Work environment, alcohol consumption and ill-health

The Whitehall II Study

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The influences of the psychosocial work environment on incident coronary heart disease and diabetes and the influences of change in work risk factors on health are reported from the longitudinal Whitehall II cohort study of 10308 British civil servants. The contribution of alcohol consumption and alcohol dependence to absence from work attributable to accidents is also investigated.

High job demands, low decision latitude and effort reward imbalance were related to increased incidence of coronary heart disease. Work characteristics were not associated with incidence of diabetes, with the exception of effort reward imbalance which was related to increased incidence of diabetes in men. These effects were not explained by conventional risk factors such as smoking and blood pressure. Adverse changes in levels of work characteristics, particularly social support at work, predicted worsening mental health functioning for men and women. The effects of change in work characteristics on physical health and coronary heart disease were modest, although there was some evidence to support a longer term influence on physical functioning and longstanding illness.

Alcohol consumption was related to risk of sickness absence due to injury with increased risk seen at moderate levels of alcohol consumption. 'Binge' drinking and alcohol dependence were also related to absence due to injury.

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EXECUTIVE SUMMARY

The objectives of the project were:

1. *To analyse work environment in relation to both incidence of diabetes and validated coronary heart disease.*

2. *To examine the influence of change in work characteristics on incidence of coronary heart disease, functioning and other health outcomes.*

3. *To establish the contribution of alcohol consumption and alcohol dependence to absence from work attributable to accidents.*

This report extends previous HSE funded research which examined the influence of work on self reported ill-health and sickness absence. This had shown that effort reward imbalance was associated with increased risk of alcohol dependence, psychiatric disorder, long spells of sickness absence and poor health functioning. High job demands was found to predict poor health functioning and psychiatric disorder. Low decision latitude was moderately associated with risk of alcohol dependence. Work social supports and control over work had a protective effect on mental health and health functioning and reduced the risk of spells of sickness absence.

This research has been carried out in the longitudinal Whitehall II study of 10308 male and female civil servants, aged 35-55 years on entry to the study in 1985. This cohort of civil servants has been followed up since then with repeated phases of data collection every 2-3 years. This research includes analyses of incident disease over an average ten year follow up. The initial response rate to the study was 73% and there has been good follow up of participants since then The longitudinal design allows work characteristics to be related to the development of subsequent illness after taking account of pre-existing ill-health.

The psychosocial work environment is measured by self report questions on decision latitude (degree of control over work and opportunity for use of skills and amount of variety present in work), psychological job demands (including pace of work and conflict between competing tasks), and work social support from supervisors and colleagues. Effort reward imbalance is an additional measure of the psychosocial work environment, in which putting in high levels of effort at work and receiving low rewards (in terms of income, promotion and being valued) is thought to increase the risk of ill-health.

Baseline measures of the psychosocial work environment were associated with incident coronary heart disease. Low decision latitude was related to both increased incidence of angina and increased incidence of myocardial infarction. For angina, the association was not explained by adjustment for employment grade but for myocardial infarction there was no longer an association with decision latitude after adjustment for employment grade. High job demands were related to both increased incidence of myocardial infarction and all validated coronary heart disease in both men and women, and this was not explained by employment grade, health behaviours or other conventional risk factors such as blood pressure. Effort reward imbalance predicted increased risk of myocardial infarction in both men and women.

The Karasek job strain model, which hypothesizes that job demands will only be related to poor health in those with low control over their work environment, was also investigated. However, there was little evidence to support any interactive effect for job demands and decision latitude in their relation with incident coronary heart disease. This is consistent with earlier Whitehall II findings for self report measures which suggest that adverse effects of job demands and decision

latitude are independently related to health.

Those in clerical employment grades had an increased risk of diabetes and among men, effort reward imbalance predicted incidence of diabetes. Other work psychosocial risk factors were not associated with incidence of diabetes.

The table below summarises the main findings from this research project and also the previous HSE funded project.

Summary of findings

Work characteristic:	Associated with:
Low decision latitude	- Obesity - Alcohol dependence - Poor mental health - Poor health functioning - Increased sickness absence - Coronary heart disease
High job demands	- Obesity - Poor mental health - Poor health functioning - Coronary heart disease
Low social support at work	- Obesity - Poor mental health - Poor health functioning - Increased sickness absence
Combination of high effort and low rewards	- Alcohol dependence - Poor mental health - Poor health functioning - Sickness absence (long spells) - Diabetes - Coronary heart disease

Since the Whitehall II cohort was recruited, there has been considerable organisational change in the Civil Service, with many civil servants transferred to Executive Agencies. This appeared to be reflected in the changes seen in self-report work characteristics in the cohort, with an increasing tendency to report greater job demands, less social support and more decision latitude. Longitudinal analyses of change in reported work characteristics in relation to health provide more information on the pathways underlying relationships between work characteristics and health.

Adverse change in most work risk factors, particularly social support, was found to be associated with increased risk of poor mental health functioning (measured by a component of the SF-36 General Health Survey), paralleling earlier results which showed a relationship

between change in work and minor psychiatric morbidity measured by the 30 item General Health Questionnaire. However, change in work characteristics was not strongly associated with the physical functioning component of the SF-36 or with reporting of longstanding illness, although the associations were somewhat stronger over a longer period of follow up, suggesting that influences of work environment on physical health may take longer to manifest themselves. More specifically, there was some evidence to support a longer term influence of changes in job demands and support at work on physical functioning among men and women, and adverse changes in decision latitude and job demands on longstanding illness among men. However, these associations between change in work characteristics and physical health were weaker than those for mental health. Increasing social support appeared to protect against future risk of myocardial infarction and reduced levels of social support were associated with increased risk of angina.

Earlier research showed that the psychosocial work environment was related to alcohol dependence (measured by the CAGE questionnaire) and also that alcohol consumption was related to overall sickness absence. Here, we investigate the relation between alcohol and absence from work attributable to injuries. Both moderate drinking (11-21 units per week in men / 8 –14 units per week in women) and heavy drinking (>21 units in men / >14 units per week in women) were associated with an increased risk of absence due to injury. 'Binge' drinking , defined as consuming more than 5 units on one occasion, was also related to both short spells (1-7 days) and long spells (8 days or more) of absence due to injury. Alcohol dependence was related to increased risk of short spells due to injury.

The work environment appears to have an important influence on physical health as well as mental health. Decision latitude, job demands, work social supports and effort reward imbalance all show some association with physical health although there are differences according to the specific health outcome. In addition, adverse changes in these aspects of work environment are related to increased risk of mental ill-health. The associations between adverse change in work and physical ill-health were weaker although there was a suggestion that these effects may take longer to manifest themselves. Workplace interventions which tackle these aspects of work environment may reduce mental ill-health and possibly physical ill-health in working populations. Differences in these work characteristics also appear to be part of the explanation for grade gradients in health. Thus improving work environments may also contribute to reducing social inequalities in health.

1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES OF THE STUDY

It has been recognised that the workplace is an effective site for intervention to improve health and reduce health inequalities as described in the Healthy Workplace Initiative (Department of Health, 1999). Whereas in the past there has been an emphasis on physical working conditions in relation to risks to health, more recently there has been a focus on psychosocial work characteristics and how these might impact on the health of workers (Health & Safety Executive, 1998). In line with the Health & Safety Commission's strategy on work-related stress, HSE has issued revised guidance with more emphasis on the steps that managers can take to prevent stress related illness (Health & Safety Executive, 2001). The Health and Safety Commission has identified work stress as one of its main priorities under the recent Revitalising Health and Safety initiative which aims to achieve, by the year 2010: a 30 per cent reduction in the incidence of working days lost through work-related illness and injury; a 20 per cent reduction in the incidence of people suffering from work related ill-health; and a 10 per cent reduction in the rate of work-related fatal and major injuries. These different concerns have led to a need to understand what aspects of work might damage health, what aspects of work might be protective to health and their relative contribution to different health outcomes.

Ill-health at work is a major problem with costs both to the individual, to organisations and to the country as a whole. Around 6.5 million working days were lost in Britain in 1995 due to stress, depression, anxiety or a physical condition ascribed to work related stress (Jones et al 1998) and a survey of work related illness in 1999 suggests that the prevalence of work related stress is increasing. The cost to employers of work related ill-health is estimated to be £370 million (in 1995/6 prices) and the total cost to society as a whole of work related illness (in 1995/96) is estimated to be £3.75 billion (Health & Safety Executive, 1999). An understanding of how the psychosocial work environment influences ill-health at work can help to try to reduce these costs both to the individual and the wider economy.

The Whitehall II Study provided the opportunity to study the influence of the psychosocial environment on health in a longitudinal cohort study of white collar employees. The study has focused on collecting information on aspects of the psychosocial work environment, such as lack of control over work, rather than asking directly about work stress. In an earlier report, we found that aspects of the psychosocial work environment were related to alcohol dependence, mental health , self reported physical functioning and sickness absence (Stansfeld et al 2000). In this report, we extend our previous research to examine both incidence of diabetes and validated coronary heart disease over a longer time period in the Whitehall II study of civil servants. We also investigate whether alcohol consumption and alcohol dependence are related to absence from work attributable to injury.

The specific objectives of this research project were to extend the work from our previous HSE funded research project (Stansfeld et al 2000):

1. *To analyse work environment in relation to both incidence of diabetes and validated coronary heart disease.*

2. *To examine the influence of change in work characteristics on incidence of coronary heart disease, functioning and other health outcomes.*

3. *To establish the contribution of alcohol consumption and alcohol dependence to absence from work attributable to accidents.*

1.2 WHITEHALL II STUDY

Whitehall II is a longitudinal study of 10308 male and female civil servants aged 35-55 years on entry to the study. This study was set up to investigate the degree and 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 years, 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. Five waves of data collection have been completed, a sixth phase is currently being undertaken and phase 7 is planned to start in 2003.

Figure 1 Information collected in first five phases of Whitehall II study

Phase 1 N = 10308 (1985-88)	Phase 2 N = 8129 (1989)	Phase 3 N = 8548 (1991-93)	Phase 4 N = 8630 (1995-96)	Phase 5 N = 7800 (1997-99)
Questionnaire Demographic Socio-economic data Work characteristics Social supports Health behaviours Health status Mental health Examination Weight, height Blood pressure ECG Blood sample	Postal questionnaire Demographic Socio-economic data Work characteristics Social supports Health behaviours Health status Mental health	Questionnaire Demographic Socio-economic data Work characteristics Social supports Health behaviours Alcohol dependence Health status SF-36 (functioning) Mental health Examination Weight, height Waist hip ratio Blood pressure ECG Blood sample Cognitive function	Postal questionnaire Demographic Socio-economic data Health status SF-36 (functioning)	Questionnaire Demographic Socio-economic data Work characteristics Attitudes to retirement Social supports Health behaviours Alcohol dependence Health status SF-36 (functioning) Mental health Examination Weight, height Waist hip ratio Blood pressure ECG Heart rate variability Blood sample Cognitive function Computerised psychiatric interview
Sickness Absence data from the Civil Service (1985-1998)				
Identification of incident coronary heart disease events through GP and hospital records, death registration (1985-1999)				

The overall response rate for the baseline phase was 73% (74% for men, 71% for women). The true response rates are likely to be higher, however, because around 4% of those on the list of employees had moved before the study and were not eligible for inclusion. Altogether 10,308 civil servants were examined – 6895 men (67%) and 3413 women (33%). The participation rates at phase 2, phase 3, phase 4 and phase 5 were 79%, 83%, 84% and 76%respectively.

Self-report questionnaires have been administered at all phases and collected information relating to personal characteristics, family, work environment, health behaviours, social

supports and self-reported health. The Civil Service identifies 12 non-industrial grades on the basis of salary. There was a steep increment in salaries from an annual salary in 1987 of between £3061 and £5841 in the clerical and office support grades to between £18020 and £62100 in the unified grades 1 to 6. Besides the steep increment in salaries there were also marked differences in other socio-economic indicators (education, housing tenure, car ownership, and fathers' occupation) by grade of employment (Marmot et al, 1991). Further details of non-work related risk factors for ill-health are reported elsewhere (Marmot et al, 1991; Stansfeld et al, 1998; Stansfeld, Fuhrer & Shipley, 1998). There have been three clinical examinations of the cohort (phases 1, 3, and 5) which have included measurement of height, blood pressure, body mass index, ECG abnormalities and glucose tolerance.

1.3 MEASURES OF WORK CHARACTERISTICS

We have self-report measures of the psychosocial work environment based on the Karasek/Theorell Job Content Instrument from 3 phases (phases 1, 2, and 3) (Karasek & Theorell, 1990). There are three dimensions as follows:

- Decision latitude
- Job demands
- Work social support

Decision latitude can be further subdivided into: decision authority and skill discretion. Work social support has three components: support from colleagues, support from superiors and information from superiors (See Appendix A for details of items included in these scales).

Each of the work measures was divided into tertiles and these were labelled 'low', 'medium', or 'high', so that, for example, those participants within the top third of all scores on the job demand scale were labelled as having 'high job demands'.

In Karasek's initial formulation of the job strain model, it was hypothesised that worst health outcomes would be predicted by a combination of high demands and low decision latitude. We have examined this by cross classifying people into four groups according to whether their scores were above or below the median on the two components of decision latitude and job demands :

- High demand and high decision latitude
- High demand and low decision latitude
- Low demand and high decision latitude
- Low demand and low decision latitude

We have also considered a different model of work environment, the effort reward imbalance model, which conceptualises psychosocial stress at work in terms of an imbalance between efforts and rewards (Siegrist, 1996). Siegrist developed a questionnaire to measure effort reward imbalance which includes 6 items to measure intrinsic effort covering the extent to which work dominates life, 6 items measuring extrinsic effort such as pressure to work overtime and 11 items measuring rewards including income, promotion prospects and receiving respect deserved. We did not include the Siegrist questionnaire at baseline but we have derived an indicator of effort reward imbalance using items included in the questionnaire at phase 1 (Bosma et al, 1998). These items were selected to cover aspects of effort expended and rewards received (see Appendix A). High efforts were defined in terms of competitiveness, work related overcommitment or hostility. Low rewards were defined by poor promotion prospects or a blocked career. We have classified people into one of three groups:

- Neither high efforts or low rewards
- One of high efforts or low rewards
- Both high effort and low rewards

1.4 DISTRIBUTION OF WORK CHARACTERISTICS BY EMPLOYMENT GRADE

Figure 1 shows the median decision latitude score for each employment grade and also the 5th and 95th percentile scores. There was a clear trend across employment grades with those in top administrative grades more likely to report high levels of decision latitude.

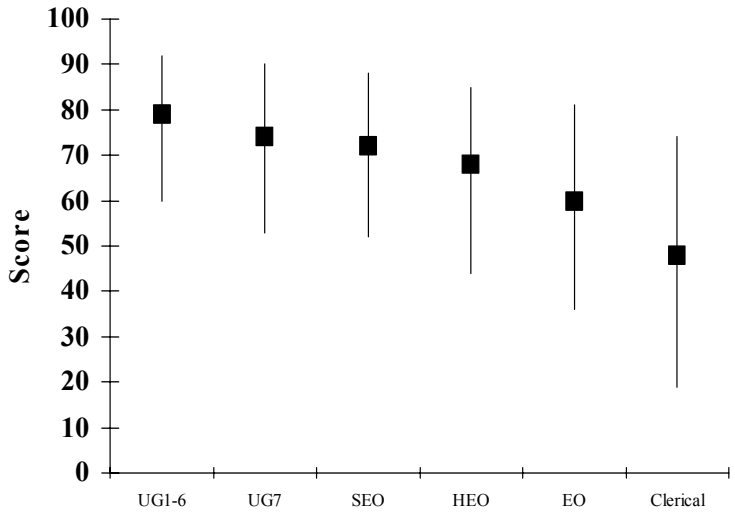

Figure 1
Decision latitude by employment grade: median score (5th and 95th percentile scores)

There were also grade differences in job demands with those in clerical grades less likely to report high job demands than those in top employment grades (Figure 2). For work social supports, median scores were very similar in all employment grades with an overall median score of 77 (5th percentile = 77, 95th percentile = 100). Within each employment grade, distributions of decision latitude, job demand and work social support scores were very similar for men and women.

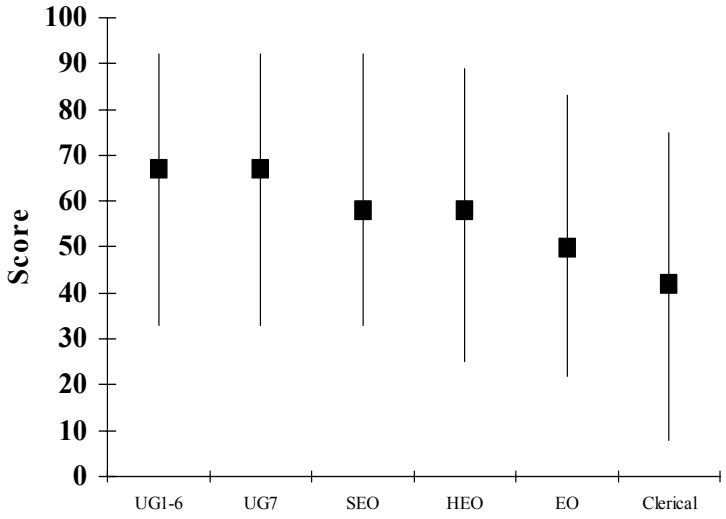

Figure 2
Job demands by employment grade: median score (5th and 95th percentile scores)

Figure 3 shows the percentages classified in the adverse tertile of each work characteristic by employment grade and again indicates that there is an employment grade gradient for decision latitude and job demands but that this is less marked for work social supports.

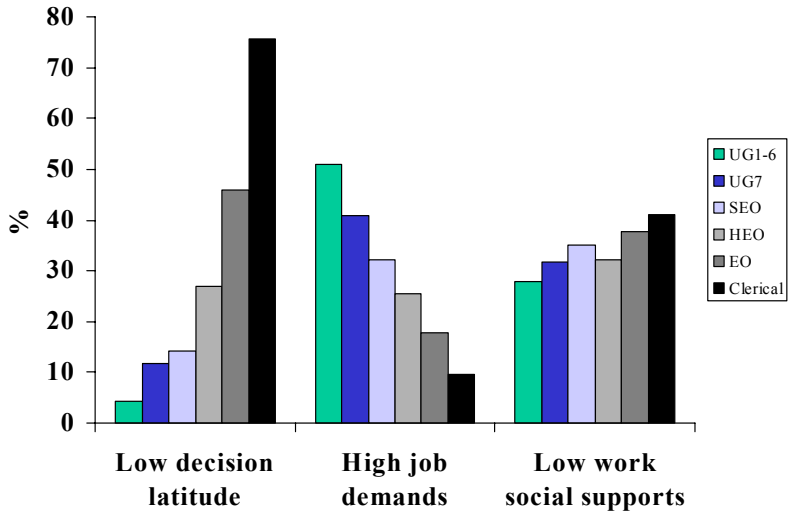

Figure 3
Percentage in adverse tertile of each work characteristic by employment grade

Figure 4 shows the percentages of men and women in different categories of effort reward imbalance based on phase 1 data. The percentages classified as putting in relatively low effort but receiving high rewards were relatively small, around 15% of men and 10% of women. About a third of both men and women were classified as having imbalance, that is putting in high effort but receiving low rewards. Figure 5 shows how the percentage with effort reward imbalance varies by employment grade. Those in clerical grades were most likely to be classified as having effort reward imbalance but otherwise grade differences were not that marked.

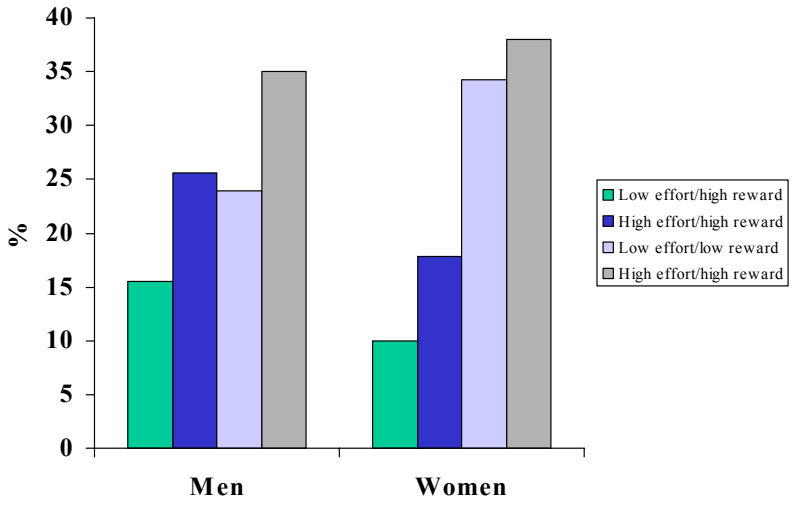

Figure 4
Percentage of men and women in each category of effort reward imbalance

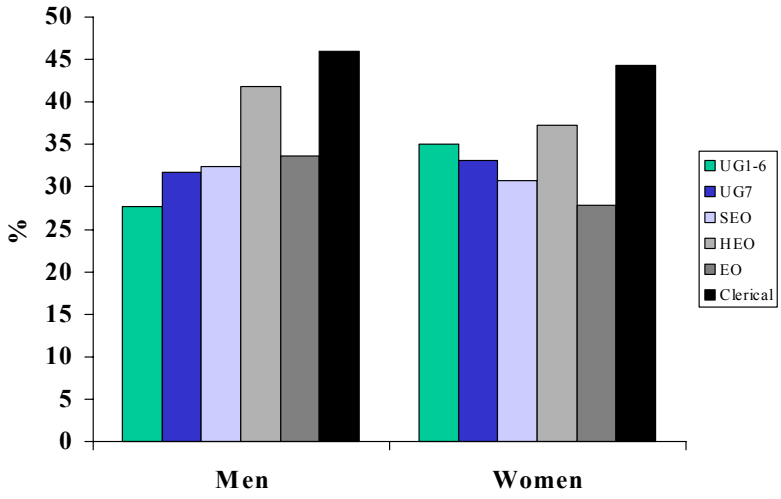

Figure 5
Percentage of men and women classified as 'high effort/low reward' by employment grade

1.5 STATISTICAL METHODS

Linear regression was used to analyse the association between the continuous health functioning outcomes and work risk factors. Logistic regression was used to analyse binary outcomes such as presence or absence of longstanding illness. Results from logistic regression are presented as odds ratios with their 95% confidence intervals.

Survival analysis was used to analyse incidence of coronary heart disease by fitting the Cox proportional hazards model. Results from these models are presented as hazard ratios with their 95% confidence intervals.

One interpretation of the Karasek job strain model postulates that high job demands will have the greatest adverse effect on health in those with low decision latitude. In order to test this hypothesis, further analyses were run to test whether the influence of job demands on health differed according to perceived level of decision latitude, by including an interaction term between job demands and decision latitude in the model.

In addition, these analyses were repeated within employment grade to test whether there is a differential effect of work related factors by employment grade. One might expect that any work related effects would be stronger in those in lower employment grades. We also investigated the possibility that the effect of work related factors may differ according to age although, of course, the Whitehall II study does not cover all working ages.

For sickness absence, the number of spells of absence of each type were computed and the follow up period was measured in person-years. Sickness absence rates were analysed using Poisson regression which was used to estimate rate ratios adjusted for age, grade and other risk factors (North et al, 1993).

2. WORK CHARACTERISTICS AND DIABETES

A number of psychosocial risk factors are related to coronary heart disease (Hemingway and Marmot 1999) but few studies have examined the role of these factors in relation to incidence of diabetes. A link is plausible as psychological stress may lead to subsequent insulin resistance which in turn leads to glucose intolerance and then diabetes.

At each phase of the study, participants were asked whether or not they had diabetes. In addition, fasting plasma glucose concentration and 2 hour post load plasma glucose concentration were measured at phases 3 and 5. Diagnosis of type 2 diabetes was made according to World Health Organisation (WHO) criteria (WHO 1999). The definition of diabetes used was 2 hour post load plasma glucose concentration >= 11.1 mmol/l (or if the 2 hour post load value was missing, fasting plasma glucose concentration >= 7.0 mmol/l) or doctor diagnosed diabetes. Those participants that reported doctor diagnosed diabetes at baseline were removed from the analyses. Overall, 4% of both men and women were classified as incident cases of type 2 diabetes by phase 5 (242 men and 119 women). As the numbers of incident cases of type 2 diabetes are relatively small, we also looked at impaired glucose tolerance (IGT) as this has been shown to be a precursor of type 2 diabetes. IGT was defined as 2 hour post load plasma glucose concentration >= 7.8 mmol/l but less than 11.1 mmol/l (or if the 2 hour post load value was missing, fasting plasma glucose concentration >= 6.1 mmol/l but less than 7.0 mmol/l),

2.1 INCIDENCE OF DIABETES BY EMPLOYMENT GRADE

Table 1 shows the incidence of type 2 diabetes by employment grade for men and women. There is a clear grade gradient with both men and women in clerical grades having a greater incidence of diabetes.

Table 1
Percentages of men and women with incident type 2 diabetes (phase 1 to phase 5) and age-adjusted odds ratios for incidence of type 2 diabetes by employment grade (phase 1)

Employment grade[1]	Men (n=5950)		Women (n=2680)	
	%	Odds ratio (95%CI)	%	Odds ratio (95% CI)
UG1-UG7	3%	1	2%	1
SEO, HEO, EO	4%	1.53 (1.1,2.1)	4%	1.38 (0.6,3.0)
Clerical	9%	2.93 (1.9,4.4)	6%	1.72 (0.8,3.7)

[1] Civil Service Unified Grades 1-6 and 7 consist of senior management and equivalent grades; SEO, HEOand EO consist of executive and equivalent professional grades; Clerical represents the clerical and office support staff.

2.2 FAMILY HISTORY OF DIABETES, ETHNICITY, BODY MASS INDEX, EXERCISE, SMOKING

Established risk factors for onset of type 2 diabetes include family history of diabetes, ethnicity, body mass index, exercise and hypertension. Table 2 shows the association between these risk factors and incidence of diabetes in the Whitehall II cohort, after taking account of employment grade. As expected, they were all associated with incidence of diabetes. We also looked at height as an indicator of childhood deprivation and health and this was related to incidence of diabetes. Smoking was not related to incidence of diabetes. An indicator of healthy eating was constructed based on phase 1 answers to diet questions. Those considered to have a less healthy diet had a greater incidence of diabetes.

Table 2
Odds ratios (95% confidence intervals) for incidence of type 2 diabetes (to phase 5) by conventional risk factors (phase 1)

	Odds ratios[1]
	(n=8386)
Parental diabetes	
No	1
Yes	2.23 (1.7,3.0)
Siblings with diabetes	
No	1
Yes	2.06 (1.3,3.4)
Ethnic group	
European	1
South Asian	3.07 (2.2,4.3)
Afro Caribbean	2.43 (1.6,3.8)
Body mass index	
Underweight	1.02 (0.6,1.9)
Normal	1
Overweight	2.14 (1.7,2.7)
Obese	4.63 (3.3,6.5)
Height tertiles	
Low	1
Medium	0.68 (0.5,0.9)
High	0.64 (0.5,0.9)
Hypertension	
No	1
Yes	1.87 (1.4,2.6)
Exercise	
Vigorous	1
Moderate	1.59 (1.1,2.2)
Mild/none	1.65 (1.1,2.4)
Smoking	
Never	1
Ex-smoker	1.00 (0.8,1.3)
Current smoker	1.01 (0.7,1.4)
Diet	(n=6267)
Good	1
Poor	1.25 (0.9,1.6)

[1] Adjusted for age, length of follow up, employment grade, ethnic group (Odds ratios for ethnic group adjusted for age and length of follow up).

2.3 WORK CHARACTERISTICS AND DIABETES

Table 3 shows the association between work psychosocial risk factors measured at phase 1and incidence of diabetes between phase 1 and phase 5 (excluding those with doctor diagnosed diabetes at phase 1). Decision latitude and work social supports were not associated with incidence of diabetes. In men, those in the middle category of job demands had the highest risk of developing diabetes but there was no significant difference between the high and the low job demand groups. In women, there was no significant association for job demands. In men, effort reward imbalance was associated with incident type 2 diabetes with those classified in the 'low effort/high reward' category having a lower incidence of diabetes than those men in the other two categories. This association remained after adjustment for established risk factors. In women, there was no significant association between effort reward imbalance and incidence of diabetes.

Table 3
Odds ratios (95% confidence interval) for incidence of type 2 diabetes (to phase 5) by work characteristics (phase 1)

	Men (n=5665)		Women (n=2402)	
	Adjusted[1]	Adjusted[2]	Adjusted[1]	Adjusted[2]
Decision latitude				
High	1	1	1	1
Medium	0.85 (0.6,1.2)	0.87 (0.6,1.2)	0.99 (0.5,1.9)	1.20 (0.6,2.3)
Low	0.77 (0.5,1.2)	0.80 (0.5,1.2)	0.82 (0.4,1.6)	0.95 (0.5,1.8)
Job Demands				
Low	1	1	1	1
Medium	1.47 (1.0,2.1)	1.42 (0.9,2.0)	0.99 (0.6,1.5)	0.88 (0.5,1.4)
High	1.11 (0.7,1.7)	1.07 (0.7,1.6)	0.59 (0.3,1.2)	0.52 (0.3,1.1)
Work social support				
High	1	1	1	1
Medium	0.97 (0.7,1.3)	0.94 (0.7,1.3)	0.96 (0.6,1.7)	0.87 (0.5,1.5)
Low	0.80 (0.5,1.1)	0.76 (0.5,1.1)	1.20 (0.7,1.9)	1.13 (0.7,1.9)
Effort reward imbalance				
Neither high effort or low reward	0.64 (0.4,1.0)	0.63 (0.4,1.0)	1.34 (0.7,2.7)	1.27 (0.6,2.7)
Either high effort or low reward	1	1	1	1
Both high effort and low reward	1.10 (0.8,1.5)	1.05 (0.8,1.4)	1.23 (0.8,1.9)	1.19 (0.8,1.8)

[1] Adjusted for age, length of follow up, grade, ethnic group
[2] Adjusted for age, length of follow up, grade, ethnic group, family history of diabetes, body mass index, height, systolic blood pressure, presence of ECG abnormalities, exercise, smoking, life events.

Table 4
Odds ratios (95% confidence interval) for incidence of type 2 diabetes (to phase 5) by non-work risk factors (phase 1)

	Men		Women	
	Adjusted[1]	Adjusted[2]	Adjusted[1]	Adjusted[2]
Confiding/emotional support				
High	1	1	1	1
Medium	0.90 (0.7,1.3)	0.89 (0.6,1.2)	1.12 (0.7,1.8)	1.08 (0.6,1.7)
Low	0.73 (0.5,1.1)	0.70 (0.5,1.0)	0.89 (0.5,1.5)	0.86 (0.5,1.5)
Practical support				
Low	1	1	1	1
Medium	1.22 (0.9,1.7)	1.19 (0.8,1.7)	0.73 (0.5,1.2)	0.68 (0.4,1.1)
High	1.17 (0.8,1.7)	1.28 (0.9,1.8)	0.93 (0.6,1.5)	0.83 (0.5,1.4)
Negative aspects of Close relationships				
Low	1	1	1	1
Medium	0.88 (0.6,1.3)	0.89 (0.6,1.3)	1.06 (0.7,1.7)	1.09 (0.7,1.8)
High	1.10 (0.8,1.5)	1.05 (0.7,1.5)	0.75 (0.5,1.2)	0.75 (0.4,1.3)
Network size				
Low	1	1	1	1
Medium	1.18 (0.8,1.7)	1.17 (0.8,1.7)	0.76 (0.5,1.2)	0.73 (0.4,1.2)
High	1.20 (0.9,1.7)	1.20 (0.8,1.7)	0.76 (0.5,1.2)	0.72 (0.4,1.2)
Life events				
0	1	1	1	1
1	1.04 (0.7,1.5)	1.03 (0.7,1.5)	1.28 (0.7,2.2)	1.33 (0.8,2.3)
2+	1.20 (0.9,1.7)	1.15 (0.8,1.6)	1.27 (0.8,2.1)	1.23 (0.7,2.1)
Material problems				
Low	1	1	1	1
Medium	1.11 (0.8,1.6)	1.09 (0.7,1.6)	1.76 (1.1,2.9)	1.77 (1.1,2.9)
High	1.18 (0.8,1.6)	1.15 (0.8,1.6)	1.34 (0.8,2.2)	1.24 (0.8,2.0)
GHQ caseness				
No	1	1	1	1
Yes	1.13 (0.8,1.5)	1.09 (0.8,1.5)	1.32 (0.9,2.0)	1.36 (0.9,2.1)
Depression score				
0-3	1	1	1	1
4+	1.17 (0.8,1.7)	1.17 (0.8,1.7)	1.08 (0.6,1.9)	1.03 (0.6,1.8)

[1] Adjusted for age, length of follow up, grade, ethnic group

[2] Adjusted for age, length of follow up grade, ethnic group, family history of diabetes, body mass index, height, systolic blood pressure, presence of ECG abnormalities, exercise, smoking

2.4 NON-WORK PSYCHOSOCIAL RISK FACTORS

Social supports outside work and social networks were not significant predictors of incident type 2 diabetes (Table 4). People who reported experiencing 2 or more life events in the last 12 months had a higher incidence of diabetes although this was not statistically significant. High levels of material deprivation were also associated with incidence of diabetes although again this was not statistically significant. Minor psychiatric morbidity measured by the 30 item General Health Questionnaire (GHQ) also appeared to predict incident diabetes and so did depressive symptoms, measured by a subscale of the GHQ.

2.5 IMPAIRED GLUCOSE TOLERANCE

As the numbers of incident cases of diabetes are relatively small, we repeated analyses for the larger group of people classified as having impaired glucose tolerance (around 15% of the total sample by phase 5). However, none of the work measures were related to impaired glucose tolerance (Table 5). Of the non-work psychosocial risk factors (Table 6), only depression score in men was related to glucose intolerance.

Table 5
Odds ratios (95% confidence interval) for impaired glucose tolerance (phase 5) by phase 1work characteristics (excluding participants with diabetes at baseline)

	Men (n=5665)		Women (n=2402)	
	Adjusted[1]	Adjusted[2]	Adjusted[1]	Adjusted[2]
Decision latitude				
High	1	1	1	1
Medium	1.04 (0.8,1.3)	1.07 (0.8,1.3)	1.03 (0.7,1.5)	1.09 (0.8,1.6)
Low	1.01 (0.9,1.3)	1.05 (0.8,1.3)	1.12 (0.8,1.6)	1.18 (0.8,1.7)
Job Demands				
Low	1	1	1	1
Medium	1.15 (0.9,1.4)	1.12 (0.9,1.4)	0.88 (0.7,1.2)	0.86 (0.6,1.2)
High	0.98 (0.8,1.2)	0.97 (0.8,1.2)	0.87 (0.6,1.3)	0.90 (0.6,1.3)
Work social support				
High	1	1	1	1
Medium	1.04 (0.9,1.3)	1.03 (0.8,1.2)	1.01 (0.7,1.4)	1.00 (0.7,1.4)
Low	0.84 (0.7,1.0)	0.82 (0.7,1.0)	1.05 (0.8,1.4)	1.06 (0.8,1.4)
Effort reward imbalance				
Neither	1.01 (0.8,1.3)	1.00 (0.8,1.3)	1.37 (0.9,2.0)	1.30 (0.9,2.0)
Either	1	1	1	1
Both	0.94 (0.8,1.1)	0.93 (0.8,1.1)	0.94 (0.7,1.2)	0.91 (0.7,1.2)

[1] Adjusted for age, length of follow up, grade, ethnic group
[2] Adjusted for age, length of follow up, grade, ethnic group, family history of diabetes, body mass index, height, systolic blood pressure, presence of ECG abnormalities, exercise, smoking, life events.

Table 6
Odds ratios (95% confidence interval) for impaired glucose tolerance (phase 5) by phase 1 non-work risk factors (excluding participants with diabetes at baseline)

	Men		Women	
	Adjusted[1]	Adjusted[2]	Adjusted[1]	Adjusted[2]
Confiding/emotional support				
High	1	1	1	1
Medium	1.08 (0.9,1.3)	1.06 (0.9,1.3)	0.88 (0.7,1.2)	0.85 (0.6,1.9)
Low	0.96 (0.8,1.2)	0.95 (0.8,1.2)	1.03 (0.8,1.4)	1.01 (0.7,1.4)
Practical support				
Low	1	1	1	1
Medium	1.18 (0.9,1.4)	1.20 (0.9,1.5)	0.91 (0.7,1.2)	0.89 (0.7,1.2)
High	0.94 (0.8,1.2)	0.94 (0.8,1.2)	1.08 (0.8,1.4)	1.03 (0.8,1.4)
Negative aspects of Close relationships				
Low	1	1	1	1
Medium	0.86 (0.7,1.1)	0.87 (0.7,1.1)	0.94 (0.7,1.3)	0.95 (0.7,1.3)
High	1.02 (0.8,1.2)	1.02 (0.8,1.2)	0.79 (0.6,1.1)	0.79 (0.6,1.1)
Network size				
Low	1	1	1	1
Medium	0.99 (0.8,1.2)	0.98 (0.8,1.2)	0.73 (0.5,0.9)	0.72 (0.5,0.9)
High	0.98 (0.8,1.2)	0.97 (0.8,1.2)	0.74 (0.6,1.0)	0.71 (0.5,0.9)
Life events				
0	1	1	1	1
1	1.04 (0.9,1.3)	1.03 (0.8,1.3)	1.08 (0.8,1.5)	1.06 (0.8,1.4)
2+	1.02 (0.8,1.2)	1.01 (0.8,1.2)	0.92 (0.7,1.2)	0.87 (0.6,1.2)
Material problems				
Low	1	1	1	1
Medium	1.04 (0.9,1.3)	1.04 (0.9,1.3)	0.95 (0.2,1.3)	0.96 (0.7,1.3)
High	0.90 (0.7,1.1)	0.90 (0.7,1.1)	0.76 (0.6,1.0)	0.73 (0.5,0.9)
GHQ cases				
No	1	1	1	1
Yes	1.01 (0.8,1.2)	1.02 (0.8,1.2)	0.92 (0.7,1.2)	0.97 (0.7,1.3)
Depression score				
0-3	1	1	1	1
4+	1.25 (1.0,1.6)	1.27 (1.0,1.6)	1.05 (0.8,1.5)	1.08 (0.8,1.5)

[1] Adjusted for age, length of follow up, grade, ethnic group
[2] Adjusted for age, length of follow up grade, ethnic group, family history of diabetes, body mass index, height, systolic blood pressure, presence of ECG abnormalities, exercise, smoking

2.6 ASSOCIATION OF WORK CHARACTERISTICS WITH OBESITY

As obesity is a strong predictor of type 2 diabetes, we also investigated whether adverse work risk factors predicted development of obesity. Table 7 shows the relation between each work factor and obesity at phase 5 (excluding those who were overweight at baseline). High job demands predicted obesity in both men and women after adjustment for employment grade and other risk factors such as smoking and blood pressure. Low work social supports predicted obesity in men and women and in women, low decision latitude was related to obesity. However, effort reward imbalance, which was related to incidence of type 2 diabetes, was not associated with obesity.

Table 7
Odds ratio * (95% confidence interval) for obesity (phase 5) by phase 1 work characteristics (excluding participants classified as overweight at baseline)

	Men (n=2352) Adjusted[1]	Women (n=1007) Adjusted[1]
Decision latitude		
High	1	1
Medium	0.79 (0.6,1.0)	1.33 (0.8,2.8)
Low	0.74 (0.5,1.0)	1.67 (1.0,2.8)
Job Demands		
Low	1	1
Medium	1.23 (0.9,1.6)	1.15 (0.8,1.7)
High	1.30 (0.9,1.8)	1.26 (0.8,2.1)
Work social support		
High	1	1
Medium	0.99 (0.8,1.3)	0.97 (0.6,1.5)
Low	1.24 (1.0,1.6)	1.31 (0.9,2.0)
Effort reward imbalance		
Neither	1.29 (1.0,1.7)	1.13 (0.9,1.4)
Either	1	1
Both	1.16 (0.9,1.5)	1.20 (0.9,1.4)

[1] Adjusted for age, grade, ethnic group, body mass index, systolic blood pressure, GHQ score, exercise, smoking.

2.7 DISCUSSION

We have demonstrated that there is a social gradient in incident type 2 diabetes mellitus and that effort reward imbalance is associated with type 2 diabetes in this relatively healthy working population. Our findings for established risk factors such as family history of diabetes and blood pressure concur with other studies which suggest that our results can be generalised.

Few published studies have examined the relation between incidence of diabetes and social position or with psychosocial risk factors such as the work environment. A recent study reported an increase in the prevalence of type 2 (non insulin dependent or mature onset) diabetes in deprived areas (Connolly et al, 2000). Air traffic controllers with a high demand job have been reported to have a high prevalence of diabetes (Cobb and Rose,1973) and job strain and job stressors including low social support at work has been reported to be associated with increased levels of glycosylated haemoglobin among non-diabetic populations (Netterstrom et al, 1991). Excessive overtime has been reported to be associated with increased incidence of

type 2 diabetes in Japanese men independent of other risk factors (Kawakami et al, 1999). Other studies have also reported a lack of association between decision latitude and diabetes prevalence (Niedhammer et al, 1998) and incidence (Kawakami et al, 1999).

It is not clear why effort reward imbalance is associated with incidence of diabetes or what the pathways or mechanisms might be. Life events, material deprivation and psychiatric morbidity also seem to be related to incidence of diabetes, which might suggest a stress mechanism. This could operate directly or indirectly through health behaviours. It is perhaps not the latter, given that adjustment for health behaviours does not much alter the association between effort reward imbalance and incidence of diabetes and that effort reward imbalance is not related to obesity. Effort reward imbalance is also associated with a number of other risk factors for cardiovascular disease including hypertension and ratio of total cholesterol to HDL cholesterol (Peter et al,1998). We found a difference between men and women in the association between effort reward imbalance and incidence of diabetes with a significant association for men but not for women. The reasons for this are not clear although other studies have suggested that there may be gender differences in responses to stress. This may not be the explanation for our results, as life events and psychiatric morbidity were associated with incident diabetes in both men and women.

We found that decision latitude, job demands and work social supports were all predictors of onset of obesity. It is perhaps surprising that the Karasek work factors predict obesity but not incidence of diabetes, given that obesity is one of the major risk factors for diabetes (Narayan et al, 2000). It may be that diabetes associated obesity is a result of other factors such as hereditary factors rather than a result of stress. Alternatively, given that the Whitehall II population in general has relatively high levels of good health, it may be that the effects of psychosocial factors have become apparent for a sub clinical condition such as obesity which is on the pathway to the clinically overt condition. This may be a more plausible explanation as a randomised controlled trial with a four year follow up has shown that lifestyle changes, including weight reduction, can protect against progression to diabetes among those with impaired glucose tolerance (Tuomilehto et al, 2001). We hope to explore this in further analyses of changes in body mass index, impaired glucose tolerance and onset of diabetes once phase 7 data becomes available.

3. WORK CHARACTERISTICS AND INCIDENCE OF CORONARY HEART DISEASE

Previous findings from the Whitehall II study showed that phase 1 measures of low decision latitude but not high job demands or low social supports predicted self-reported incident coronary heart disease up to phase 3 (Bosma et al, 1997) and low decision latitude explained part of the employment grade gradient in incidence of coronary heart disease (Marmot et al, 1997). An indicator of effort reward imbalance was also found to be associated with self-reported coronary heart disease (Bosma et al, 1998). Here, we report the associations between work psychosocial factors and validated incidence of coronary heart disease up to the time of phase 5.

Self-report questions relating to possible coronary heart disease have been included at all phases of the study and phases 1, 3 and 5 also included a measure of ECG abnormalities. Together with death registration and sickness absence records, we have used this information to identify possible cases of coronary heart disease. A research nurse collected further information from hospital records and general practitioners for all potential cases. This information was used to validate both fatal and non-fatal cases of coronary heart disease using recognised criteria for diagnosis of myocardial infarction and angina. Self-report angina was also measured at each phase using the Rose questionnaire and defined as pain located over the sternum or in both the left chest and the left arm that is precipated by exertion, that causes the person to stop, and that goes away in 10 minutes or less (Rose, 1977). In this report, we analyse three different classifications of coronary heart disease :

i) **Fatal CHD/non fatal MI** All deaths with CHD as underlying cause and validated incident cases of non-fatal myocardial infarction
ii) **Angina** All incident cases of angina including both clinically validated angina and Rose self-reported angina
iii) **All validated CHD excluding Rose angina** All fatal and non-fatal incident cases of validated coronary heart disease including both myocardial infarction and validated angina (but excluding cases of angina identified solely through the Rose angina questionnaire)

The analyses presented here are based on incident cases of coronary heart disease with those who already had coronary heart disease at phase 1 excluded from the analysis.

3.1 EMPLOYMENT GRADE DIFFERENCES IN INCIDENCE OF CORONARY HEART DISEASE

The incidence of each of the three coronary heart disease measures by employment grade and sex is shown in Table 8. There are grade gradients in both men and women for all three measures with those in lower employment grades being at greater risk of coronary heart disease.

Table 8
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 1 to phase 5) by employment grade (phase 1), adjusted for age

	Fatal/non fatal MI		CHD (excluding Rose angina)		Angina	
Grade level[1]	Men (n=6754)	Women (n=3333)	Men (n=6557)	Women (n=3292)	Men (n=6589)	Women (n=3192)
UG1-UG7	1	1	1	1	1	1
SEO,HEO,EO	1.38 (1.0,1.8)	1.15 (0.4,3.2)	1.24 (1.0,1.5)	1.15 (0.6,2.2)	1.38 (1.1,1.7)	1.21 (0.8,1.8)
Clerical	2.50 (1.7,3.7)	1.31 (0.5,3.4)	2.01 (1.5,2.7)	1.80 (1.0,3.3)	1.58 (1.2,2.2)	1.37 (0.9,2.0)

[1] Civil Service Unified Grades 1-6 and 7 consist of senior management and equivalent grades; SEO, HEO and EO consist of executive and equivalent professional grades; Clerical represents the clerical and office support staff.

3.2 WORK CHARACTERISTICS AND INCIDENCE OF CORONARY HEART DISEASE

Table 9 shows the association between decision latitude and each of the three measures of incident coronary heart disease. Results are presented both before and after adjustment for employment grade. In men, results from age-adjusted analyses showed that decision latitude was associated with all three measures of coronary heart disease. However, after adjustment for employment grade, decision latitude was not significantly associated with incidence of fatal CHD/non fatal MI or with incidence of all validated CHD. The statistically significant association between decision latitude and angina in men remained after taking account of employment grade.

As employment grade is directly related to decision latitude, controlling for grade may be an over-adjustment and might have removed some of the decision latitude effect. Thus, analyses were repeated with an adjustment for alternative indicators of socio-economic status(SES) based on car and home ownership. Adjusting for these alternative SES indicators also reduced the association between decision latitude and both fatal CHD/non fatal MI incidence and all validated CHD incidence, although not as much as after adjusting for grade, and only marginally reduced the association with incidence of angina.

A further analysis including an additional adjustment for traditional coronary risk factors (exercise, smoking, body mass index, cholesterol level and hypertension) made little diference to either the age adjusted or the age-grade adjusted hazard ratios for the association between decision latitude and the three CHD outcomes.

Table 9
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 1 to phase 5) by decision latitude (phase 1)

MEN	Age adjusted	Adjusted for age and grade	Adjusted for age, car and home ownership	Adjusted for age and risk factors[1]	Adjusted for age, grade, risk factors[1]
Fatal/nonfatal MI[2]	6719 (248)	6719 (248)	6664 (246)	6616 (244)	6616 (244)
Low decision latitude	1.25 (0.9,1.7)	0.78 (0.5,1.2)	1.08 (0.8,1.5)	1.06 (0.8,1.5)	0.81 (0.6,1.2)
Medium decision latitude	1.30 (1.0,1.7)	1.14 (0.8,1.5)	1.26 (0.9,1.7)	1.32 (1.0,1.8)	1.20 (0.9,1.6)
High decision latitude	1	1	1	1	1
Angina	6554 (500)	6554 (500)	6501 (495)	6453 (490)	6453 (490)
Low decision latitude	1.69 (1.4,2.1)	1.45 (1.1,1.9)	1.65 (1.3,2.1)	1.57 (1.3,2.0)	1.47 (1.1,1.9)
Medium decision latitude	1.42 (1.2,1.8)	1.33 (1.1,1.7)	1.41 (1.1,1.7)	1.45 (1.2,1.8)	1.39 (1.1,1.7)
High decision latitude	1	1	1	1	1
CHD (excl. Rose angina)	6642 (433)	6642 (433)	6588 (427)	6541 (425)	6541 (425)
Low decision latitude	1.48 (1.2,1.9)	1.11 (0.8,1.5)	1.35 (1.1,1.7)	1.33 (1.0,1.7)	1.11 (0.8,1.5)
Medium decision latitude	1.25 (1.0,1.6)	1.15 (0.9,1.4)	1.23 (1.0,1.5)	1.27 (1.0,1.6)	1.21 (1.0,1.5)
High decision latitude	1	1	1	1	1

WOMEN	Age adjusted	Adjusted for age and grade	Adjusted for age, car and home ownership	Adjusted for age and risk-factors[1]	Adjusted for age, grade, risk factors[1]
Fatal/nonfatal MI	3262 (60)	3262 (60)	3212 (60)	3203 (59)	3203 (59)
Low decision latitude	1.13 (0.6,2.2)	1.03 (0.5,2.4)	1.05 (0.5,2.1)	1.02 (0.5,2.0)	1.08 (0.5,2.5)
Medium decision latitude	0.69 (0.3,1.6)	0.66 (0.3,1.6)	0.68 (0.3,1.5)	0.68 (0.3,1.5)	0.69 (0.3,1.6)
High decision latitude	1	1	1	1	1
Angina	3123 (304)	3123 (304)	3075 (295)	3069 (300)	3069 (300)
Low decision latitude	1.12 (0.8,1.5)	0.94 (0.6,1.4)	1.09 (0.8,1.5)	1.10 (0.8,1.5)	0.98 (0.7,1.4)
Medium decision latitude	1.14 (0.8,1.6)	1.03 (0.7,1.5)	1.16 (0.8,1.6)	1.10 (0.8,1.6)	1.03 (0.7,1.5)
High decision latitude	1	1	1	1	1
CHD (excl. Rose angina)	3222 (152)	3222 (152)	3173 (150)	3164 (149)	3164 (149)
Low decision latitude	1.50 (0.9,2.4)	1.05 (0.6,1.8)	1.44 (0.9,2.3)	1.46 (0.9,2.4)	1.07 (0.6,1.9)
Medium decision latitude	1.29 (0.8,2.2)	1.08 (0.6,1.9)	1.25 (0.7,2.1)	1.24 (0.7,2.1)	1.06 (0.6,1.9)
High decision latitude	1	1	1	1	1

[1] Exercise, smoking, past smoker, body mass index, cholesterol, hypertension.
[2] Total number in analysis (number of incident events) given on this row.

Table 10
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 1 to phase 5) by job demands (phase 1)

MEN	Age adjusted	Adjusted for age and grade	Adjusted for age, car and home ownership	Adjusted for age and risk factors[1]	Adjusted for age, grade, risk factors[1]
Fatal/nonfatal MI	6738 (248)	6738 (248)	6683 (246)	6644 (244)	6644 (244)
Low job demands	1	1	1	1	1
Medium job demands	1.44 (1.0,2.0)	1.81 (1.3,2.6)	1.54 (1.1,2.2)	1.51 (1.1,2.1)	1.74 (1.2,2.5)
High job demands	1.28 (0.9,1.8)	1.84 (1.3,2.7)	1.39 (1.0,2.0)	1.43 (1.0,2.1)	1.82 (1.2,2.7)
Angina	6573 (500)	6573 (500)	6520 (495)	6480 (491)	6480 (491)
Low job demands	1	1	1	1	1
Medium job demands	0.89 (0.7,1.1)	0.99 (0.8,1.3)	0.93 (0.8,1.2)	0.91 (0.7,1.1)	0.97 (0.8,1.2)
High job demands	1.00 (0.8,1.3)	1.23 (1.0,1.6)	1.06 (0.8,1.3)	1.05 (0.8,1.3)	1.21 (0.9,1.6)
CHD (excl. Rose angina)	6661 (433)	6661 (433)	6607 (427)	6569 (425)	6569 (425)
Low job demands	1	1	1	1	1
Medium job demands	1.03 (0.8,1.3)	1.21 (0.9,1.6)	1.09 (0.9,1.4)	1.05 (0.8,1.3)	1.18 (0.9,1.5)
High job demands	1.07 (0.8,1.4)	1.38 (1.1,1.8)	1.13 (0.9,1.5)	1.13 (0.9,1.5)	1.36 (1.0,1.8)
WOMEN	Age adjusted	Adjusted for age and grade	Adjusted for age, car and home ownership	Adjusted for age and risk-factors[1]	Adjusted for age, grade, risk factors[1]
Fatal/nonfatal MI	3295 (60)	3295 (60)	3244 (60)	3233 (59)	3233 (59)
Low job demands	1	1	1	1	1
Medium job demands	1.19 (0.7,2.1)	1.29 (0.7,2.3)	1.22 (0.7,2.2)	1.12 (0.6,2.0)	1.17 (0.6,2.1)
High job demands	1.40 (0.7,2.8)	1.65 (0.8,3.5)	1.46 (0.7,2.9)	1.71 (0.9,3.4)	1.84 (0.9,3.9)
Angina	3154 (309)	3154 (309)	3105 (300)	3097 (304)	3097 (304)
Low job demands	1	1	1	1	1
Medium job demands	0.97 (0.8,1.3)	1.05 (0.8,1.4)	1.00 (0.8,1.3)	0.98 (0.8,1.3)	1.04 (0.8,1.4)
High job demands	1.25 (0.9,1.7)	1.50 (1.1,2.1)	1.29 (1.0,1.8)	1.27 (0.9,1.7)	1.47 (1.1,2.0)
CHD (excl. Rose angina)	3254 (152)	3254 (152)	3204 (150)	3193 (149)	3193 (149)
Low job demands	1	1	1	1	1
Medium job demands	0.89 (0.6,1.3)	1.03 (0.7,1.5)	0.93 (0.6,1.3)	0.87 (0.6,1.3)	1.00 (0.7,1.5)
High job demands	1.06 (0.7,1.6)	1.47 (0.9,2.3)	1.12 (0.7,1.7)	1.09 (0.7,1.7)	1.44 (0.9,2.3)

[1] Exercise, smoking, past smoker, body mass index, cholesterol, hypertension.

High job demands was associated with both fatal CHD/non fatal events and all validated CHD events in both men and women, after adjusting for grade (Table 10). Men and women with high job demands also had a higher incidence of angina. Controlling for SES variables other than grade resulted in slightly weaker associations between demand and CHD events. These associations were influenced little by adjustment for traditional coronary risk factors.

There was no association between social support at work and CHD events, in either men or women, before or after adjustment for grade level (Table 11).

Table 11
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 1 to phase 5) by work social supports (phase 1)

	Men		Women	
	Age adjusted	Age and grade adjusted	Age adjusted	Age and grade adjusted
Fatal/nonfatal MI	6728 (248)		3273 (61)	
Low work social support	1	1	1	1
Medium work social support	1.18 (0.9,1.6)	1.26 (0.9,1.7)	1.02 (0.6,1.9)	1.03 (0.6,1.9)
High work social support	1.02 (0.8,1.4)	1.10 (0.8,1.5)	0.94 (0.5,1.7)	0.93 (0.5,1.7)
Angina	6563 (498)		3133 (308)	
Low work social support	1	1	1	1
Medium work social support	0.91 (0.7,1.1)	0.94 (0.8,1.2)	0.93 (0.7,1.2)	0.95 (0.7,1.2)
High work social support	0.82 (0.7,1.0)	0.85 (0.7,1.1)	0.86 (0.7,1.1)	0.86 (0.7,1.1)
CHD (excl. Rose angina)	6651 (431)		3232 (154)	
Low work social support	1	1	1	1
Medium work social support	1.08 (0.9,1.4)	1.14 (0.9,1.4)	0.89 (0.6,1.3)	0.91 (0.6,1.3)
High work social support	0.91 (0.7,1.2)	0.96 (0.8,1.2)	0.90 (0.6,1.3)	0.89 (0.6,1.3)

Table 12 shows the association of effort reward imbalance and incidence of CHD. Both men and women classified as having effort reward imbalance had an increased risk of fatal/non-fatal events and all validated CHD events when compared to those classified as making either high efforts or receiving low rewards. This was also the case for angina in women but not in men. These results were not much affected by adjustment for grade. With the exception of fatal CHD/non-fatal MI in men, the group considered to be receiving high reward but making low efforts had similar or lower risks when compared with the reference group ‘either high effort or low reward’.

Table 12
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 1 to phase 5) by indicator of effort reward imbalance (phase 1)

	Men		Women	
	Age adjusted	Age and grade adjusted	Age adjusted	Age and grade adjusted
Fatal/nonfatal MI	5264 (191)		2451 (43)	
Neither high effort or low reward	1.18 (0.7,2.0)	1.34 (0.8,2.2)	0.42 (0.1,3.1)	0.43 (0.1,3.3)
Either high effort or low reward	1	1	1	1
Both high effort and low reward	1.52 (1.1,2.1)	1.42 (1.0,1.9)	1.51 (0.8,2.8)	1.50 (0.8, 2.8)
Angina	5128 (390)		2339 (225)	
Neither high effort or low reward	0.77 (0.5,1.1)	0.80 (0.5,1.2)	0.48 (0.2,1.1)	0.49 (0.2,1.1)
Either high effort or low reward	1	1	1	1
Both high effort and low reward	1.19 (0.9,1.5)	1.15 (0.9,1.4)	1.44 (1.1,1.9)	1.41 (1.1,1.9)
CHD (excluding Rose angina)	5205 (343)		2420 (107)	
Neither high effort or low reward	1.09 (0.8,1.6)	1.19 (0.8,1.7)	0.17 (0.1,1.2)	0.20 (0.1,1.4)
Either high effort or low reward	1	1	1	1
Both high effort and low reward	1.32 (1.1,1.7)	1.28 (1.0,1.6)	1.57 (1.1,2.3)	1.47 (1.0,2.2)

3.3 THE KARASEK JOB STRAIN MODEL

The next step was to investigate the job strain hypothesis and see if the association of job demands with CHD incidence differed acccording to degree of decision latitude. Given the lack of apparent difference in the association of components of the job strain model and CHD events between men and women, these analyses were conducted on men and women combined. People who simultaneously scored above the median for job demands and below the median for decision latitude, that is had job strain, consistently had the highest risk for CHD events during follow up (Table 13). But high job demands in those with high decision latitude was also associated with an increased risk of incident CHD and there was no evidence for a multiplicative interaction between low decision latitude and high demand in their relation to CHD events. These analyses were repeated within sub-groups stratified by social support at work, but there was no evidence of a strengthened effect of job strain in the low social support at work group (Table 13).

Table 13
Karasek job strain model: Decision latitude and job demands cross-classified for all men and women
and within high and low social supports
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 1 to phase 5)

	Total group (men and women)		Low social support at work		High social support at work	
	Age adjusted	Age and grade adjusted	Age adjusted	Age and grade adjusted	Age adjusted	Age and grade adjusted
Fatal/non fatal MI	10087 (310)	10087 (310)	5690 (172)	5690 (172)	4397 (138)	4397 (138)
Low demand high control	1	1	1	1	1	1
Low demand low control	0.97 (0.7,1.4)	0.68 (0.5,1.0)	0.83 (0.5,1.5)	0.61 (0.3,1.1)	1.19 (0.7,2.0)	0.80 (0.5,1.4)
High demand low control	1.52 (1.1,2.2)	1.32 (0.9,1.9)	1.59 (1.0,2.6)	1.40 (0.9,2.3)	1.39 (0.8,2.4)	1.18 (0.7,2.1)
High demand high control	1.14 (0.8,1.6)	1.34 (0.9,1.9)	1.14 (0.7,1.9)	1.30 (0.8,2.2)	1.14 (0.7,1.8)	1.38 (0.9,2.2)
Interaction between demand and control	p = 0.19	p = 0.13	p = 0.12	p = 0.09	p = 0.95	p = 0.84
Angina	9781 (819)	9781 (819)	5507 (497)	5507 (497)	4274 (322)	4274 (322)
Low demand high control	1	1	1	1	1	1
Low demand low control	1.30 (1.0,1.6)	1.16 (0.9,1.5)	1.27 (0.9,1.8)	1.14 (0.8,1.6)	1.27 (0.9,1.8)	1.11 (0.8,1.6)
High demand low control	1.60 (1.3,2.0)	1.51 (1.2,1.9)	1.50 (1.1,2.1)	1.42 (1.0,2.0)	1.61 (1.1,2.3)	1.52 (1.1,2.2)
High demand high control	1.14 (0.9,1.4)	1.25 (1.0,1.6)	1.12 (0.8,1.5)	1.21 (0.9,1.7)	1.12 (0.8,1.6)	1.24 (0.9,1.7)
Interaction between demand and control	p = 0.60	p = 0.75	p = 0.77	p = 0.90	p = 0.61	p = 0.66
CHD (excl. Rose angina)	9969 (592)	9969 (592)	5621 (351)	5621 (351)	4348 (241)	4348 (241)
Low demand high control	1	1	1	1	1	1
Low demand low control	1.38 (1.0,1.8)	1.06 (0.8,1.4)	1.43 (1.0,2.1)	1.10 (0.7,1.7)	1.30 (0.9,2.0)	0.99 (0.6,1.5)
High demand low control	1.64 (1.2,2.2)	1.47 (1.1,1.9)	1.65 (1.1,2.4)	1.48 (1.0,2.2)	1.55 (1.0,2.4)	1.39 (0.9,2.1)
High demand high control	1.19 (0.9,1.6)	1.32 (1.0,1.7)	1.23 (0.8,1.8)	1.32 (0.9,2.0)	1.12 (0.8,1.6)	1.29 (0.9,1.9)
Interaction between demand and control	p = 0.99	p = 0.77	p = 0.78	p = 0.96	p = 0.82	p = 0.77

3.4 WORK CHARACTERISTICS WITHIN EMPLOYMENT GRADE AND AGEGROUP

Analyses were repeated within grade as adverse work psychosocial risk factors may have more of an impact on health in low employment grades. There was a tendency for associations between job demands and incident CHD to be stronger in the clerical grades than in other grades but the interaction between job demands and employment grade was not significant (Table 14). Job strain appeared to be more deleterious with respect to risk of fatal CHD/non-fatal MI among clerical workers than either professionals or administrative workers (Table 15).

Job demands and decision latitude were most closely related to CHD risk during follow up in the youngest age group (Table 16).

Table 14
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 1 to phase 5) by job demands (phase 1) within employment grade, adjusted for age and sex

	Clerical	SEO,HEO,EO	UG1-UG7
Fatal/non fatal MI	2220 (74)	4841 (146)	2972 (88)
Low demand	1	1	1
Medium demand	2.11 (1.3,3.5)	1.20 (0.8,1.8)	1.98 (0.9,4.4)
High demand	2.86 (1.4,5.6)	1.42 (0.9,2.2)	1.61 (0.7,3.6)
Angina	2130 (219)	4694 (387)	2903 (203)
Low demand	1	1	1
Medium demand	0.96 (0.7,1.3)	1.07 (0.8,1.4)	0.94 (0.6,1.5)
High demand	1.10 (0.7,1.7)	1.39 (1.1,1.8)	1.15 (0.8,1.8)
CHD (excl. Rose angina)	2181 (153)	4794 (263)	2940 (169)
Low demand	1	1	1
Medium demand	1.08 (0.8,1.5)	1.12 (0.8,1.5)	1.12 (0.7,1.9)
High demand	1.67 (1.0,2.7)	1.23 (0.9,1.7)	1.27 (0.8,2.1)

Table 15
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 1 to phase 5) by cross-classified decision latitude and job demands (Karasek job strain model) within employment grade, adjusted for age and sex

	Clerical	SEO,HEO,EO	UG1-UG7
Fatal/non fatal MI	1385 (42)	3723 (116)	3156 (91)
Low demand high control	1	1	1
Low demand low control	1.29 (0.3,5.5)	0.72 (0.4,1.3)	0.34 (0.1,1.5)
High demand low control	2.34 (0.5,10.3)	1.44 (0.8,2.5)	1.37 (0.7,2.8)
High demand high control	1.84 (0.3,13.1)	1.27 (0.7,2.2)	1.20 (0.7,2.2)
Interaction between demand and control	p = 0.99	p = 0.24	p = 0.13
Angina	1326 (168)	3607 (351)	3082 (227)
Low demand high control	1	1	1
Low demand low control	1.05 (0.6,2.0)	1.27 (0.9,1.8)	1.10 (0.6,2.0)
High demand low control	1.36 (0.7,2.6)	1.63 (1.2,2.3)	1.44 (0.9,2.2)
High demand high control	0.75 (0.2,2.4)	1.40 (1.0,2.0)	1.05 (0.7,1.5)
Interaction between demand and control	p = 0.38	p = 0.70	p = 0.54
CHD (excl. Rose angina)	1357 (105)	3689 (226)	3125 (177)
Low demand high control	1	1	1
Low demand low control	2.01 (0.7,5.5)	1.24 (0.8,1.9)	0.67 (0.3,1.5)
High demand low control	2.08 (0.7,6.0)	1.83 (1.2,2.8)	1.48 (0.9,2.5)
High demand high control	1.98 (0.5,8.0)	1.44 (0.9,2.2)	1.14 (0.7,1.7)
Interaction between demand and control	p = 0.38	p = 0.93	p = 0.15

Table 16
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 1 to phase 5) by cross,classified decision latitude and job demands (Karasek job strain model) within agegroup, adjusted for age and employment grade

	Age 35-39	Age 40-44	Age 45-49	Age 50-55
Fatal CHD/ non-fatal MI	2761 (43)	2613 (40)	2055 (84)	2658 (143)
Low demand high control	1	1	1	1
Low demand low control	1.52 (0.5,5.1)	0.41 (0.1,1.4)	0.71 (0.3,1.5)	0.60 (0.3,1.1)
High demand low control	1.56 (0.5,5.0)	1.53 (0.6,4.0)	1.20 (0.6,2.4)	1.26 (0.7,2.2)
High demand high control	2.32 (0.8,7.0)	1.26 (0.5,3.3)	1.29 (0.7,2.5)	1.18 (0.7,2.0)
Angina	2699 (138)	2540 (172)	1989 (193)	2553 (316)
Low demand high control	1	1	1	1
Low demand low control	1.52 (0.8,2.9)	1.08 (0.6,1.9)	1.33 (0.8,2.2)	1.03 (0.7,1.5)
High demand low control	2.05 (1.1,3.7)	1.39 (0.8,2.4)	1.64 (1.0,2.6)	1.34 (0.9,2.0)
High demand high control	1.32 (0.7,2.5)	1.42 (0.8,2.4)	1.07 (0.7,1.7)	1.28 (0.9,1.8)
CHD (excl. Rose angina)	2752 (87)	2595 (102)	2023 (146)	2599 (257)
Low demand high control	1	1	1	1
Low demand low control	1.76 (0.8,4.0)	1.09 (0.5,2.3)	1.14 (0.6,2.0)	0.88 (0.6,1.4)
High demand low control	2.24 (1.0,4.9)	1.84 (0.9,3.7)	1.41 (0.8,2.5)	1.21 (0.8,1.8)
High demand high control	1.53 (0.7,3.5)	1.59 (0.8,3.2)	1.39 (0.8,2.4)	1.17 (0.8,1.8)

3.5 INCIDENCE IN RELATION TO MEASUREMENT OF WORK CHARACTERISTICS AT DIFFERENT PHASES: DOES RISK RELATE TO TIME SINCE EXPOSURE?

Low decision latitude measured at phase 1, 2 or 3 had approximately the same association with incidence of fatal CHD/non-fatal MI between phases 3 and 5, but low decision latitude measured at phase 1 was most closely related to all CHD events between phases 3 and 5 (Table 17). Conversely, high job demands were most strongly associated with fatal CHD/non-fatal MI when measured at phase 1, but job demands measured at any of phases 1, 2 or 3 had approximately the same association with all CHD incidence during follow up.

Table 17
Hazard ratios (95% confidence intervals) for incidence of coronary heart disease (phase 3 to phase 5) by decision latitude and job demands, measured at phases 1, 2, and 3[1].

	Phase 1 predictors		Phase 2 predictors		Phase 3 predictors		Mean of three phases predictors	
	Age adjusted	Age and grade adjusted	Age adjusted	Age and grade adjusted	Age adjusted	Age and grade adjusted	Age adjusted	Age and grade adjusted
Fatal/non fatal MI	6318 (132)	6318 (132)	6318 (132)	6318 (132)	6318 (132)	6318 (132)	6318 (132)	6318 (132)
Decision latitude								
Low	1.47 (0.9,2.3)	1.18 (0.7,2.0)	1.51 (1.0,2.3)	1.18 (0.7,2.0)	1.43 (0.9,2.2)	1.12 (0.7,1.8)	1.37 (0.9,2.1)	1.02 (0.6,1.7)
Medium	1.29 (0.8,2.0)	1.12 (0.7,1.7)	1.30 (0.9,2.0)	1.11 (0.7,1.7)	0.96 (0.6,1.5)	0.83 (0.5,1.3)	1.06 (0.7,1.6)	0.89 (0.6,1.4)
High	1	1	1	1	1	1	1	1
p for trend	0.08	0.50	0.06	0.52	0.13	0.77	0.16	0.97
Fatal/non fatal MI	6378 (132)	6378 (132)	6378 (132)	6378 (132)	6378 (132)	6378 (132)	6378 (132)	6378 (132)
Job demands								
Low	1	1	1	1	1	1	1	1
Medium	1.74 (1.1,2.8)	1.98 (1.2,3.2)	1.01 (0.6,1.6)	1.11 (0.7,1.8)	1.11 (0.7,1.7)	1.18 (0.8,1.8)	1.28 (0.8,1.9)	1.44 (0.9,2.2)
High	1.42 (0.8,2.4)	1.89 (1.1,3.2)	0.89 (0.6,1.4)	1.11 (0.7,1.8)	0.67 (0.4,1.1)	0.80 (0.5,1.4)	0.90 (0.6,1.4)	1.16 (0.7,1.9)
p for trend	0.26	0.03	0.58	0.71	0.09	0.37	0.62	0.54
All CHD	5880 (347)	5880 (347)	5880 (347)	5880 (347)	5880 (347)	5880 (347)	5880 (347)	5880 (347)
Decision latitude								
Low	1.26 (1.0,1.7)	1.11 (0.8,1.5)	1.17 (0.9,1.5)	0.96 (0.7,1.3)	1.03 (0.8,1.4)	0.81 (0.6,1.1)	1.23 (0.9,1.6)	1.02 (0.7,1.4)
Medium	1.17 (0.9,1.5)	1.07 (0.8,1.4)	1.14 (0.9,1.5)	1.02 (0.8,1.3)	1.15 (0.9,1.5)	1.01 (0.8,1.3)	1.11 (0.8,1.4)	0.99 (0.7,1.3)
High	1	1	1	1	1	1	1	1
p for trend	0.09	0.52	0.25	0.84	0.73	0.25	0.13	0.91
All CHD	5935 (348)	5935 (348)	5935 (348)	5935 (348)	5935 (348)	5935 (348)	5935 (348)	5935 (348)
Job demands								
Low	1	1	1	1	1	1	1	1
Medium	1.10 (0.8,1.4)	1.17 (0.9,1.5)	1.12 (0.8,1.5)	1.19 (0.9,1.6)	1.16 (0.9,1.5)	1.21 (0.9,1.6)	1.05 (0.8,1.4)	1.14 (0.9,1.5)
High	1.04 (0.8,1.4)	1.21 (0.9,1.6)	1.20 (0.9,1.6)	1.40 (1.0,1.9)	1.04 (0.8,1.4)	1.19 (0.9,1.7)	1.17 (0.9,1.5)	1.44 (1.1,1.9)
p for trend	0.77	0.22	0.24	0.03	0.91	0.32	0.23	0.01

[1] Analysis restricted to those who had data on work characteristics at all three phases

3.6 DISCUSSION

In summary, we found that job demands were associated with incident coronary heart disease. This was not explained by health behaviours or other conventional risk factors such as blood pressure. Low decision latitude was related to increased incidence of angina independent of employment grade but not related to validated CHD events after adjustment for employment grade. Effort reward imbalance predicted increased risk of CHD in both men and women.

The original Karasek hypothesis (Karasek,1979) was that high demands would only be associated with ill-health in those with low decision latitude. There was little evidence to support any interactive effect of decision latitude and job demands with high job demands predicting increased incidence of CHD in both those with low and with high decision latitude. This is consistent with earlier Whitehall II findings for self report measures which suggest that adverse effects of job demands and decision latitude are independent.

As hypothesised, the association between psychosocial risk factors and incident CHD may be stronger among people who are in the lower employment grades, although both job demands and job strain predict CHD events in all employment grades thus indicating that the association between these work risks and CHD events is not a consequence of confounding by grade. There was no clear evidence that poor work conditions at a particular time were particularly strongly related to risk of CHD events.

These results are largely consistent with previous findings from the Whitehall II study. However, contrary to a previous report (Bosma et al, 1997) high job demands appeared to be a more important predictor of CHD events than was apparent based on the earlier phases of the study. This earlier report was consistent with the review by Schnall et al (1994), who found that out of 25 studies investigated, job control was significantly associated with cardiovascular events in 17 studies, but job demand in only 8 of 23 studies. Other studies, however, have supported our present finding that both high demand and low decision latitude(Karasek et al, 1981; Hammar et al, 1994; Johnson and Hall, 1988) and job strain (Haan, 1988; Johnson and Hall, 1988; Falk, 1992; Alterman et al, 1994; Hammar et al, 1994; Sacker et al, 2001) are associated with increased risk of CHD. Furthermore, here we report no apparent cumulative effect of job characteristics on incident CHD, which is contrary to earlier publications from Whitehall II (Bosma et al, 1997), but in support of other researchers investigating this question (Johnson et al, 1996).

The lack of difference in these associations between men and women is consistent with the findings of the review by Schnall et al (1994) which found no evidence of effect modification by sex of the association between work characteristics and CHD events. Moreover, the results of this study do not support the hypothesis that low social networks further increases risks among individuals in a state of job strain (Johnson and Hall, 1988; Falk, 1992), although it lends some support to the idea that the effect of job strain may be stronger at younger age groups (Alfredsson et al, 1982; Alfredsson et al, 1985; Karasek et al, 1988), and among lower employment grades (Johnson and Hall, 1988; Johnson et al, 1989; Karasek et al, 1981; La Croix and Haynes, 1984; Lynch et al, 1997).

Chance is an unlikely explanation for our findings, since both high demand and low decision latitude were separately predictors of CHD events. Furthermore, the effect was found in both men and women and at different time points. Bias can be invoked as an explanation for our findings, if it can be argued that more susceptible people may choose to work in jobs with low control or high demands. Self-report bias, or negative affectivity, is unlikely to explain our results, since we used validated events as our outcomes. Bias due to loss to follow up is also an unlikely explanation of our results, since the rate of follow up was very high and loss to follow up did not influence these associations.

Confounding by baseline characteristics could go some way to explaining the association between work characteristics and CHD events but as controlling for risk factors had little impact on the results we feel that uncontrolled confounding by traditional coronary heart disease risk factors probably cannot explain our findings entirely. Furthermore, there could be confounding of the associations between psychosocial work characteristics and CHD events by other psychosocial variables (Williams et al, 1997). This is not likely since Bosma reported from the Whitehall II study that psychological attributes, including hostility, negative affectivity and minor psychiatric disorders, could not explain the association between low decision latitude and self-reported incidence of CHD (Bosma et al, 1998).

The association between psychosocial work risk factors such as job demands and coronary heart disease may be causal. The effect may be through neuroendocrine mechanisms affecting

blood lipids and blood pressure variation, or neuroendocrine mechanisms that do not affect blood lipids and blood pressure variation. Moreover, stresses arising from adverse work environtment could exert their influence through modification of future coronary heart disease risk factors, such as deleterious changes in smoking, exercise and dietary patterns, which in turn influence risk of CHD events.

Within the Whitehall II study low decision latitude is more common in the lower employment grades, but high job demands were more common in the highest employment grades. This creates a fundamental problem of whether or not to adjust for grade, since controlling for employment grade could be over-adjustment with respect to decision latitude, but necessary with respect to job demands. Thus , we also adjusted for other measures of socio-economic status, car and home ownership as these variables are less highly colinear with work characteristics. It may be that the true association between work characteristics and CHD events is in between the grade adjusted and unadjusted estimates, and so close to estimates in the socio-economic status adjusted analyses. However, these alternative measures of socioeconomic status may not adequately reflect social class in a London based cohort.

There are specific limitations to the Karasek model and other potential sources of stress, such as low pay or job insecurity, are ignored. Siegrist and his colleagues (1990) argued that this model does not take account of individual variation in coping characteristics, or 'need for control'. They therefore set out a modified theory based on effort and reward imbalance, where the mismatch between high workload and low status control was tempered by individual need for control. We constructed an indicator of effort reward imbalance based on information collected at baseline and this was associated with incident CHD. More recently, we included questions on effort reward imbalance from the Siegrist model in our phase 5 questionnaire and we plan to examine whether this better measure of effort reward imbalance is also related to health.

4 CHANGE IN WORK CHARACTERISTICS

We have previously reported associations between psychosocial risk factors and both physical and mental health functioning (Stansfeld et al 1998, Stansfeld et al 2000). Here , we extend this to look at change in reported work characteristics in relation to health. Longitudinal analyses of change in work characteristics may inform us about the pathways underlying these relationships and so inform policy.

Since the Whitehall II cohort was recruited, there has been considerable organisational change in the Civil Service, with many civil servants transferred to Executive Agencies. This appeared to be reflected in the changes seen in self-report work characteristics in the cohort, with an increasing tendency to report greater job demands, less social support and more decision latitude.

4.1 CHANGE IN WORK CHARACTERISTICS AND PHYSICAL AND MENTAL HEALTH FUNCTIONING IN 1991-1993

The SF-36 General Health Survey (Stewart et al, 1998; Ware & Sherbourne, 1992) was included at phases 3, 4 and 5 and provides analysis of physical, psychological and social functioning which indicate how illness influences a person's everyday life. In this analysis, we analyse two summary component scores relating to physical and mental health. These scores are more normally distributed than scores from the eight SF36 subscales. Low component summary scores imply low functioning and a mean of 50 is observed in the general US population.

Self reported work characteristic scores from phases 1 and 2 were compared and people classified into one of three groups:

- stable work characteristics
- declining (decline of more than 10 scale points)
- increasing (increase of more than 10 scale points).

Decline in decision latitude and social supports scores would be considered an adverse change whereas decline in job demands score would be considered a beneficial change.

Table 18 shows the association of work change to phase 3 physical and mental health functioning measured in men. Results for three analyses are presented, the first adjusting for age only, the second additionally adjusting for the corresponding baseline phase 1 work characteristic, the third additionally adjusting for pre-existing baseline ill-health, and fourth additionally adjusting for employment grade. Changes in decision latitude, job demands and social supports were related to subsequent mental health functioning in the direction expected and this association remained after adjustment for baseline work, baseline health and employment grade. However, changes in work were not much associated with physical functioning at phase 3.

Table 18
The effects of change in work characteristics from 1985-88 (phase 1) to 1989 (phase 2) on physical and mental health functioning in 1991-1993 (phase 3) in men

	no. of sub-jects	mean change in work score	Physical component summary					Mental component summary				
			Crude mean	Adjusted difference in mean[1]				Crude mean	Adjusted difference in mean[1]			
				Age adjusted	+ baseline work[2]	+ baseline health[3]	+ grade		age adjusted	+ baseline work[2]	+ baseline health[3]	+ grade
Decision latitude												
Stable	3193	0.17	53.50	0	0	0	0	51.70	0	0	0	0
Decline	618	-15.78	53.91	0.42	0.31	0.52	0.58*	50.33	-1.38*	-1.66*	-1.22*	-1.33*
Increase	877	16.97	53.42	-0.22	0.20	0.20	0.15	50.74	-0.64*	0.45	0.67*	0.76*
Job demands												
Stable	2400	0.55	53.65	0	0	0	0	51.45	0	0	0	0
Decline	907	-23.73	53.42	-0.26	-0.13	-0.15	-0.07	51.58	0.19	0.64	0.66*	0.70*
Increase	1381	24.85	53.44	-0.23	-0.37	-0.27	-0.32	50.99	-0.39	-0.84*	-0.56*	-0.58*
Support at work												
Stable	1895	-0.17	53.48	0	0	0	0	51.84	0	0	0	0
Decline	1504	-20.60	53.57	0.09	-0.02	0.06	0.06	50.85	-0.94*	-1.36*	-1.22*	-1.22*
Increase	1289	21.02	53.59	0.10	0.37	0.11	0.13	51.18	-0.59	0.76*	0.41	0.41

[1] Difference in mean functioning relative to stable group ; a positive difference indicates a relative improvement in functioning;
* = difference is statistically significant ($p<0.05$)

[2] adjusted for age, duration of follow up and corresponding baseline work characteristic

[3] adjusted for age, duration of follow up, corresponding baseline work characteristic and baseline perceived health, GHQ score and presence of coronary heart disease symptoms

Partly similar patterns were seen for women for mental health functioning; in particular, changes in social support were relatively strongly and consistently related to functioning (Table 19). However, changes in job demands were not consistently related to mental health functioning. Changes in job demands and support at work were associated with physical functioning in the expected direction.

Table 19
The effects of change in work characteristics from 1985-88 (phase 1) to 1989 (phase 2) on physical and mental health functioning in 1991-1993 (phase 3) in women

			Physical component summary					Mental component summary				
	number of subjects	mean change in work score	Crude mean	Adjusted difference in mean[1]				Crude mean	Adjusted difference in mean[1]			
				Age adjusted	+ baseline work[2]	+ baseline health[3]	+ grade		age adjusted	+ baseline work[2]	+ baseline health[3]	+ grade
Decision latitude												
Stable	1138	0.39	50.49	0	0	0	0	50.51	0	0	0	0
Decline	311	-17.93	50.78	0.42	0.29	0.49	0.62	50.64	-0.11	-0.25	-0.14	-0.34
Increase	536	18.47	50.95	0.52	1.00*	0.72	0.65	49.56	-0.86	-0.46	-0.65	-0.53
Job demands												
Stable	904	0.69	50.79	0	0	0	0	50.46	0	0	0	0
Decline	357	-25.12	51.06	0.26	0.57	0.71	0.86	49.61	-0.94	-0.08	-0.20	-0.15
Increase	724	26.00	50.31	-0.40	-0.71	-0.51	-0.56	50.38	-0.21	-1.13*	-0.66	-0.65
Support at work												
Stable	722	-0.32	50.92	0	0	0	0	50.49	0	0	0	0
Decline	672	-22.86	49.96	-0.94*	-1.19*	-0.59	-0.60	49.78	-0.63	-0.96*	-0.59	-0.60
Increase	591	23.55	51.15	0.18	0.76	0.70	0.73	50.57	0.18	1.64*	1.39*	1.33*

[1] Difference in mean functioning relative to stable group ;
* = difference is statistically significant ($p<0.05$)

[2] adjusted for age, duration of follow up and corresponding baseline work characteristic

[3] adjusted for age, duration of follow up, corresponding baseline work characteristic and baseline perceived health, GHQ score and presence of coronary heart disease symptoms

We further investigated the effect of change in work characteristics by classifying people into four groups as follows:

High decision latitude at both phases 1 and 2 (high score defined as being above the median)
High decision latitude at phase 1/ low decision latitude at phase 2
Low decision latitude at phase 1/high decision latitude at phase 2
Low decision latitude at both phases 1 and 2

Change in job demands and work social supports were grouped in a similar fashion.

In both men and women (Tables 20 and 21), these results confirm most of the results obtained in the previous two tables. For example, those with high support at work on both occasions had better mental health functioning than those whose scores moved from high to low. Also, improvements in work support were associated with better mental health functioning.

Table 20
The effects of change in work characteristics from 1985-88 (phase 1) to 1989 (phase 2) on physical and mental health functioning in 1991-1993 (phase 3) in men

	Physical component score				Mental component score			
	Crude Mean	Adjusted difference in mean[2]			Crude Mean	Adjusted difference in mean[2]		
		Age adjusted	+ baseline health[3]	+ grade		Age adjusted	+ baseline health[3]	+ grade
Decision latitude[1]								
High-high (n=2269)	53.81	0	0	0	52.44	0	0	0
High-low (n=490)	53.56	-0.28	0.22	0.30	50.33	-2.09*	-1.41*	-1.51*
Low-high(n=633)	53.43	0.58*	-0.10	0.00	51.20	-0.90*	-0.15	-0.30
Low-low (n=1296)	53.12	-0.81*	-0.23	-0.03	49.85	-2.40*	-1.68*	-2.00*
Job demands								
High-high (n=2410)	53.42	0	0	0	50.98	0	0	0
High-low (n=520)	53.76	0.32	0.23	0.33	51.73	0.76	0.48	0.49
Low-high(n=816)	53.67	0.23	0.13	0.23	51.45	0.51	-0.08	-0.07
Low-low (n=942)	53.62	0.24	0.07	0.27	51.94	0.86*	0.06	0.09
Support at work								
High-high (n=1242)	53.79	0	0	0	52.99	0	0	0
High-low (n=877)	53.73	-0.09	-0.02	-0.03	51.06	-1.81*	-1.71*	-1.71*
Low-high(n=736)	53.76	-0.06	0.15	0.16	51.56	-1.32*	-0.67*	-0.67*
Low-low (n=1833)	53.19	-0.65*	-0.09	-0.07	50.26	-2.61*	-1.49*	-1.49*

[1] The cutpoint for low-high work characteristics was the 50th percentile for men and women together (decision latitude score = 67.59, job demands = 58.33, support at work = 77.78)

[2] Difference in mean functioning relative to those with high work score on both occasions ;
* = difference is statistically significant ($p<0.05$)

[3] adjusted for age, duration of follow up and baseline perceived health, GHQ score and presence of coronary heart disease symptoms

Table 21
The effects of change in work characteristics from 1985-88 (phase 1) to 1989 (phase 2) on physical and mental health unctioning in 1991-1993 (phase 3) in women

	Physical component score				Mental component score			
	Crude Mean	Adjusted difference in mean[2]			Crude Mean	Adjusted difference in mean[2]		
		Age adjusted	+ baseline health[3]	+ grade		Age adjusted	+ baseline health[3]	+ grade
Decision latitude[1]								
High-high (n=457)	51.00	0	0	0	50.59	0	0	0
High-low (n=195)	51.30	0.57	1.00	1.25	50.94	-0.05	0.06	-0.18
Low-high (n=280)	51.38	0.67	1.32*	1.61*	49.86	-0.88	-0.70	-1.04
Low-low (n=1053)	50.21	-0.28	0.62	1.10*	50.13	-1.11*	-0.81	-1.54*
Job demands								
High-high (n=716)	50.57	0	0	0	48.93	0	0	0
High-low (n=217)	50.90	0.48	0.37	0.49	49.97	0.99	0.28	0.27
Low-high (n=451)	50.14	-0.11	-0.33	-0.16	50.43	1.19*	0.49	0.41
Low-low (n=601)	51.07	0.86	0.45	0.70	51.88	2.57*	1.26*	1.13*
Support at work								
High-high (n=513)	51.52	0	0	0	51.99	0	0	0
High-low (n=333)	50.77	-0.85	-0.48	-0.52	49.94	-1.80*	-1.30*	-1.27*
Low-high (n=313)	51.31	-0.34	0.06	0.08	50.86	-0.84	-0.45	-0.47
Low-low (n=826)	49.84	-1.53*	-0.46	-0.48	49.13	-2.98*	-1.62*	-1.57*

[1] The cutpoint for low-high work characteristics was the 50th percentile for men and women together (decision latitude score = 67.59, job demands = 58.33, support at work = 77.78)

[2] Difference in mean functioning relative to those with high work score on both occasions ;
* = difference is statistically significant ($p<0.05$)

3 adjusted for age, duration of follow up and baseline perceived health, GHQ score and presence of coronary heart disease symptoms

4.2 CHANGE IN WORK CHARACTERISTICS AND PHYSICAL AND MENTAL HEALTH FUNCTIONING IN 1995

We next investigated whether these associations between change and mental health functioning were apparent over a longer period by repeating the analyses using functioning measured at phase 4. It may also be that influences on physical health may only appear in the longer term.

Tables 22 and 23 show the results of these analyses for men and women respectively. There was still an association with mental health functioning over this longer follow up for the work characteristics mentioned previously. In addition, there were associations between some work dimensions and physical functioning, particularly among women. For example, those men and women with beneficial changes in job demands and support at work tended to have better physical functioning scores than those whose status remained the same. This was not fully explained by adjustment for baseline health and employment grade.

Table 22
The effects of change in work characteristics from 1985-88 (phase 1) to 1989 (phase 2) on physical and mental health functioning in 1995 (phase 4) in men

	Physical component score				Mental component score			
	Crude Mean	Adjusted difference in mean[2]			Crude Mean	Adjusted difference in mean[2]		
		Age adjusted	+ baseline health[3]	+ grade		Age adjusted	+ baseline health[3]	+ grade
Decision latitude[1]								
High-high (n=2075)	52.69	0	0	0	51.66	0	0	0
High-low (n=442)	51.98	-0.71	-0.15	-0.08	49.22	-2.40*	-1.69*	-1.63*
Low-high (n=574)	51.99	0.93*	-0.41	-0.32	50.11	-1.00*	-0.27	-0.19
Low-low (n=1149)	51.51	-1.34*	-0.72*	-0.48	48.61	-2.68	-2.01*	-1.84*
Job demands								
High-high (n=2193)	51.85	0	0	0	50.02	0	0	0
High-low (n=472)	52.36	0.50	0.34	0.52	50.71	0.71	0.42	0.64
Low-high (n=743)	52.61	0.71*	0.50	0.67*	50.53	0.59	-0.15	0.06
Low-low (n=832)	52.65	0.85*	0.59*	0.94*	50.95	0.84*	-0.07	0.33
Support at work								
High-high (n=1134)	52.61	0	0	0	52.07	0	0	0
High-low (n=788)	52.59	-0.08	0.04	0.03	50.78	-1.08*	-0.90*	-0.92*
Low-high (n=671)	52.71	0.03	0.24	0.27	50.63	-1.24*	-0.62	-0.58
Low-low (n=1647)	51.52	-1.17*	-0.50	-0.46	48.90	-3.00*	-1.78*	-1.75*

[1] The cutpoint for low-high work characteristics was the 50th percentile for men and women together (decision latitude score = 67.59, job demands = 58.33, support at work = 77.78)

[2] Difference in mean functioning relative to those with high work score on both occasions ;
* = difference is statistically significant ($p<0.05$)

[3] adjusted for age, duration of follow up and baseline perceived health, GHQ score and presence of coronary heart disease symptoms

Table 23
The effects of change in work characteristics from 1985-88 (phase 1) to 1989 (phase 2) on physical and mental health functioning in 1995 (phase 4) in women

	Physical component score				Mental component score			
	Crude Mean	Adjusted difference in mean[2]			Crude Mean	Adjusted difference in mean[2]		
		Age adjusted	+ baseline health[3]	+ grade		Age adjusted	+ baseline health[3]	+ grade
Decision latitude[1]								
High-high (n=416)	50.36	0	0	0	50.28	0	0	0
High-low (n=170)	50.49	0.41	0.66	1.16	48.96	-1.61	-1.58	-1.73
Low-high (n=249)	49.74	-0.29	0.10	0.68	48.20	-2.32*	-2.19*	-2.41*
Low-low (n=904)	48.56	-1.28*	-0.46	0.52	48.99	-2.08*	-1.72*	-2.31*
Job demands								
High-high (n=637)	49.04	0	0	0	47.75	0	0	0
High-low (n=192)	49.43	0.59	0.55	1.00	49.03	1.20	0.64	0.79
Low-high (n=386)	49.06	0.41	0.06	0.72	49.06	0.79	0.10	0.22
Low-low (n=524)	49.92	1.34*	0.85	1.79*	51.07	2.89*	1.67*	1.80*
Support at work								
High-high (n=452)	50.61	0	0	0	50.62	0	0	0
High-low (n=299)	49.42	-1.28	-0.71	-0.82	48.19	-2.17*	-1.63*	-1.66*
Low-high (n=266)	50.50	-0.20	0.42	0.47	50.95	0.51	0.94	0.94
Low-low (n=722)	48.11	-2.29*	-1.07*	-1.17*	48.04	-2.74*	-1.41*	-1.38*

[1] The cutpoint for low-high work characteristics was the 50th percentile for men and women together (decision latitude score = 67.59, job demands = 58.33, support at work = 77.78)

[2] Difference in mean functioning relative to those with high work score on both occasions ;
* = difference is statistically significant ($p<0.05$)

[3] adjusted for age, duration of follow up and baseline perceived health, GHQ score and presence of coronary heart disease symptoms

4.3 CHANGE IN WORK CHARACTERISTICS AND LONGSTANDING ILLNESS

We repeated analyses using an alternative measure, presence or absence of longstanding illness. This question was included at all phases of the study and is similar to the question included in the Census and other national surveys. Tables 24 and 25 show the association between change in work and longstanding illness at each of phases 2, 3 and 4. There is little or no association between change in work and longstanding illness at phase 2 but by phase 4, some significant differences have emerged. Men whose decision latitude score changed from high to low between phases 1 and 2 were at greater risk of reporting a longstanding illness by phase 4 compared to those whose decision latitude was high on both occasions. Also, adverse changes in job demands led to increased reporting of longstanding illness among men, but among women change in work was not associated with longstanding illness.

Table 24
Odds ratios for longstanding illness in 1989 (phase 2), 1991-93 (phase 3), 1995 (phase 4) by change in work characteristics from 1985-88 (phase 1) to 1989 (phase 2) in men

	1989 Odds ratios			1991-1993 Odds ratios			1995 Odds ratios		
	Age-adjusted	+ baseline health[1]	+ grade	Age-adjusted	+ baseline health[1]	+ grade	Age-adjusted	+ baseline health[1]	+ grade
Decision latitude									
High-high (n=2268)	1	1	1	1	1	1	1	1	1
High-low (n=490)	1.20	1.02	1.03	1.33*	1.16	1.20	1.48*	1.32*	1.32*
Low-high (n=633)	1.13	0.96	0.97	1.18	1.02	1.07	1.19	1.05	1.05
Low-low (n=1296)	1.20*	1.00	1.00	1.25*	1.06	1.14	1.20*	1.05	1.04
Job demands									
High-high (n=2410)	1	1	1	1	1	1	1	1	1
High-low (n=520)	0.94	0.97	0.97	0.88	0.91	0.93	0.97	1.00	0.99
Low-high (n=815)	0.85	0.86	0.86	0.88	0.91	0.93	0.99	1.05	1.04
Low-low (n=942)	0.87	0.91	0.90	0.85*	0.90	0.94	0.76*	0.81*	0.79*
Support at work									
High-high (n=1242)	1	1	1	1	1	1	1	1	1
High-low (n=877)	1.13	1.13	1.13	1.26*	1.26*	1.25*	1.09	1.06	1.06
Low-high (n=735)	1.07	1.00	1.00	1.21	1.13	1.13	1.05	0.98	0.98
Low-low (n=1833)	1.16	0.97	0.97	1.21*	1.00	1.01	1.20*	1.02	1.02

[1] Adjusted for age, duration of follow up and baseline perceived health, GHQ score and presence of coronary heart disease symptoms

Table 25
Odds ratios for longstanding illness in 1989 (phase 2), 1991-93 (phase 3), 1995 (phase 4) by change in work characteristics from 1985-88 (phase 1) to 1989 (phase 2) in women

	1989 Odds ratios			1991-1993 Odds ratios			1995 Odds ratios		
	Age-adjusted	+ baseline health[1]	+ grade	Age-adjusted	+ baseline health[1]	+ grade	Age-adjusted	+ baseline health[1]	+ grade
Decision latitude									
High-high (n=457)	1	1	1	1	1	1	1	1	1
High-low (n=195)	1.03	0.95	0.95	0.74	0.66*	0.67*	1.05	0.99	1.04
Low-high (n=279)	0.89	0.79	0.80	0.92	0.84	0.85	0.99	0.94	1.00
Low-low (n=1052)	1.06	0.90	0.99	0.89	0.75*	0.79	1.18	1.04	1.23
Job demands									
High-high (n=716)	1	1	1	1	1	1	1	1	1
High-low (n=217)	0.88	0.89	0.89	0.85	0.88	0.91	0.83	0.88	0.90
Low-high (n=450)	0.80	0.82	0.84	0.74*	0.78	0.81	0.83	0.88	0.93
Low-low (n=600)	0.68*	0.72*	0.75*	0.73*	0.82	0.88	0.73*	0.82	0.89
Support at work									
High-high (n=513)	1	1	1	1	1	1	1	1	1
High-low (n=333)	1.31	1.24	1.23	1.11	1.00	0.98	1.28	1.14	1.13
Low-high (n=312)	0.86	0.77	0.77	1.12	1.02	1.02	1.23	1.12	1.13
Low-low (n=825)	1.45*	1.19	1.18	1.50*	1.19	1.18	1.59*	1.26	1.24

[1] Adjusted for age, duration of follow up and baseline perceived health, GHQ score and presence of coronary heart disease symptoms

4.4 CHANGE IN WORK CHARACTERISTICS AND INCIDENCE OF CORONARY HEART DISEASE

Finally, we examined the relation between changes in work characteristics and incidence of CHD, post phase 3. Increasing levels of social support at work between phases 1 and 3 were protective for risk of fatal CHD/non-fatal MI after phase 3, and decreasing levels of social support at work increased risk of all CHD (Table 26). Changing levels of decision latitude and job demands were generally unrelated to risk for CHD events; falling levels of demands seemed to predict fatal CHD/non-fatal MI incidence, but this association largely disappeared after adjustment for grade.

Table 26
Hazard ratios (95% confidence interval) for incidence of coronary heart disease (phase 3 to phase 5)
by change in work characteristics between phases 1 and 3 (classified as stable, increasing or decreasing)

	Decision latitude		Job demands		Social support at work	
	Age and baseline work adjusted	Age, grade and baseline work adjusted	Age and baseline work adjusted	Age, grade and baseline work adjusted	Age and baseline work adjusted	Age, grade and baseline work adjusted
Fatal/non fatal MI	7235 (146)	7235 (146)	7282 (145)	7282 (145)	7198 (145)	7198 (145)
Work characteristic						
Decreasing	0.95 (0.6,1.6)	0.89 (0.5,1.5)	1.40 (0.9,2.1)	1.28 (0.9,1.9)	0.93 (0.6,1.4)	0.93 (0.6,1.4)
Stable	1	1	1	1	1	1
Increasing	1.07 (0.7,1.6)	1.10 (0.7,1.7)	0.95 (0.6,1.5)	1.01 (0.7,1.6)	0.64 (0.4,1.0)	0.63 (0.4,1.0)
Angina	6788 (326)	6788 (326)	6832 (327)	6832 (327)	6754 (324)	6754 (324)
Work characteristic						
Decreasing	1.12 (0.8,1.6)	1.08 (0.8,1.5)	1.17 (0.9,1.6)	1.10 (0.8,1.5)	1.33 (1.0,1.7)	1.33 (1.0,1.7)
Stable	1	1	1	1	1	1
Increasing	1.06 (0.8,1.4)	1.08 (0.8,1.4)	1.01 (0.8,1.3)	1.05 (0.8,1.4)	1.02 (0.8,1.4)	1.01 (0.8,1.4)
CHD (ex Rose angina)	7068 (270)	7068 (270)	7114 (270)	7114 (270)	7032 (268)	7032 (268)
Work characteristic						
Decreasing	1.15 (0.8,1.6)	1.10 (0.8,1.6)	1.16 (0.8,1.6)	1.10 (0.8,1.5)	1.05 (0.8,1.4)	1.05 (0.8,1.4)
Stable	1	1	1	1	1	1
Increasing	1.10 (0.8,1.5)	1.12 (0.8,1.5)	1.03 (0.8,1.4)	1.08 (0.8,1.5)	0.77 (0.6,1.1)	0.76 (0.6,1.1)

4.5 DISCUSSION

Adverse changes in many dimensions of work were clearly related to worse mental health functioning over both short term and longer term follow up and this was not explained by pre-existing ill-health. This strengthens our previous findings that psychosocial work factors are related to both minor psychiatric morbidity measured by the GHQ (Stansfeld et al, 1999) and mental health functioning (Stansfeld et al,1998). The fact that individual change in work is related to subsequent mental health functioning suggests that these associations may be real and causal.

We have previously reported an association between psychosocial work factors and physical functioning (Stansfeld et al,1998) and a longitudinal study of female nurses in America also showed that adverse psychosocial work conditions are important predictors of poor functioning (Cheng et al, 2000). We found modest associations between change in work and physical functioning or long term illness in the short term but there was some evidence to suggest that there may be longer term effects on physical health. Improved social support at work, but not changes in demand or decision latitude at work, were protective of risk of CHD events during follow up.

Other studies have also demonstrated associations between adverse working conditions and mental health and wellbeing but few have examined the influence of change in working conditions on mental health. Some studies in other countries have demonstrated an association between downsizing and sickness absence (Indulski and Szubert,1999, Vahtera et

al 1997) and a study in Finland showed that some of the effect of downsizing on sickness absence could be explained by changes in work, including decision latitude and job insecurity (Kivimaki et al, 2000; Vahtera et al, 2000). Some small scale studies have shown that changes in work factors are related to biochemical risk factors, such as cholesterol and blood pressure (Theorell et al, 1998; Grossi et al 1999). Findings from the Whitehall II study also indicate that downsizing has an effect on minor psychiatric morbidity. However, in these data effects of downsizing on physical health and biochemical risk factors are conflicting (Ferrie et al, 2001).

5 ALCOHOL AND ABSENCE FROM WORK ATTRIBUTABLE TO INJURY

Previous research from the Whitehall II study has shown that alcohol consumption is related to overall rates of sickness absence (Marmot et al, 1993). Although the link between alcohol and both mortality due to injury and alcohol related industrial accidents is well established, there is less evidence on the relation between alcohol consumption and accidents in white collar working populations. Here, we examine the association between measures of alcohol consumption, alcohol dependence and sickness absence attributable to injury.

5.1 MEASURES OF ALCOHOL CONSUMPTION

Several questions relating to alcohol consumption were included in the phase 1 questionnaire, covering frequency of alcohol consumption in the last 12 months, units consumed in the past week, usual amount consumed at one sitting and maximum amount consumed on one occasion. For these analyses, units consumed in the last 7 days were grouped into categories related to recommendations on sensible drinking limits. Different cutpoints were used for men and women as metabolism rates differ in men and women. Current sensible drinking recommendations are that men should not consume more than 21 units a week and women should not consume more than 14 units a week. It might be expected that consuming large amounts on one occasion or 'binge' drinking would increase the risk of accidents. We examined this in two ways, first by using questions on usual amount consumed at one sitting and second, by using maximum reported consumption on one occasion. These latter questions may not have been as reliably answered as the question on amount consumed in the last seven days but nevertheless may give some indication of 'binge' drinking.

Alcohol dependence was measured by the CAGE questionnaire which was first included in the Whitehall II study at phase 3. This brief four item scale is a well used and validated screening instrument for alcohol dependence developed originally for general practice settings. The CAGE has been used in a variety of clinical settings (Ewing, 1984) and in population surveys (Smart et al, 1991; Whichelow, 1993; Hedges, 1996). This short scale appears to correlate well with a clinical diagnosis of alcoholism (Mayfield, McLeod & Hall, 1974) and may even be a better predictor than biochemical indicators of alcohol dependence (Bernadt et al, 1972). A cut off of two or more positive responses to the CAGE questions has been found to identify problems in a number of studies (Ewing, 1984) and has been used here.

5.2 SICKNESS ABSENCE RECORDS

Ninety three percent (9564) of participants gave consent for us to access their civil service sickness absence records and, of these, 96% (9179) were linked with their records. Computerised civil service sickness absence records including the first and last dates of all absences were obtained annually for participants to the end of 1998. Between 1985 and 1990, two thirds of civil service departments included a coded reason for absence on their computerised records (5620 participants), using a 4 digit code based on the 'C' list of the 8th revision of the International Classification of Diseases. From 1990 onwards, the civil service introduced a modified coding system which all departments used. For absences of seven days or less, civil servants were able to complete their own certificate and give a reason for absence. For absences longer than seven days, a medical certificate was required. We classified codes into disease groupings using the Royal College of General Practitioners Morbidity (RCGP) Coding System which is comparable with the International Classification of Diseases. Here, we analyse absences attributed to reasons classified under the RCGP heading Injury and Poisoning.

The analyses include those participants for whom reason for absence was recorded throughout the follow up period and excludes those participants in departments which did not code reason in the earlier period 1985-1990. Initial analyses were performed for men and women separately and for short (<= 7 calendar days) and long spells (> 7 calendar days). Unless there were differences between men and women or short and long spells, we present results for all spells of absence attributable to injury among men and women combined.

5.3 ALCOHOL AND ABSENCE FROM WORK DUE TO INJURY

In total, we have sickness absence for an average eight year follow up in 4584 men and women who had complete information on baseline measures of alcohol consumption. Around 5% of all spells during this period were attributed to injury.

The risk of spells of absence attributable to injury did not differ according to reported frequency of alcohol consumption (Table 27) but was related to amount of alcohol consumed in the last week (Table 28). There was an increased risk of absence due to injury at moderate levels of alcohol consumption (11-21 units per week in men/ 8-14 units per week in women) as well as at heavy levels of alcohol consumption. Estimated risks were very similar for men and women with moderate drinkers having about a 20% increased risk of a spell of absence due to injury when compared with light drinkers. Both smoking and baseline health status were also related to risk of absence attributable to injury but further adjustment for these risk factors did not alter the risks seen for alcohol consumption. In order to test the specificity of the relation between alcohol and absence due to injury, we also examined the association between alcohol and total spells of absence for all reasons. There was only a weak association between levels of consumption and all spells of absence with an inverse relation between consumption and total spells (Table 28).

Table 27
Rate ratios (95% confidence intervals) for spells of absence[1] attributable to injury and for all spells by frequency of alcohol consumption in last 12 months (phase 1)

	Adjusted rate ratios[2] for men and women combined (n= 4585)	
	Spells due to injury	Spells for all reasons
Frequency of alcohol consumption		
None/special occasions	0.95 (0.8,1.1)	1.10 (1.0,1.2)
1-2 month	1.03 (0.9,1.2)	1.04 (1.0,1.1)
1-2 week	1	1
Daily	0.93 (0.7,1.3)	0.92 (0.8,1.1)
2+ a day	0.94 (0.8,1.1)	0.94 (0.9,1.0)

[1] spells of absence from phase 1 (1985-1988) to end 1998; average follow up = 8 years
[2] adjusted for age, sex , employment grade (including interaction terms for age by sex and employment grade by sex).

Table 28
Rate ratios (95% confidence intervals) for spells of absence[1] attributable to injury and for all spells by units of alcohol consumption in last 7 days (phase 1)

	Adjusted rate ratios[1] for men and women combined (n=4585)	
	Spells due to injury	Spells for all reasons
Units per week[3] (Men/Women)		
None	1.04 (0.9,1.2)	1.06 (1.0,1.1)
1-10/1-7	1	1
11-21/8-14	1.20* (1.1,1.3)	0.98 (0.9,1.0)
22-35/15+	1.19* (1.0, 1.4)	0.93 (0.8,1.0)

* statistically significant ($p<0.05$)

[1] Spells of absence from phase 1(1985-1988) to end 1998; average follow up = 8 years

[2] Adjusted for age, sex , employment grade (including interaction terms for age by sex and employment grade by sex).

[3] Different groupings used for men and women

Table 29 shows the association between usual amount consumed on one occasion and sickness absence. Separate questions were asked for beer and wine/spirits and it is not possible to combine the two questions as people may not drink both types on one occasion.
Both usual amount of beer consumed and usual amount of spirits/wine were related to absence attributable to injury. Those who reported usually consuming 3-4 pints of beer on one occasion had about a 20% increased risk of injury related absence compared to those reporting usual consumption of 1-2 pints of beer. Similarly, those consuming more than 3 units of wine/spirits had increased risks with results being consistent with a linear dose-response relationship. Again, adjustment for smoking and baseline health did not alter these associations. The relationship of usual amount consumed with all spells of absence was much weaker.

Table 29
Rate ratios (95% confidence intervals) for spells of absence[1] attributable to injury and for all spells by usual amounts of beer and wine/spirits consumed on one occasion (phase 1)

	Adjusted rate ratios[1] for men and women combined (n=4585)	
	Spells due to injury	Spells for all reasons
Usual amount of Beer[3]		
Don't drink beer	0.96 (0.9,1.1)	1.03 (0.9,1.1)
1-2 pints	1	1
3-4 pints	1.20* (1.0,1.4)	1.03 (0.9,1.1)
Usual amount of Wine/spirits		
Don't drink wine	0.94 (0.8,1.1)	1.08* (1.0,1.2)
1-2 units	1	1
3-4 units	1.12* (1.0,1.2)	0.96 (0.9,1.0)
5+ units	1.24* (1.0,1.5)	1.07* (0.9,1.2)

* statistically significant ($p<0.05$)
[1] Spells of absence from phase 1(1985-1988) to end 1998; average follow up = 8 years
[2] Adjusted for age, sex , employment grade (including interaction terms for age by sex and employment grade by sex).
[3] One pint of beer is equivalent to 2 units of alcohol

Participants were also asked to record the maximum amounts of beer and of wine/spirits that they would consume at one sitting. There were significant positive associations between rates of spells of absence due to injury and maximum amounts of both beer and wine/spirits. An indicator of 'binge' drinking was constructed based on whether people reported maximum amounts greater than 5 units at one sitting. Those classified as 'binge' drinkers had an approximate 25% increased risk of absence due to injury (Table 30) whereas the increased risk for all spells was estimated to be around 5%.

Table 30
Rate ratios (95% confidence intervals) for spells of absence[1] attributable to injury and for all spells by maximum account consumed on one occasion (phase 1)

	Adjusted rate ratios[1] for men and women combined (n=4585)	
	Spells due to injury	Spells for all reasons
Maximum amount > 5 units on one occasion		
No	1	1
Yes	1.24* (1.1,1.4)	1.04 (0.9,1.1)

* statistically significant ($p<0.05$)
[1] Spells of absence from phase 1(1985-1988) to end 1998; average follow up = 8 years
[2] Adjusted for age, sex , employment grade (including interaction terms for age by sex and employment grade by sex).

Participants classified as alcohol dependent on the basis of their answers to the CAGE questionnaire had a significantly increased risk of short spells of absence due to injury (Table 31). Alcohol dependence was not much related to risk of long spells of absence due to injury. As expected, given that we have previously found both that alcohol dependence is related to minor psychiatric morbidity and that mental health is related to sickness absence, there was an association between alcohol dependence and overall rates of short and long spells of absence for all reasons. However, the estimated increase in risk of short spells of absence due to injury (rate ratio 1.46) was greater than the increased risk for all short spells (rate ratio 1.25), suggesting that there may be a causal relation between alcohol dependence and injury related absence.

Table 31
Rate ratios (95% confidence intervals) for spells of absence[1] attributable to injury and for all spells by alcohol dependence (phase 3)

	Adjusted rate ratios[1] for men and women combined (n=4625)			
	Short spells (<= 7 days) due to injury	Long spells (>7 days) due to injury	Short spells All reasons	Long spells All reasons
Alcohol dependence				
No	1	1	1	1
Yes	1.46* (1.3,1.7)	1.09 (0.8,1.5)	1.25* (1.1,1.3)	1.29* (1.1,1.5)

* statistically significant ($p<0.05$)
[1] Spells of absence from phase 1(1985-1988) to end 1998; average follow up = 8 years
[2] Adjusted for age, sex , employment grade (including interaction terms for age by sex and employment grade by sex).

5.4 DISCUSSION

Our results suggest that alcohol consumption, even at moderate levels, leads to increased risk of absence due to injury. The effects seem to be specific to absence due to injury with much weaker relationships seen for all spells. It appears that alcohol dependence is also related to increased injury related absence. Those classified as alcohol dependent were more likely to be heavy drinkers, but it is also possible that alcohol dependence puts people at greater risk of injury because of timing or patterns of alcohol consumption.

Can these results be generalised to other working populations? The drinking patterns of civil servants in the Whitehall II study are fairly typical of the country as a whole (Marmot et al, 1993) and reported alcohol consumption levels were fairly similar to those seen in non-manual social classes in general population surveys.

We were not able to determine whether injuries occurred within or outside the workplace. However, the most common reasons for absence recorded under the RCGP Injury chapter heading related to injuries that could occur anywhere, such as falls and broken bones. (There were extremely few absences attributed to road traffic accidents or poisoning related injuries).

We have previously conducted a validation study to assess the accuracy of reasons recorded by the Civil Service (Feeney et al, 1998). For all spells lasting more than 21 days, we wrote to the participant's General Practioner to obtain independent information on the reason for absence. We found that there was reasonable agreement between GP diagnosis and civil service recorded reason for absence. Furthermore, associations between other risk factors and injury related absence were as expected. Minor psychiatric morbidity, which we have found to be a strong predictor of all spells of absence, was not related to the risk of spells due to injury.

Although the link between alcohol and accidents is well established, few other studies have examined the association between moderate levels of alcohol consumption and accidental injury in a white collar occupational cohort. Most studies have been case-control or in specific occupational groups at high risk of injury (Observer and Maxwell, 1959; Webb et al, 1994). Some cross-sectional surveys have shown an association between heavy drinking, defined as drinking more than 5 units on one occasion, and work injuries (Hingson et al, 1985; Dawson1994). A review of the literature in 1993 concluded that the true magnitude of alcohol related work injuries had not been adequately assessed (Stallones and Kraus, 1993).

Alcohol consumption is related to mortality due to injury and a metaanalysis estimated that around 31% to 50% of deaths due to accidental falls were attributable to alcohol (English et al, 1995). It has been estimated that, in England and Wales, accidental falls are one of the most common causes of alcohol attributable deaths (other common causes being cirrhosis, breast cancer, colon cancer, suicide, road traffic accidents and oesophageal cancer) (Britton and McPherson, 2001).

Longitudinal studies have demonstrated a link between the psychosocial work environment and subsequent risk of alcohol dependence (Crum et al,1995; Frone,1999;Stansfeld et al, 2000). Crum reported that men (but not women) in high demand/low control jobs were at increased risk of developing alcohol abuse or alcohol dependence. In the Whitehall II study, Stansfeld et al found effort reward imbalance predicted alcohol dependence in men whereas low decision latitude predicted alcohol dependence in women.

It is difficult to define an exact level of alcohol consumption above which risk of injury is increased but our results suggest that risks are increased at relatively low levels of consumption. Thus policies to reduce alcohol related absenteeism from work need to address moderate drinking as well as heavy drinking . Attention also needs to be given to work design factors which influence drinking patterns and alcohol dependence.

6. CONCLUSIONS

6.1 WORK ENVIRONMENT AND HEALTH

Psychosocial work factors were related to incidence of angina and myocardial infarction. Those with high job demands had higher incidence of coronary heart disease and this was not explained by employment grade, health behaviours or other conventional risk factors such as blood pressure. Effort reward imbalance was also related to coronary heart disease independently of other risk factors. Low decision latitude was related to increased incidence of angina independent of employment grade. These work factors were not much related to diabetes apart from effort reward imbalance which, in men, was associated with incidence of diabetes. However those reporting low decision latitude, high job demands or low work social support were at increased risk of becoming obese. As obesity is one of the major risk factors for diabetes, it is possible that relationships between these other work characteristics and diabetes will emerge over the longer term.

There were clear associations between adverse changes in work characteristics and subsequent worsening mental health functioning over both short term and longer term follow up. Adverse change in work characteristics was not related to worsening physical functioning in the short term but there was some indication that adverse changes may have longer term effects on physical health. Adverse changes in levels of work social supports, but not changes in decision latitude or job demands, predicted increased incidence of coronary heart disease.

The original Karasek hypothesis was that high job demands would only have a detrimental effect on health among those people with little control over their work environment. However, our findings suggest that both high job demands and low decision latitude have independent effects on health. Thus, high job demands is related to poorer health in both people with high levels decision latitude and people with low levels of decision latitude. Other studies have also found that both decision latitude and job demands are independently related to health, and that support for the Karasek job strain interaction is not strong (Theorell 1996;Wall 1996;Dollard and Winefield 1998;Parkes 2000).

6.2 SOCIAL INEQUALITIES IN HEALTH

There are marked employment grade gradients for many of the health measures included in the Whitehall II study. We have found that adverse work characteristics appears to be part of the explanation for these grade gradients. A cross-sectional analysis of employment grade differences in depressive symptoms showed that grade differences were explained by differences in work characteristics (Stansfeld et al, 1998). These findings have more recently being confirmed in longitudinal analyses of grade gradients in depressive symptoms, as part of research under the ESRC health variations project. Work characteristics also explained part of the social gradient in incidence of self-reported symptoms of coronary heart disease (Marmot et al, 1997).

6.3 ALCOHOL AND ABSENCE FROM WORK DUE TO INJURY

Increased risk of sickness absence due to injury was seen for moderate levels of drinking (11-21 units per week in men/ 8-14 units per week in women) as well as for heavy drinking. 'Binge' drinking, defined as consuming more than 5 units on one occasion, was also related to spells of absence due to injury. Alcohol dependence was associated with increased risk of short spells due to injury.

6.4 GENERALISABILITY OF OUR RESULTS

The degree to which findings from the Whitehall II study can be generalised to other occupational groups has been questioned. The British Civil Service has traditionally been seen as a workforce with high levels of job security and excellent working conditions. In fact, the Civil Service is not very different from other large white collar workforces and the changes in the Civil Service in the past decade have made it more similar to other white collar workforces in both the public and private sectors. Where it has been possible to make comparisons between Whitehall II and nationally representative datasets, the results have been fairly consistent.

There are few national datasets which examine the psychosocial work environment and health. In the 1994 Health Survey for England (Taylor, 1994) higher levels of work pace, variety and control were reported in social classes I and II compared to other social classes, similar to the findings in the Whitehall II Study. A cross-sectional analysis of data from the 1993 Health Survey for England reported an association between job strain and various health measures including self-reported coronary heart disease (Sacker et al, 2001).

6.5 IMPLICATIONS

Our earlier research for the Health and Safety Executive demonstrated associations between work characteristics and both mental health and sickness absence. In this report, we show that work characteristics may also adversely influence physical health. Some aspects of work seem to be linked to poorer health on most health outcomes whereas the associations for other aspects are specific to certain health outcomes. Nevertheless, we have shown that each of decision latitude, job demands and work social supports and effort reward imbalance is associated with one or more physical or mental health outcomes. Thus, policies to improve health in the workplace cannot only focus on one or two aspects of work design.

Our results suggest that policies to promote positive aspects of work organisation and management may reduce morbidity in working populations. These policies may also contribute to reducing inequalities in health.

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APPENDIX A

WORK MEASURES

KARASEK MODEL

Decision Authority

Do you have a choice in deciding how you do your work?
Do you have a choice in deciding what you do at work?
Others take decisions concerning my work
I have a good deal of say in decisions about work
I have a say in my own work speed
My working time can be flexible
I can decide when to take a break
I have a say in choosing with whom I work
I have a great deal of say in planning my own work environment

Skill Discretion

Do you have to do the same thing over and over again?
Does your job provide you with a variety of interesting things?
Is your job boring?
Do you have the possibility of learning new things through your work?
Does your work demand a high level of skill or expertise?
Does your job require you to take the initiative?

Job Demands

Do you have to work very fast?
Do you have to work very intensively?
Do you have enough time to do everything?
Do different groups at work demand things from you that you think are hard to combine?

Social Support at Work

Support from colleagues

How often do you get help and support from colleagues?
How often are your colleagues willing to listen to your work related problems?

Support from superiors

How often do you get help and support from your immediate superior?
How often is your immediate superior willing to listen to your problems?

Information from superiors

Do you get sufficient information from line management (your superiors)?
Do you get consistent information from line management (your superiors)?

EFFORT REWARD IMBALANCE

High Effort

Competitiveness

Being bossy or dominating
Having a strong need to excel
Being hard driving and competitive

Work-related overcommitment

Usually being pressed for time
Have you often felt very pressed for time?
Has your work often stayed with you so that you were thinking about it after working hours?
Has your work often stretched you to the very limits of energy and capacity?

Hostility

When someone does me a wrong I feel I should pay him back if I can, just for the principle of the thing
It makes me impatient to have people ask my advice or otherwise interrupt me when I am working on something important
I am not easily angered

If in high tertile for any of above three then classified as 'high effort'

Low Rewards

Poor promotion prospects

How satisfied have you been with your work prospects?

Blocked career

Current employment grade lower than what on average could be expected given grade level on entry to civil service (adjusted for number of years in civil service)

If either poor promotion prospects or blocked career, classified as 'low reward'

APPENDIX B
PUBLISHED WHITEHALL II PAPERS

Marmot MG, Davey Smith G, Stansfeld SA, Patel C, North F, Head J et al. Health inequalities among British Civil Servants: the Whitehall II study. Lancet 1991;337:1387-93.

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