Work characteristics predict psychiatric disorder: prospective results from the Whitehall II study

S A Stansfeld, R Fuhrer, M J Shipley, M G Marmot

Abstract

***Objectives*—The impact of work on the risk of future psychiatric disorder has been examined in few longitudinal studies. This was examined prospectively in a large epidemiological study of civil servants.**

***Methods*—In the Whitehall II study, a longitudinal, prospective cohort study of 6895 male and 3413 female London based civil servants, work characteristics measured at baseline (phase 1: 1985–8) and first follow up (phase 2: 1989) were used to predict psychiatric disorder measured by a 30 item general health questionnaire (GHQ) at phase 2 and phase 3 follow up (phase 3: 1991–3). Work characteristics and GHQ were measured at all three phases.**

***Results*—Low social support at work and low decision authority, high job demands and effort-reward imbalance were associated with increased risk of psychiatric disorder as assessed by the GHQ at follow up adjusting for age, employment grade, and baseline GHQ score.**

***Conclusions*—Social support and control at work protect mental health while high job demands and effort-reward imbalance are risk factors for future psychiatric disorder. Intervention at the level of work design, organisation, and management might have positive effects on mental health in working populations.**

(*Occup Environ Med* 1999;**56**:302–307)

Keywords: work; mental illness; epidemiology; cohort studies

International Centre for Health and Society, Department of Epidemiology and Public Health, and Department of Psychiatry and Behavioural Sciences, Royal Free and University College Medical School, University College London, UK
S A Stansfeld
R Fuhrer
M J Shipley
M G Marmot

Correspondence to:
Dr S A Stansfeld, Department of Epidemiology and Public Health, University College London, 1–19 Torrington Place, London WC1E 6BT, UK. Telephone 0044 171 391 1692; fax 0044 171 813 0242; email Stephen@public-health.ucl.ac.uk

Accepted 12 November 1998

The impact of positive and negative characteristics of work as risk factors for psychiatric disorder has not been clearly delineated in white collar working populations. Most previous studies have been cross sectional,[1–5] with few exceptions.[6 7]

In the past 10 years two models have predominated in the description of the psychosocial work environment and its relation to health. The most influential model has been the job strain hypothesis of Karasek and Theorell.[8] This involves two orthogonal dimensions: job demands, including workpace and conflicting demands, and decision latitude, including decision authority (control) and skill discretion (variety of work and opportunity for use of skills). It is hypothesised that high decision latitude and low to moderate job demands are good for health, and the combination of high job demands and low decision latitude would result in worse health. The second model is Siegrist's effort-reward imbalance paradigm.[9] In this model of work stress, the combination of great efforts at work, measured by work related overcommitment and competitiveness, and insufficient rewards in terms of lack of promotion prospects and blocked career confer an increased risk of ill health. In the present study of an occupational cohort study of middle aged civil servants we tested the job strain[8] and effort-reward imbalance[9] models of work stress as predictors of psychiatric disorder with longitudinal associations between self reported work characteristics, and subsequent development of psychiatric disorder measured by the general health questionnaire (GHQ).[10]

Cross sectional analyses at the first phase of data collection, showed that higher levels of self reported decision authority, skill discretion, and social support at work were associated with lower GHQ scores whereas job demands (high pace and conflicting demands) were associated with higher GHQ scores.[11] It was not clear whether these associations might be causal. Because of their cross sectional nature it was possible that an existing psychiatric disorder might be associated with reporting adversely on work. In this paper we use longitudinal analyses to assess the influence of these aspects of work on future psychiatric disorder.

Methods

STUDY POPULATION

The Whitehall II study was set up to investigate the causes of the social gradient in morbidity and mortality. A cohort of civil servants was established between 1985 and 1988 (phase 1). All male and female civil servants, aged between 35 and 55, in 20 London based civil service departments were sent an introductory letter and screening questionnaire and had a screening examination including measurement of blood pressure, an electrocardiogram, and a blood sample.[12] The overall response rate was 73% (74% for men and 71% for women). The true response rates are likely to be higher, however, because around 4% of those on the list of employees had in fact moved before the study and were thus not eligible for inclusion. Altogether 10 308 civil servants were examined: 6895 men (67%) and 3413 women (33%). After initial participation at phase 1, a further postal questionnaire was sent in 1989 (phase 2) and the participants were approached again for a further screening examination in 1991–3 (phase 3: questionnaire and screening examination). The participation rates at these two phases were 79% and 83% respectively; 7372 subjects (72%) were participants at all three phases, 9302 participants (90%) took part at either phase 2 or phase 3

although full data were only available for 7978 participants. The mean duration of follow up is 5.3 years, with a range of 3.7 to 7.6 years. Full details of the screening examination are reported elsewhere.[12]

WORK CHARACTERISTICS

Work characteristics were measured at all three phases as a self reported questionnaire by an adapted version of the job content instrument as developed by Karasek and Theorell.[8] The work characteristics assessed the main components in the job strain model—that is, decision latitude (internal consistency of scale, Cronbach's α=0.84), job demands (Cronbach's α=0.67), and social support at work (Cronbach's α=0.79). Decision latitude is made up of two components: decision authority, the amount of control over work, and skill discretion, a measure of job variety and opportunities for use of skills. Social support at work is made up of three types: support from colleagues, support from supervisors, and clarity and consistency of information from supervisors. All scales were divided into tertiles because of the non-normal distribution of the work characteristics.

We also used the effort-reward imbalance model, as recently developed by Siegrist.[9]The model conceptualises psychosocial stress at work in terms of an imbalance between efforts and rewards. A combination of high efforts spent, and low rewards received, are thought to result in emotional distress and adverse health effects. In a previous Whitehall II analysis,[13] an indicator of effort-reward imbalance was constructed which had three categories: (*a*) neither high efforts nor low rewards; (*b*) either high efforts or low rewards, and (*c*) both high efforts and low rewards. High efforts were defined by: competitiveness, work related overcommitment, or hostility. Low rewards were defined by poor promotion prospects or a blocked career. It is postulated that the cumulative effects of the combination of high efforts and low rewards is deleterious to health.

In 18 out of 20 departments 140 personnel managers assessed each job, independently of the holder of the post, for the level of control and work demands. This external assessment could be considered a more objective measure of the work environment in that it was made independently of the participants' perceptions of the job.[14]

PSYCHIATRIC DISORDER

The main measure of psychiatric disorder carried out at each of the three phases was the 30 item GHQ,[10] which was validated against the clinical interview schedule[15] in a subsample. A threshold between 4 and 5 on the GHQ was chosen on the basis of receiver operating characteristic analysis.[16] At this threshold the sensitivity of the GHQ was 72.7% and the specificity was 78.0% against the clinical interview schedule.[17] The GHQ is a well established screening questionnaire for psychiatric disorder suitable for use in general population samples. All those scoring 0–4 on the GHQ were considered not to be cases, and those scoring $\geq$5 were deemed to be cases.

NEGATIVE AFFECTIVITY AND HOSTILITY

Negative affectivity, as a measure of a tendency to report negatively on self reported questionnaires, was assessed by the negative affect scale of the affect balance scale.[18] Hostility, as a personality measure likely to influence reporting of working conditions, was measured by 38 items from the Cook-Medley hostility scale.[19]

STATISTICAL METHODS

Logistic regression analyses were used to examine the longitudinal relation between the work characteristics and subsequent psychiatric disorder. These allowed the effect of the work characteristics on psychiatric disorder as assessed by the GHQ to be expressed as ORs (ORs), with their 95% confidence intervals (95% CIs), relative to the reference group. Subjects with complete data contributed two sets of measurements relating work characteristics at phases 1 and 2 to psychiatric disorder as assessed by the GHQ at phases 2 and 3. The analyses of such data need to allow for within subject clustering of measurements. The logistic regression models have therefore been fitted with the generalised estimating equation approach for analysing correlated data.[20] The confounding effects of the cross sectional relation between work characteristics and psychiatric disorder at phases 1 and 2 where existing psychiatric disorders might influence reporting of work characteristics, were adjusted for by adding the GHQ score into the logistic regression models as an explanatory variable. Also, for some analyses, cases at phases 1 and 2 were also excluded. All analyses were conducted with the statistical package SAS with the generalised estimating equation models fitted with the SAS macro GEE.

Results

At phase 2, 27.6% of men (1499/5430) and 33.8% of women (840/2485) scored $\geq$5 on the GHQ and were considered to be cases of psychiatric disorder. At phase 3, 20.6% of men (997/4845) and 25.2% of women (530/2105) were considered to be cases of psychiatric disorder.

The associations between the three Karasek work characteristics, decision authority, skill discretion, job demands, and effort-reward imbalance predicting the combined risk of psychiatric disorder at phases 2 and 3, are reported in table 1. High efforts in combination with low rewards were strikingly associated with an increased risk of psychiatric disorder. This has not previously been reported. High job demands were also related to an increased risk of psychiatric disorder and this effect remained in both men and women after controlling for baseline GHQ score to adjust for the effect of baseline psychiatric disorder. This effect was also found when subjects who were cases at baseline as assessed by the GHQ were excluded from the analysis. In both men and women there was a small increased risk of psychiatric disorder among those with low

Table 1 OR (95%CI) of risk of psychiatric disorder as assessed by GHQ by work characteristics at previous phase

	Men			*Women*		
Work characteristics	*Adjusted**	*Fully adjusted†*	*Fully adjusted excluding baseline GHQ cases*	*Adjusted**	*Fully adjusted†*	*Fully adjusted excluding baseline GHQ scores*
Decision authority:						
n	5471	5471	4680	2507	2507	2000
High	1.00	1.00	1.00	1.00	1.00	1.00
Medium	1.12 (1.0 to 1.3)	1.06 (0.9 to 1.2)	1.11 (1.0 to 1.3)	1.02 (0.8 to 1.1)	0.91 (0.7 to 1.1)	0.93 (0.7 to 1.2)
Low	1.37 (1.2 to 1.6)	1.19 (1.0 to 1.4)	1.29 (1.1 to 1.5)	1.23 (1.0 to 1.5)	1.20 (1.0 to 1.5)	1.37 (1.1 to 1.8)
Skill discretion:						
n	5469	5469	4680	2516	2516	2012
High	1.00	1.00	1.00	1.00	1.00	1.00
Medium	1.08 (1.0 to 1.2)	1.04 (0.9 to 1.2)	1.01 (0.9 to 1.2)	0.94 (0.8 to 1.1)	1.03 (0.8 to 1.1)	0.91 (0.7 to 1.2)
Low	1.23 (1.1 to 1.4)	1.10 (1.0 to 1.3)	1.11 (0.9 to 1.3)	1.06 (0.9 to 1.3)	1.00 (0.8 to 1.2)	1.09 (0.8 to 1.4)
Job demands:						
n	5470	5470	4681	2514	2514	2011
Low	1.00	1.00	1.00	1.00	1.00	1.00
Medium	1.16 (1.0 to 1.3)	1.13 (1.0 to 1.3)	1.15 (1.0 to 1.4)	1.21 (1.0 to 1.4)	1.15 (1.0 to 1.4)	0.97 (0.8 to 1.2)
High	1.50 (1.3 to 1.7)	1.36 (1.2 to 1.6)	1.33 (1.1 to 1.6)	1.48 (1.2 to 1.8)	1.26 (1.1 to 1.7)	1.24 (1.0 to 1.6)
Effort reward imbalance:						
n	4239	4239	3104	1871	1871	1245
Neither‡	1.00	1.00	1.00	1.00	1.00	1.00
Either	2.08 (1.6 to 2.7)	1.84 (1.4 to 2.4)	1.93 (1.4 to 2.7)	1.19 (0.8 to 1.8)	1.11 (0.7 to 1.7)	1.20 (0.7 to 2.1)
Both	3.62 (2.8 to 4.8)	2.64 (2.0 to 3.5)	2.57 (1.8 to 3.6)	1.90 (1.2 to 2.9)	1.48 (0.9 to 2.3)	1.67 (1.0 to 2.9)

*Adjusted for age and employment grade.
†Adjusted for age, employment grade and baseline GHQ score.
‡Neither=high efforts nor low rewards; either=high efforts or low rewards; both=high efforts and low rewards, assessed at phase 1 predicting GHQ at phase 2.
GHQ=general health questionnaire.

decision authority after adjustment for age and grade of employment. This risk was stronger when workers with baseline psychiatric disorder were excluded.

The analyses of work characteristics and psychiatric disorders as assessed by the GHQ were adjusted for age and employment grade. As self reported work characteristics may be biased by negative affectivity we also adjusted them by the negative affect scale of the affect balance scale measured at phases 1 and 2. This made small reductions in the ORs for decision authority (low decision authority OR reduced from 1.37 (95% CI 1.2 to 1.6) to 1.27 (95% CI 1.1 to 1.5) in men and from 1.23 (95% CI 1.0 to 1.5) to 1.19 (95% CI 1.0 to 1.5) in women). Odds ratios for skill discretion were markedly reduced in men after adjustment for negative affect (low skill discretion OR reduced from 1.23 (95% CI 1.1 to 1.4) to 0.94 (95% CI 0.8 to 1.1)) but were unchanged for job demands in men and increased for job demands in women (low job demands OR increased from 1.48 (95% CI 1.2 to 1.8) to 1.55 (95% CI 1.3 to 1.9)).

It is possible that aspects of personality measured by the Cook-Medley hostility scale might either relate to selection into unfavourable jobs or influence reporting of work characteristics in a negative manner. Thus personality factors might confound the association between work reported characteristics and psychiatric disorders. To control for this we additionally adjusted our analyses of work characteristics and psychiatric disorder as assessed by the GHQ by hostility measured at phase 1. This had little effect on decision authority, but decreased the effect of job demands in men (low job demands OR reduced from 1.36 (95% CI 1.2 to 1.6) to 1.23 (95% CI 1.0 to 1.5)) and increased the effect of job demands in women (low job demands OR

Table 2 OR (95%CI) of risk of psychiatric disorder as assessed by GHQ by work social support at previous phase

	Men		*Women*	
Work social support	*Adjusted**	*Fully adjusted†*	*Adjusted**	*Fully adjusted†*
Support from colleagues:				
n	5469	5469	2515	2515
High	1.00	1.00	1.00	1.00
Medium	1.19 (1.1 to 1.3)	1.10 (1.0 to 1.2)	0.96 (0.8 to 1.1)	0.94 (0.8 to 1.1)
Low	1.48 (1.3 to 1.7)	1.29 (1.1 to 1.5)	1.19 (1.0 to 1.4)	1.12 (0.9 to 1.4)
Support from supervisors:				
n	5470	5470	2515	2515
High	1.00	1.00	1.00	1.00
Medium	1.17 (1.1 to 1.3)	1.10 (1.0 to 1.2)	1.07 (0.9 to 1.2)	1.07 (0.9 to 1.3)
Low	1.48 (1.3 to 1.7)	1.31 (1.1 to 1.5)	1.19 (1.0 to 1.4)	1.11 (0.9 to 1.3)
Information from supervisors:				
n	5469	5469	2513	2513
High	1.00	1.00	1.00	1.00
Medium	1.16 (1.0 to 1.3)	1.13 (1.0 to 1.3)	1.11 (1.0 to 1.3)	1.15 (1.0 to 1.4)
Low	1.63 (1.4 to 1.9)	1.46 (1.3 to 1.7)	1.46 (1.2 to 1.7)	1.43 (1.2 to 1.7)
Overall work social support:				
n	5471	5471	2515	2515
High	1.00	1.00	1.00	1.00
Medium	1.15 (1.0 to 1.3)	1.06 (0.9 to 1.2)	1.09 (0.9 to 1.3)	1.07 (0.9 to 1.3)
Low	1.50 (1.3 to 1.7)	1.31 (1.2 to 1.5)	1.25 (1.1 to 1.5)	1.17 (1.0 to 1.4)

*Adjusted for age and employment grade.
†Adjusted for age, employment grade and baseline GHQ score.
GHQ=general health questionnaire.

Table 3 OR (95% CI) of risk of psychiatric disorder as assessed by GHQ at phase 3 by changes in work characteristics between phase 1 and phase 2

	Men		*Women*	
	*Adjusted**	*Fully adjusted†*	*Adjusted**	*Fully adjusted†*
Decision authority:				
n	4854		2101	
Beneficial change	0.90 (0.8 to 1.1)	0.92 (0.8 to 1.1)	0.82 (0.6 to 1.0)	0.86 (0.7 to 1.1)
No change	1.00	1.00	1.00	1.00
Adverse change	1.26 (1.0 to 1.5)	1.20 (1.0 to 1.5)	0.92 (0.7 to 1.3)	0.84 (0.6 to 1.2)
Job demands:				
n	4872		2119	
Beneficial change	0.82 (0.7 to 1.0)	0.82 (0.7 to 1.0)	0.72 (0.5 to 1.0)	0.79 (0.6 to 1.1)
No change	1.00	1.00	1.00	1.00
Adverse change	1.66 (1.4 to 2.0)	1.62 (1.3 to 2.0)	1.31 (1.0 to 1.7)	1.16(0.9 to 1.5)
Work social support:				
n	4845		2104	
Beneficial change	0.78 (0.6 to 0.9)	0.83 (0.7 to 1.0)	1.05 (0.8 to 1.4)	1.15 (0.9 to 1.5)
No change	1.00	1.00	1.00	1.00
Adverse change	1.24 (1.0 to 1.5)	1.23 (1.0 to 1.5)	1.21 (0.9 1.6)	1.19 (0.9 to 1.6)

*Adjusted for age, employment grade and baseline work characteristics.
†Adjusted for age, employment grade, baseline work characteristics and baseline GHQ score.
GHQ=general health questionnaire.

increased from 1.24 (95% CI 1.0 to 1.6) to 1.61 (95% CI 1.2 to 2.1)).

Lack of support from colleagues and supervisors, and lack of clarity and consistency of information from supervisors, were associated with increased risk of psychiatric disorders which remained after adjustment for baseline GHQ scores (table 2). Lack of support from colleagues and supervisors was a more powerful predictor in men than women (table 2). Adjustment for negative affectivity measured by the negative affect scale had little effect in reducing the significance of the ORs.

In a further model, adjusting for all the Karasek work characteristics simultaneously, the effects of job demands and work support on psychiatric disorders as assessed by the GHQ did not change. We also tested a model including Karasek work characteristics and effort-reward imbalance together and found that the effect of effort-reward imbalance was minimally reduced by adjustment for decision authority. Furthermore, we also tested the original job strain model—that is, whether there was an interaction between job demands and decision latitude in their effect on psychiatric disorder—with psychiatric disorders in phase 2, but found none.

A further way to look at the association between work characteristics and risk of psychiatric disorders was to examine whether there was an increased risk of psychiatric disorders as assessed by the GHQ at phase 3 in those who had experienced either an adverse or a beneficial change in their work characteristics between phases 1 and 2 (defined by change to a more negative or a more positive tertile of work characteristics) compared with those whose work had stayed the same. An advantage of this type of analysis is that it may be less susceptible to response bias. For decision authority there was a small gradient in men but no effect in women (table 3). For job demands there was a clear gradient, with beneficial change reducing risk and adverse change increasing risk for both men and women. For social support at work, combining all three measures of support, there was a small adverse effect of deterioration in support in both men and women and a positive effect of beneficial change in support in men.

EXTERNALLY ASSESSED WORK CHARACTERISTICS

In the present prospective analyses as in our cross sectional analyses, we found little effect of externally assessed work characteristics of the GHQ score at either phase 2 or phase 3, except that there was a decreased risk of psychiatric disorder as assessed by the GHQ associated with high job demands in women (psychiatric disorder as assessed by the GHQ at phase 2 OR 0.79 (95% CI 0.6 to 1.0).

Discussion

In summary, in this occupational cohort of middle aged civil servants, demands at work increase risk, whereas decision authority and support at work protect against future psychiatric morbidity. Furthermore, this is the first report of high efforts and low rewards in the effort-reward imbalance model[9] being associated with increased risk of psychiatric morbidity. The association of work characteristics and psychiatric morbidity may be causal. Although these findings rely on self reported data, the present analyses are longitudinal and the results persist after adjustment for baseline psychiatric disorder to control for the effect of current mood on reporting of working conditions, negative affectivity, and personality.

Several studies suggest that work demands may be important determinants of mental ill health.[21–23] In a study of the National Health Service (NHS) work force[24] high work demands were associated with worse mental health. In our study perceived work demands include both work pace and conflicting demands; in the cross sectional data conflicting demands had a more powerful association with psychiatric disorder. In the NHS study job demands include both work overload in terms of hours worked and role conflict.[25] In the Whitehall II study work demands have specific effects rather than increasing general susceptibility to illness; they do not seem to confer increased risk of heart disease or sickness absence and yet are related to increased risk of psychiatric disorders. Demands are more often

in higher employment grades, where demanding jobs are also interesting and challenging which may explain why we did not confirm the job strain model of an interaction between demands and decision authority. As well as different interpretations of job demands by employment grade, there may also be greater access to material and coping resources in higher employment grades, not captured by decision authority, to deal with job demands.

People may react differently to a given work environment, some perceiving high levels of stress, whereas others do not. Thus in turn some people may develop health problems more readily than others. This is illustrated by the effort-reward imbalance model where, considering rewards as well as demands, and taking into account individual characteristics—such as effort applied to the work—increases the prediction of future morbidity. Thus individual characteristics influence how much the work environment has an impact on future mental health.

It should be noted that decision authority, or control over work, at phase 1 had less impact on psychiatric disorder at phase 3 than at phase 2, which was not the case for the effects of job demands and social support.[25] Perhaps control at work has a more immediate effect than the other work characteristics on future mental health although this is not in keeping with effects on risk of coronary heart disease.

High levels of social support at work have been found to be predictive of better mental health in employees in other studies.[26 27] Our findings suggest that the effects are stronger in men than women, and more so from supervisors than from colleagues. This has some obvious implications for emphasising this aspect of management of workforces. Social support at work is also protective against short spells of psychiatric sickness absence.[28] This provides some additional evidence for the validity of the protective effect of social support on mental health.

The longitudinal nature of the analyses, the adjustment for psychiatric disorder at baseline to adjust for the effect of mood on reporting of work, and negative affectivity reduce the limitations of these data, which rely on self reports of both work characteristics and psychiatric disorder. Paradoxically, externally assessed work characteristics did not predict psychiatric disorders. It could be that external assessments did not fully capture the detailed experience of these jobs and thus there was error in the measurement of job characteristics.[29] It seems more likely that the effects of working conditions on future mental health are mediated through individual perceptions of work. Thus susceptibility to psychiatric disorder related to work cannot be separated from how the person perceives, interacts, and reacts to working conditions, colleagues, and supervisors. These results suggest that the work environment does influence the risk of future psychiatric disorder.

Moreover, although it has been argued that psychiatric disorders as assessed by the GHQ are merely measures of distress, from the results of our validation study we consider that the GHQ does measure psychiatric disorder, which is also associated with reduced functioning and greater risk of work absence.[28] It might be that personality factors determine both reporting of work and susceptibility to psychiatric disorder. However, adjustment for baseline psychiatric disorder should control for neuroticism, the most likely confounding factor, and adjustment for both negative affectivity and hostility which might influence selection into jobs[30] did not markedly reduce the associations between work characteristics and psychiatric disorder as assessed by the GHQ.

Population based interventions for improving mental health are difficult to achieve. One feasible area for intervention is in the workplace. The partnership on the health of the NHS workforce representing most major organisations providing and regulating health care, and concerned with NHS staff health has made trenchant recommendations for improving the health of the NHS workforce based on a systematic review of the work and health literature.[31] They state unequivocally that "management style clearly affects health". Their 10 point "action now" plan recommends action on several of the risk factors for mental ill health that we have identified in civil servants. These include "a major initiative to improve two way communications to increase staff involvement and enhance team working and control over work". In more detail this means to "enhance a sense of control by staff over the work environment", to "develop a culture in which staff are valued", and to "structure situations to promote both formal and informal social support within the workplace". Moreover, they suggest there is a need to "evaluate work demands and review staffing". Our results suggest that intervention at the level of Cox's "true prevention"[32] at the level of work design, organisation, and management could lead to positive effects in workforces. On the other hand the current trend towards neglect of these factors in short term pursuit of business efficiency may lead to an increase in future mental ill health and concomitant costs both to business and health sectors.

We thank all participating Civil Service Departments and their welfare and personnel officers in the Civil Service Occupational Health Service Agency and their directors, Drs Elizabeth McCloy, George Sorrie, Adrian Semmence, and all participating civil servants. The work presented in this paper was supported by grants from the Department of Health and the Health and Safety Executive. The Whitehall II study is currently supported by the Medical Research Council, British Heart Foundation, National Heart, Lung, and Blood Institute (2 RO1 HL36310), National Institute on Aging, the Institute for Work and Health, Toronto, Ontario, and the John D and Catherine T MacArthur Foundation Research Network on Successful Midlife Developments. MGM is supported by a Medical Research Council Research Professorship. MJS is supported by the British Heart Foundation.

1 Payne R, Fletcher BC. Job demands, supports and constraints as predictors of psychological strain among school teachers. *Journal of Vocational Behaviour* 1983;**22**:*136–47*.
2 Kasl SV. Stress and disease in the work place: A methodological commentary on the accumulated evidence. In: Cataldo MF, Coates TJ, eds. *Health and industry: a behavioural medicine perspective*. New York: John Wiley, 1984:52–85.

3 Adelmann PK. Occupational complexity, control, and personal income: their relation to psychological wellbeing in men and women. *J Appl Psychol* 1987;**72**:529–37.
4 Wall TD, Jackson PR, Mullarkey S, *et al.* The demands-control model of job strain: a more specific test. *Journal of Occupational and Organisational Psychology* 1996;**69**:153–66.
5 Landsbergis P. Occupational stress among health care workers: a test of the job demands-control model. *Journal of Organizational Behaviour* 1988;**9**:217–39.
6 Parkes KR, Mendham CA, Von Rabenau C. Social support and the demand-discretion model of job stress: test of additive and interactive effects in two samples. *Journal of Vocational Behaviour* 1994;**44**:91–113.
7 Niedhammer I, Goldberg M, Leclerc A, *et al*. Psychosocial factors at work and subsequent depressive symptoms in the Gazel cohort. *Scand J Work Environ Health* 1998;**24**:197–205.
8 Karasek R, Theorell T. *Healthy work: stress, productivity, and the reconstruction of working life*. New York: Basic Books, 1990.
9 Siegrist J. Adverse health effects of high-effort/low-reward conditions. *Journal of Occupational Health Psychology* 1996; **1**:27–41.
10 Goldberg DP. *The detection of psychiatric illness by questionnaire*. Oxford: Oxford University Press, 1972.
11 Stansfeld SA, North FM, White I, *et al*. Work characteristics and psychiatric disorder in civil servants in London. *J Epidemiol Community Health* 1995;**49**:48–53.
12 Marmot MG, Davey Smith G, Stansfeld S, *et al.* Health inequalities among British civil servants: the Whitehall II study. *Lancet* 1991;**337**:1387–93.
13 Bosma H, Peter R, Siegrist J, *et al.* Alternative job stress models and the risk of coronary heart disease: the effort-reward imbalance model and the job strain model. *Am J Public Health* 1998;**88**:68–74.
14 North FM, Syme SL, Feeney A, *et al*. Psychosocial work environment and sickness absence. The Whitehall II study. *Am J Public Health* 1996;**86**:332–40.
15 Goldberg DP, Blackwell B. Psychiatric illness in general practice. A detailed study using a new method of case identification. *BMJ* 1970:439–43.
16 Hanley JA, McNeil BJ. A method of comparing the areas under receiver operating characteristics curves derived from the same cases. *Radiology* 1983;**148**:839–43.
17 Stansfeld SA, Marmot MG. Social class and minor psychiatric disorder in British civil servants: a validated screening survey using the general health questionnaire. *Psychol Med* 1992;**22**:739–49.
18 Bradburn NM. *The structure of psychological wellbeing.* Chicago: Aldine, 1969.
19 Cook WW, Medley DM. Proposed hostility and pharisaic-virtue scales for the MMPI. *J Appl Psychol* 1954;**34**:414–8.
20 Lian KY, Zeger SL. Longitudinal data analysis using generalized linear models. *Biometrika* 1986;**73**:13–22.
21 Loscocco KA, Spitze G. Working conditions, social support and the well-being of female and male factory workers. *Journal of Health and Social Behaviour* 1991;**31**:313–27.
22 Eshelinen L, Toikkanen J, Tuomi K, *et al*. Work related stress symptoms of aging employees in municipal occupations. *Scand J Work Environ Health* 1991;**17**:87– 93.
23 Fletcher BC, Jones F. A refutation of Karasek's demand-discretion model of occupational stress with a range of dependent measures. *Scand J Work Environ Health* 1991;**17**:87–93.
24 Wall TD, Bolden RI, Borrill CS, *et al*. Minor psychiatric disorder in NHS trust staff: occupational and gender differences. *Br J Psychiatry* 1997;**171**:519–23.
25 Stansfeld SA, Fuhrer R, Head J, *et al*. Work and psychiatric disorder in the Whitehall II study. *J Psychosom Res* 1997;**43**:73–81.
26 La Rocco JM, House JS, French JRP. Social support, occupational stress and health. *J Health Soc Behav* 1980;**21**: 202–16.
27 Karasek RA, Triantis KP, Chandhry SS. Co-worker and supervisor support as moderation of association between task characteristics and mental strain. *Journal of Occupational Behaviour* 1982;**3**:181–200.
28 Stansfeld SA, Rael EGS, Head J, *et al*. Social support and psychiatric sickness absence: a prospective study of British civil servants. *Psychological Medicine* 1997;*27*:**35–48.**
29 Semmer N, Zapf D, Greif S. Shared job strain: a new approach for assessing the validity of job stress managements. *Journal of Occupational and Organisational Psychology* 1996;**69**:293–310.
30 Semmer N, Schallberger U. Selection, socialisation and mutual adaption: resolving discrepancies between people and work. *Applied Psychology: an international review* 1996;**45**:263–88.
31 Williams S, Michie S, Pattani S. *Improving the health of the NHS workforce: report of the partnership on the health of the NHS workforce*. London: Nuffield Trust, 1998.
32 Cox T. *Stress research and stress management: putting theory to work*. Norwich: HMSO, 1993. (HSE Contract Research Report No 61/1993).