job training) was not fully implemented. Prior support from employees is not reported.	Work overload (D) ↓ Control (C) ↔ Co-worker problems (S) ↔ Supervisor problems (S) ↔	Mental health ( <i>Zung self-rating depression score</i> )  Absenteeism  Cardiovascular proxies ( <i>systolic and diastolic blood pressure</i> )
Wahlstedt et al (2000, 2001)[32] [37]	Prospective cohort with comparison group  1 month follow-up  Final sample n=82  Methods appraisal: 1 3 4 5 7 10	Postal sorting office, Sweden.  Manual workers and shop floor supervisors.	Increased task variety, more teamwork, more personnel, more time to plan work, bonus scheme.  Intervention(s) introduced by employers to improve the psychosocial work environment and to reduce sickness absence and staff turnover. Employees volunteered to be involved in the intervention.	Psychological work demands (D) ↑ Authority over decisions (C) ↑ Skill discretion (C) ↔ Social support (S) ↑ Contact with superior (S) ↔ Contact with team mates (S) ↔	Shoulder and thoracic symptoms ( <i>Nordic questionnaire on Musculoskeletal Complaints</i> )  Neck and low back symptoms ( <i>Nordic questionnaire on Musculoskeletal Complaints</i> )
Fredriksson et al (2001)[40]	Prospective cohort. Some qualitative components.  9 month follow-up  Final sample n=102  Methods appraisal: 1 2 4 9 10	Factory floor, Sweden.  Manual workers.	Production line introduced, decreased task variety, team working  Introduced to increase productivity, reduce the need for skilled labour and reduce sick leave. Few reported details on effectiveness of implementation or commitment of employees.	High job demands (D) ↔ Possibilities to influence work (C) ↓ Poor social support at work (S) ↔	Musculoskeletal disorders  Visits to health centre  Sickness absence
Wahlstedt and Edling (1994, 1997)[42] [43] <sup>E</sup>	Prospective cohort  8 and 12 month follow-ups  Final sample n=100  Methods appraisal: 1 2 4 6 7 8 9 10	Postal sorting office, Sweden.  Manual workers and shop floor supervisors.	More teamwork, more personnel, role clarification, production goals, fewer supervisors, partial change in shift system, increased feedback, new vending machine and microwave oven.  Intervention(s) introduced by employers to improve the psychosocial work environment and to reduce sickness absence and staff turnover. Positive experience on one section of workers extended to others. Employees involved in planning the intervention.	Psychological work demands (D) ↔ Skill discretion (C) ↑ Authority over decisions (C) ↑ Contact with team-mates (S) ↔ Contact with superiors (S) ↔	Sick leave  Sleep and gastrointestinal complaints
Korunka et al (2003)[44]	Prospective cohort. Some qualitative components.	Local government office, Austria.	More teamwork (through re-structuring, team leaders with autonomous budgets), incentive	Job control (C) ↔ Social support (S) ↔	Perceived stress ( <i>Weyer Questionnaire</i> )

	2 months and 1 year follow-ups Final sample n=185 Methods appraisal: 1 2 4 5 7 9	Managerial, technical, administrative and customer service workers.	system.  Intervention implemented as part of a politically and economically motivated shift in the style of public sector management. Authors imply that implementation may have been of a 'poor professional quality' due to 'rigid bureaucratic structures'.		Emotional strain ( <i>Weyer Questionnaire</i> )  Tiredness ( <i>Weyer Questionnaire</i> )
Sutherland and Cooper (1989, 1992)[45] [46]	Prospective repeat cross-section  3 year follow-up Final sample n=917 Methods appraisal: 1 2 4 5 9 10	Health centres, UK.  General Practitioners (Doctors)	More teamwork, new roles.  Intervention(s) in the context of the introduction of a new employment contract 'at the end of a period of considerable dispute and disagreement'. Few reported details on effectiveness of implementation.	Time pressure Pressure due to unrealistic expectations of others Demands of job on family life Demands of job on social life Responsibility Job variety Freedom to choose method of working Satisfaction with co-workers Satisfaction with supervisors ↓ ↓ ↓ ↓ ↓ ↓ ↑ ↑	Free floating anxiety ( <i>Crown-Crisp experimental index</i> )  Somatic anxiety ( <i>Crown-Crisp experimental index</i> )  Depression ( <i>Crown-Crisp experimental index</i> )
Appleton et al (1998)[47] <sup>F</sup>	Retrospective cross-section  7 year follow-up Final sample n=285 Methods appraisal: 2 4 7 9 10	Health centres, UK.  General Practitioners (Doctors)	More teamwork, new roles  Intervention(s) in the context of the introduction of a new employment contract. Few reported details on effectiveness of implementation or commitment of employees.	Satisfaction with amount of responsibility given Satisfaction with freedom to choose method of working Satisfaction with opportunity to choose abilities Satisfaction with job variety Satisfaction with colleagues and fellow workers ↓ ↓ ↔ ↔ ↔	Work related physical health  Psychological symptoms

<sup>A</sup> Methods appraisal (Box 2): 1= prospective; 2= representative sample; 3= appropriate comparison group; 4= baseline response >60%; 5= follow-up >80% in cohort, >60% in cross-section; 6= adjustment for non-response and drop-out; 7= conclusions substantiated by data; 8=adjustment for confounders; 9= all intervention group exposed, non-contaminated comparison group; 10= appropriate statistical tests.

<sup>B</sup> See Box 1.

<sup>C</sup> D = Demand; C = Control; S = Support.

<sup>D</sup> ↑ = improvement ↓ = worsening ↔ = little change

<sup>E</sup> Study is set in the same workplace as Wahlstedt et al (2000, 2001).[32] [37]

<sup>F</sup> Study uses baseline results from Sutherland and Cooper (1992) and Cooper et al (1989). [45] [46] Little change for sample as a whole but health outcomes worsened for lower grade employees

### *Manual employees*

Three of the four studies of mainly male, manual workers[32] [37] [40] [41] [42] [43] were Swedish. They reported an improved work environment: demand decreased and social support increased in the prospective study with a comparison group (outlined above),[32] [37] whilst job control in terms of skill discretion and authority increased (measured with the Job Content Questionnaire) in a prospective cohort study by Wahlstedt and Edling,[42] [43] and decreased in Fredriksson and colleagues' prospective cohort study of task variety reduction.[40] Health changes were also evident: musculoskeletal symptoms decreased in one study[32] [37] and increased in another,[40] whilst sick leave was significantly reduced in the Wahlstedt and Edling study.[42] [43] In contrast, the Japanese prospective cohort study with a comparison group[41] found little change in psychosocial outcomes, as measured using Zung self-rating depression score, but still reported a reduction in sick leave and depression amongst men.

### *Mixed grade employees*

One Austrian prospective cohort study of work reorganisation in a local government office[44] found no significant changes in self-reported job control or social support for the sample as a whole (Sainfort Perceived Job Resources Scale). Nonetheless, those in the lowest occupational grades had adverse health outcomes, (measured with Weyer Questionnaire): perceived stress, emotional strain, and tiredness increased amongst customer service advisers; tiredness increased amongst administrators, but there were no significant changes in perceived stress, emotional strain, or tiredness amongst managers. It is possible that this was a result of the poor implementation of the intervention by management and the broader context of organisational change in which this intervention took place (see Table 2).

### *Professional employees*

Two related cross-sectional studies[45][46] [47] examined the increase in teamwork that resulted after a change in contract, working hours and job roles amongst UK doctors. The earlier prospective repeat cross-sectional study[45] [46] found increased demands, decreased control,

and increased social support (Warr Job Satisfaction Scale and Cooper Job Stress Questionnaire) (Table 3). In terms of self-reported health (Crown-Crisp experimental index), men and women reported an increase in anxiety, somatic anxiety and depression. The linked retrospective cross-section[47] found that seven years on, levels of control (Warr and Cooper scales) were still lower than before the reorganisation, and that the increase in support identified in the earlier study no longer existed. Taken together the two studies suggest that team working only increased support in the short-term, and that support did not compensate for the adverse health effects of decreased control and increased demands.

### **Autonomous groups**

Six studies were located which examined the introduction of more autonomous production groups into factory-based mass production systems (Table 3). Lean production[48] [49] and 'just in time'[50] [51] were production efficiency interventions, whilst the autonomous workgroups[31] [52] were also motivated by job redesign[31] or the prevalence of musculoskeletal disorders.[52]

#### *Lean production and 'just in time'*

Both of the UK studies of lean production interventions[48] [49] found that control and autonomy deteriorated (as measured by the Jackson et al Task Control, Skill Utilisation and Work Demands Scales). In the prospective cohort study with comparison group by Parker,[48] job autonomy and skill utilisation decreased amongst all three intervention groups, and participation also decreased in two. Job anxiety and depression (Warr Job Related Anxiety Scale) increased in all three groups (Table 3). In the retrospective cross-sectional study with comparison group,[49] individual and collective timing control deteriorated, problem solving, skill utilisation and monitoring demands also worsened (i.e. increased), while social contact and trust improved. However, there was no difference in the Warr Scale measure of job related strain. This lack of adverse effect may be linked to the reported enhanced pay of the intervention group.[49]



**Table 3: Summary of evidence of the psychosocial and health effects of autonomous group interventions**

Study	Design & Methods Appraisal <sup>A</sup>	Setting & Participants	Intervention & Implementation <sup>B</sup>	Psychosocial Outcomes (P<0.05) <sup>C,D</sup>	Health Outcomes (P<0.05) <sup>D</sup>
Parker (2003)[48]	Prospective cohort with comparison group  3 year follow-up  Final sample n=368  Methods appraisal: 1 2 4 6 7 8 9 10	Factory floor, UK.  Manual workers.	Lean Production - A=lean teams, B=assembly lines, C=workflow formalisation and standardisation.  Introduced for economic reasons to increase productivity and improve product quality. Context of increased demand for product. Few reported details on effectiveness of implementation or commitment of employees.	Job autonomy (C) ↓ Skill utilisation (C) ↓ Participation in decision making (C) ↓	Job depression (Warr Job Related Anxiety Scale)  Job anxiety (Warr Job Related Anxiety Scale)
Jackson and Mullarky (2000)[49]	Retrospective cross-section with comparison group.  Final sample n=556  Methods appraisal: 2 3 7 8 9 10	Factory floor (four sites), UK.  Manual workers (female).	Lean Production  Introduced to increase productivity. Managers in charge of implementation. Few reported details on effectiveness of implementation or commitment of employees. However, authors comment that intervention group received an increase in pay.	Problem solving demands (D) ↓ Skill utilisation demands (D) ↓ Monitoring demands (D) ↓ Production pressure (D) ↓ Production responsibility (D) ↓ Individual timing control (C) ↓ Collective timing control (C) ↓ Role breadth (C) ↑ Task variety (C) ↑ Individual method control (C) ↔ Collective method control (C) ↔ Social contact (S) ↑ Co-worker trust (S) ↑ Group cohesiveness (S) ↓ Social support (S) ↔	Job related strain (Warr Job Related Anxiety Scale)
Jackson and Martin (1996)[50] <sup>E</sup>	Prospective cohort with comparison group  7 month follow-up  Final sample n=44  Methods appraisal: 1 2 5 7 8 9 10	Factory floor, UK  Manual workers.	Just in Time  Introduced by managers to increase productivity. Few reported details on effectiveness of implementation or commitment of employees.	Production pressure (D) ↓ Problem solving demands (D) ↔ Monitoring demands (D) ↑ Timing control (C) ↓ Skill utilisation (C) ↑ Method control (C) ↔ Boundary control (C) ↔ Task variety (C) ↔	Psychological strain (GHQ-12)
Mullarky et al (1995)[51] <sup>F</sup>	Prospective repeat cross-section  Phase 1: 14 month follow-up  Phase 2: 4 month follow-up  Final sample n=44	Factory floor, UK  Manual workers.	Just in Time  Introduced to increase productivity. Few reported details on effectiveness of implementation or commitment of employees.	Monitoring demands ↓ Problem solving demands ↔ Production responsibility ↔ Individual timing control ↑ Method control ↑ Boundary control ↑ Team timing control ↑ Team method control ↔	General strain (GHQ-12)  Job related anxiety (GHQ-12)  Job related depression (GHQ-12)

	Methods appraisal: 1 2 4 5 7 9			Co-worker support Group cohesiveness	↑ ↑	
Wall et al (1986)[31]	A: Prospective cohort with comparison group at 6 month follow-up, prospective cohort at 18 and 30 month follow-ups  B: Prospective cohort with 12 and 24 month follow-ups  Final sample n=50  Methods appraisal: 1 2 4 7 10	Factory floor, UK.  Manual and shop floor supervisors.	Autonomous work groups  Intervention occurred in a purpose built factory which was designed with increasing factory floor responsibility and job redesign in mind. Researchers were not involved in the design or implementation of the intervention. Employee support for the intervention was mixed. Training on intervention was provided.	Workgroup autonomy	↑	Mental health (GHQ-12)
Christmansson et al (1999)[52]	Prospective repeat cross-section  12 month follow-up  Final sample n=12  Methods appraisal: 1 4 5 9 10	Factory floor, Sweden.  Manual and Shop floor supervisors.	Autonomous work groups  Intervention introduced to improve efficiency and reduce prevalence of work related musculoskeletal disorders in a department with historically a high incidence. Mixed response to intervention from employees, managers supportive. Few reported details on effectiveness of implementation.	Psychological workload Influence on and control of work Relationship with other workers Supervisor climate	↔ ↑ ↓ ↔	Upper extremity pain disorders  Psychosomatic reactions

<sup>A</sup> Methods appraisal (Box 2): 1= prospective; 2= representative sample; 3= appropriate comparison group; 4= baseline response >60%; 5= follow-up >80% in cohort, >60% in cross-section; 6= adjustment for non-response and drop-out; 7= conclusions substantiated by data; 8=adjustment for confounders; 9= all intervention group exposed, non-contaminated comparison group; 10= appropriate statistical tests.

<sup>B</sup> See Box 1.

<sup>C</sup> D = Demand; C = Control; S = Support.

<sup>D</sup> ↑ = improvement ↓ = worsening ↔ = little change

<sup>E</sup> Linked to Mullarky et al (1995) [51]

<sup>F</sup> Linked to Jackson and Martin (1996) [50]

The psychosocial effects of the UK prospective cohort study with comparison group[50] of a 'just in time' intervention were rather mixed as, for example, whilst production demand increased there were no changes in monitoring demand (measured using the Jackson et al scales). Similarly, in the prospective repeat cross-section monitoring demands increased but problem solving demands did not (Wall et al Work Demands Scale). Co-worker support and group cohesiveness did increase (Jackson Group Climate Scale).[51] However, neither study found any significant effects on mental health (measured using GHQ-12). It should be noted that the 'just in time' interventions generally made only minor changes to the psychosocial work environment, so would not be predicted to have a sizable impact on health.

#### *Autonomous work groups*

Two studies, one a UK based prospective cohort study (initially with a comparison group but without after 18 months)[31] and the other, a prospective repeat cross-section from Sweden,[52] examined the introduction of autonomous workgroups. Autonomy and control increased in both studies, and support decreased in one[52] (measured using Warr et al[31] and Rubenowitz[52] Attitudes to Work Scales) (Table 3). Mental health (GHQ-12) improved in the short term (after six months) but not in the longer term (after thirty months) in the UK study,[31] suggesting that the health effects of enhanced control may only be short-lived in certain settings. Musculoskeletal health (assessed via medical history and clinical examination) deteriorated in the other study.[52] This intervention increased control but health still deteriorated. This result may be due to the study designs and the influence of other factors such as psychological demands (unmeasured in the cohort study), physical workloads (not adjusted for in the repeat cross-sectional study), or the reduction in levels of social support.[52]

## **DISCUSSION**

### **Effects of the interventions**

In summary, those interventions that improved the psychosocial work environment by increasing task variety either had no effect (primary nursing) or a limited positive effect (production line) on

health. The team working interventions tended to improve the psychosocial work environment in most studies, although not for all workers, but the health effects were less apparent. The autonomous work groups, contrary to the stated aims of such interventions, caused deterioration in the psychosocial work environment, and, as would be predicted from the demand-control-support model, the resulting health effects were correspondingly adverse, though in some cases they were negligible. It is important to note that some interventions did not greatly alter the psychosocial work environment at all, and so could not be expected to have a measurable effect on health. This may have been due to poor implementation of the interventions or, in some cases, because of concurrent negative changes occurring in the wider work environment (see Tables 1-3).[23] It may also be simply because some of the task restructuring interventions were not substantial enough to alter the psychosocial work environment[23].

Change in level of control appeared to be a more important factor than change in support. Those interventions that did achieve alterations in levels of control tended to report significant changes in self-reported mental and physical health:[34] [40] [42] [43] [44] [45] [46] [47] [48] [52] in line with predictions, decreased levels of control almost invariably resulted in adverse health outcomes[40] [44] [45] [46] [47] [48] and, albeit to a lesser extent, increased levels of control resulted in improved health outcomes.[31] [42] [43] In all but one study,[49] interventions that increased support, whilst demands were increased and control decreased, still reported adverse health consequences.[44] [45] [46] [47] In terms of study design, in three of the seven prospective cohort studies with a comparison group and four of the nine other studies in which the intervention changed the psychosocial work environment, health outcomes also changed. When the interventions increased demand and decreased control, this negatively affected health, in keeping with the results of epidemiological research and predictions based on the demand-control-support model [7] [8] [9] [10] [11] [12] [13] [14]. Increases to workplace support had minimal mediating effects.

Some interventions failed to bring about a measurable change in the psychosocial work environment[33] [36] [41] whilst others made the environment worse.[34] [44] [45] [46] [47] [48]

[49] The majority of the interventions that we reviewed were introduced for economic or managerial reasons rather than as attempts to apply the demand-control-support model to the workplace to improve employee health. Those studies in which the motivation was employee wellbeing tended to have more positive psychosocial and health effects, [32] [37] [41] [42] [43] whilst the effects of those which were the most overtly driven by economics were negative or negligible in relation to health outcomes.[31] [48] [49] [50] [51] Implementation may also have been a problem as we cannot be sure that the interventions actually did increase task variety, team working or group autonomy. It was not always clear from the reporting of the studies if employees or managers were supportive of the intervention, or involved in its delivery. Furthermore, as Karasek has suggested, micro level restructuring may be vulnerable to the wider constraints of the macro work environment. The interventions which tended to have more positive psychosocial and health effects were those in which the macro environment was also more positive to employee control and involvement.[41] [42] [43] This suggests that work reorganisation that ignores possible health impact may in fact be health damaging.

The studies provide little insight into the differing effects of task restructuring interventions by gender or socio-economic group. Only one study differentiated by socio-economic status.[44] It found that the adverse health effects of the intervention were only felt by the lowest grade employees. However, the intervention was poorly implemented and the study lacked a comparison group. In one study of a team working intervention,[41] depression levels improved only in men but in another team working study[45] [46] no differences were found between men and women in terms of anxiety or depression.

### **Research implications**

This systematic review suggests that micro level interventions that change the psychosocial work environment affect health in the direction predicted by the demand-control-support model. However, the evidence base is only partial and the studies we have synthesised were subject to a number of methodological limitations. Most noticeably, although several studies had a comparison group, these were often not matched or randomised,[31] [32] [33] [36] [37] and

contamination was commonplace.[31] [32] [33] [34] [35] [36] A sizeable number of the studies reported on the effects of concurrent interventions,[32] [35] [37] [40] [42] [43] [45] [64] [47] thereby preventing the isolation of the influence of a particular intervention on the psychosocial work environment or health. We also had concerns about the extent to which some interventions had been implemented (as noted in Tables 1-3).[53] The measures of demand, control and support also varied from study to study and well validated questionnaires, such as the Karasek and Theorell Job Content Questionnaire,[3] were seldom used. The outcome measures used in the studies were very varied and this means that our interpretation of the overall health effects of altering demand, control or support aspects of the work environment are indicative rather than definitive. Furthermore, only three studies differentiated outcomes by gender or socio-economic group[41] [44] [45] [46] and so little overall insight was gained into how task restructuring might impact on health inequalities. Prospective, well controlled studies of task structure interventions which examine the impacts on the psychosocial work environment, health and health inequalities, and which also assess the fidelity of implementation, are therefore needed in the future. Studies which particularly examine the effects of interventions which increase control would be the most useful.[54]

### **Policy implications**

Change in job control emerges as the most important, and support the least important, aspects of the demand-control-support model in terms of health. Interventions that increase control may have positive effects on health, especially, if they are implemented with the demand-control-support model in mind.[23] The psychosocial aspects of the workplace, as well as more traditional factors such as wages and hours of work, can therefore be important targets for health improvement: policy interventions, such as the recently enforced EU directive on participation at work,[55] which aims to increase job control and autonomy, should therefore remain as a priority for public health policy.[2]

## **ACKNOWLEDGEMENTS**

The authors would like to acknowledge Nessa Barry, Val Hamilton, Mary Robins, and Hilary Thomson who assisted with the early stages of the electronic searches. This study was funded by ESRC grant no: H141251011, under the auspices of the ESRC Centre for Evidence-based Public Health Policy.

## **COMPETING INTERESTS**

All authors declare that they have no competing interests.

## **ETHICAL APPROVAL**

Ethical approval was not required for this literature review.

## **CONTRIBUTORS**

CB planned the study, collected and analysed the data, is lead author and guarantor. ME, ST, MP and MW assisted in various aspects of the study including writing up.

## **LICENCE**

The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, an exclusive licence (or non-exclusive for government employees) on a worldwide basis to the BMJ Publishing Group Ltd and its Licensees to permit this article (if accepted) to be published in JECH and any other BMJPGL products to exploit all subsidiary rights, as set out in our licence.

**What is already known on this subject**

- Observational evidence from the Whitehall and other studies suggests that the psychosocial work environment can affect health, and health inequalities.
- In particular, adverse health outcomes have been associated with high task demand and low control, leading to the hypothesis that interventions which modify these work characteristics may be health-protective.

**What this study adds**

- This is the first systematic review of intervention studies of the health and psychosocial effects of changes to the work environment brought about by task structure work reorganisation.
- Change in job control in particular was an important factor in terms of health: where interventions increased demand or decreased control, health appeared to get worse. Very little evidence was found as to whether these effects differ for different socio-economic groups.

**Policy implications**

- Task restructuring interventions that increase control may have positive effects on health, especially, if they are implemented with the demand-control-support model in mind.
- Policy interventions such as the recently enforced EU directive on participation at work - which aims to increase job control and autonomy - should remain as a priority for public health policy.



## REFERENCES

1. Wanless D. *Securing good health for the whole population: final report [The Wanless Report]*. London: HM Treasury; 2004.
2. Department of Health. *Choosing Health: Making healthier choices easier*. London: HMSO; 2004.
3. Karasek R, Theorell T. *Healthy work: stress, productivity and the reconstruction of working life*. New York: Basic Books; 1990.
4. Karasek R. Job demands, job decision latitude, and mental strain: implications for job redesign. *Administrative Science Quarterly* 1979;**24**:285-311.
5. Siegrist J. Adverse health effects of high effort/low-reward conditions. *Journal of Occupational Health Psychology* 1996;**1**:27-41.
6. Johnson J, Hall E. Job strain, work place social support, and cardiovascular disease: a cross-sectional study of a random sample of the Swedish working population. *Amer. J. Publ Hlth* 1988;**78**:1336-42.
7. Marmot M, Bosma H, Hemingway H, et al. Contribution of job control and other risk factors to social variations in coronary heart disease incidence. *Lancet* 1997;**350**:235-239
8. Marmot M, Smith G, Stansfeld S, et al. Health inequalities among British civil servants – the Whitehall II study. *Lancet* 1991;**337**:1387-1393.
9. Kuper H, Marmot M. Job strain, job demands, decision latitude, and risk of coronary heart disease within the Whitehall II study. *J Epidemiol Commun H* 2003;**57**:147-153.
10. Bosma H, Marmot M, Hemingway H, et al. Low job control and risk of coronary heart disease in Whitehall II (prospective cohort) study. *Brit Med J* 1997;**314**:558-565.
11. Karasek R, Baker D, Marxer F, Ahlbom A, Theorell T. Job decision latitude, job demands and cardiovascular disease: a prospective study of Swedish men. *Am. J. Publ Hlth* 1981;**71**:694-795.
12. Bongers P, Dewinter C, Kompier M, et al. Psychosocial factors at work and musculoskeletal disease. *Scand J Work Environ Health* 1993;**19**:297-312
13. Stansfeld S, Fuhrer R, Shipley M, et al. Work characteristics predict psychiatric disorder: prospective results from the Whitehall II study. *Occup Environ Med* 1999;**56**:302-307.
14. North F, Syme S, Feeney A, et al. Psychosocial work environment and sickness absence among British civil servants: The Whitehall II Study. *Am. J. Pub Hlth* 1996;**86**:332-340
15. Stansfeld S, Rael E, Head J, et al. Social support and psychiatric sickness absence: A prospective study of British civil servants. *Psychological Medicine* 1997; **27**:35-48.
16. Marmot M, Siegrist J, Theorell T. Health and the psychosocial environment at work. In: Marmot M, Wilkinson R, editors. *Social determinants of Health*. Oxford: Oxford University Press; 1999.
17. Marmot M, Theorell T, Siegrist J. Work and coronary heart disease. In: Stansfeld S, Marmot M, editors. *Stress and the heart. Psychosocial pathways to coronary heart disease*. London: BMJ Books; 2002. p. 50-71.
18. Godin I, Kittel F. Can we disentangle life course processes of accumulation, critical period and social mobility? An analysis of disadvantaged socio-economic positions and myocardial infarction in the Stockholm Heart Epidemiology Program (SHEEP). *Soc Sci Med*; 2003; **58**:1543-1553.
19. Linton SJ, Boersma K. Early identification of patients at risk of developing a persistent back problem: The predictive validity of the Orebro Musculoskeletal Pain Questionnaire. *Clin J Pain* 2003;**19**:80-86.
20. Stansfeld S, Head J, Marmot M. *Work related factors and ill health: The Whitehall II Study*. Norwich: HMSO; 2000.
21. Bartys S, Burton K, Main C. A prospective study of psychosocial risk factors and absence due to musculoskeletal disorders - implications for occupational screening. *Occup Med* 2005;**55**:375-379.
22. Bartley M. *Health inequality: an introduction to theories, concepts and methods*. Cambridge: Polity Press; 2004.
23. Karasek R. Stress prevention through work reorganisation: a summary of 19 case studies. *Conditions of Work Digest* 1992;**11**:23-42.
24. Egan M, Bambra C, Thomas S, Petticrew M, Whitehead M. The psychosocial and health effects of workplace reorganisation. Paper 1: A systematic review of labour-management

- interventions.
25. Landsbergis P, Cahill J, Schnall P. The impact of lean production and related new systems of work organisation on worker health. *Journal of Occupational Health Psychology* 1999;**4**:108-130.
  26. Deeks J, Dinnes J, D'Amico R, et al. Evaluating non-randomised intervention studies. *Health Technology Assessment* 2003;**7**.
  27. NHS Centre for Reviews and Dissemination. *Undertaking systematic reviews of research on effectiveness: CRD's guidance for those carrying out or commissioning reviews*. York: NHS CRD; 2001.
  28. Bambra C, Whitehead M, Hamilton V. Does "welfare to work" work? A systematic review of the effectiveness of the UK's welfare to work programmes for people with a chronic illness or disability. *Soc Sci Med* 2005;**60**:1905-1918.
  29. Egan M, Petticrew M, Oglivie D, Hamilton V. New roads and human health: a systematic review. *Am. J. Pub Hlth* 2003;**93**:1463-1471.
  30. Thomson H, Petticrew M, Morrison D. Health effects of housing improvement: systematic review of intervention studies. *Brit Med J* 2001;**323**:187-190.
  31. Wall T, Kemp N, Jackson P, et al. Outcomes of autonomous workgroups: a long-term field experiment. *Academy of Management Journal* 1986;**29**:280-304.
  32. Wahlstedt K. *Postal Work – Work organisational changes as tools to improve health*. Uppsala, Sweden: University of Uppsala; 2001.
  33. Boumans N, Landerweerd A. Nurses' well-being in a Primary Nursing care setting in the Netherlands. *Scand J Caring Sci* 1999;**13**:116-122.
  34. Boumans N, Berg A. Job innovation for direct caregivers in the care of persons with mental retardation. *Scand J Caring Sci* 2000;**14**:216-223.
  35. Melchor H, Huyer Abu-Saad H, Halfens R, et al. The effectiveness of primary nursing on burnout among psychiatric nurses in long-stay settings. *Journal of Advanced Nursing* 1996;**24**:694-702.
  36. Berkhout A, Boumans N, Breukelen G, Abu-Saad H, Nijhuis F. Resident-orientated care in nursing homes: effects on nurses. *Journal of Advanced Nursing* 2004;**45**:621-632.
  37. Wahlstedt K, Nygard C, Kemmlert K, et al. The effects of a change in work organisation upon the work environment and musculoskeletal symptoms among letter carriers. *International Journal of Occupational Safety and Ergonomics* 2000;**2**:237-255.
  38. Wall T, Corbett M, Martin R, et al. Advanced manufacturing technology, work design and performance: a change study. *Journal of Applied Psychology* 1990;**75**:691-697.
  39. Majchrzak A, Cotton J. A longitudinal study of adjustment to technological change: from mass to computer-automated batch production. *Journal of Occupational Psychology* 1988;**61**:43-66.
  40. Fredriksson K, Bildt C, Hagg G, et al. The impact on musculoskeletal disorders of changing physical and psychosocial work environment conditions in the automobile industry. *Industrial Ergonomics* 2001;**28**:31-45.
  41. Kawakami N, Araki A, Kawahima M, et al. Effects of work-related stress reduction on depressive symptoms among Japanese blue-collar workers. *Scand J Work Environ Health* 1997;**23**:54-9.
  42. Wahlstedt K, Edling C. Psychosocial factors and their relations to psychosomatic complaints amongst postal workers. *European Journal of Public Health* 1994;**4**:60-64.
  43. Wahlstedt K, Edling C. Organisational changes at a postal sorting terminal – their effects upon work satisfaction, psychosomatic complaints and sick leave. *Work and Stress* 1997;**11**:279-291.
  44. Korunka C, Scharitzer D, Carayons P, et al. Employee strain and job satisfaction related to an implementation of quality in a public service organisation: a longitudinal study. *Work and Stress* 2003;**17**:52-72.
  45. Sutherland V, Cooper C. Mental health, job satisfaction, and job stress among general practitioners. *Brit Med J* 1989;**298**:366-70.
  46. Sutherland V, Cooper C. Job stress, satisfaction, and mental health among general practitioners before and after introduction of new contract. *Brit Med J* 1992;**304**:1545-48.
  47. Appleton K, House A, Dowell A. A survey of job satisfaction, sources of stress and psychological symptoms among general practitioners in Leeds 1998. *British Journal of General Practice* 1998;**48**:1059-1063.
  48. Parker S. Longitudinal effects of lean production on employee outcomes and the mediating

- role of work characteristics. *Journal of Applied Psychology* 2003;**88**:620-63.
49. Jackson P, Mullarky S. Lean production teams and health in garment manufacture. *Journal of Occupational Psychology* 2000;**2**:231-245.
50. Jackson P, Martin R. Impact of just-in-time on job content, employee attitudes and well-being: a longitudinal study. *Ergonomics* 1996;**39**:1-16.
51. Mullarky S, Jackson P, Parker S. Employee reactions to JIT manufacturing practices: a two-phase investigation. *International Journal of Operations and Production Management* 1995;**15**:62-79.
52. Christmansson M, Friden J, Sollermna C. Task design, psycho-social work climate and upper extremity pain disorders – effects of an organisational redesign on manual repetitive assembly. *Applied Ergonomics* 1999;**30**:463-472.
53. Rychetnik L, Frommer M, Hawe P, Shiell A. Criteria for evaluating evidence on public health interventions. *J Epidemiol Commun H* 2002;**56**:119-127.
54. Head J, Kivimaki M, Vahtera J, et al. Influence of change in psychosocial work characteristics on sickness absence. *J Epidemiol Commun H* 2006;**69**:55-61.
55. European Union Online. EU Council Directive 94/45/EC In: [http://ec.europa.eu/employment\\_social/labour\\_law/directive9445/9445euen.htm](http://ec.europa.eu/employment_social/labour_law/directive9445/9445euen.htm); 1994.