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► **To cite this version:**

Marianna Virtanen, Jane Ferrie, Archana Singh-Manoux, Martin Shipley, Jussi Vahtera, et al.. Overtime work and incident coronary heart disease: the Whitehall II prospective cohort study.. European Heart Journal, Oxford University Press (OUP): Policy B, 2010, 31 (14), pp.1737-44. 10.1093/eurheartj/ehq124 . inserm-00488827

HAL Id: inserm-00488827

<https://www.hal.inserm.fr/inserm-00488827>

Submitted on 13 May 2011

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Revision 2

Overtime work and incident coronary heart disease: the Whitehall II prospective cohort study

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Abstract

Aims To examine the association between overtime work and incident coronary heart disease among middle-aged employees.

Methods and Results 6,014 British civil servants (4,262 men, 1,752 women), aged 39 to 61 years who were free from coronary heart disease and worked full time at baseline (1991-4) were followed until 2002-4, an average of 11 years. The outcome measure was incident fatal coronary heart disease, clinically verified incident non-fatal myocardial infarction, or definite angina (a total of 369 events). Cox proportional hazard models adjusted for sociodemographic characteristics showed that 3-4 hours overtime work per day was associated with 1.60-fold (95% CI, 1.15–2.23) increased risk of incident coronary heart disease compared with employees with no overtime work. Adjustment for all 21 cardiovascular risk factors measured made little difference to these estimates (HR 1.56, 95% CI, 1.11–2.19). This association was replicated in multivariate analysis with only fatal cardiovascular disease and incident non-fatal myocardial infarction as the outcome (HR 1.67, 95% CI, 1.02-2.76).

Conclusions Overtime work is related to increased risk of incident coronary heart disease independently of conventional risk factors. These findings suggest that overtime work adversely affects coronary health.

Key words: working hours; stress; CHD; myocardial infarction; angina; middle-aged; prospective

Word count: 189 in Abstract, 3619 in text

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Introduction

Overtime work is common in developed countries and has increased steadily in recent years.¹ A survey from the OECD shows that countries exceeding most the OECD average were United States, South Korea, Greece, Mexico, Australia, and Japan.² Employees in the United Kingdom also had working hours above the average in the 15 member countries of the European Union.² A growing body of evidence suggests that working overtime may be associated with adverse health outcomes, such as hypertension, subjective health complaints, sleep problems, and depression.^{1,3-8}

Studies on the relationship between overtime work and coronary heart disease (CHD) are scarce, and we are not aware of previous prospective studies on this issue. One study in California, U.S., used census data collected between 1949-51 and reported that the highest standardised mortality ratio for CHD was among employees in occupations with long average working hours.⁹ A Swedish study used a similar approach and found an association between overtime work and hospitalization for myocardial infarction (MI) among women,¹⁰ but the inverse among men. The other studies on this topic have been case-control studies.¹¹⁻¹⁴ The major problem in case-control studies is the retrospective assessment of working hours, i.e. it is possible that the diseases itself, here CHD, influences the patient's work behavior and perception or recall of working hours prior to the onset of illness.

The aim of the present study is to investigate the effect of overtime work on incident CHD, followed-up over a 11-year period in a large-scale, prospective occupational cohort of British Civil Servants (the Whitehall II Study).¹⁵ We take into account several factors that may act as confounders or mediators of this association, such as sex, age, and occupational grade, as well as several biological, behavioral, psychosocial and psychological risk factors

for CHD, including work characteristics and type A behavior pattern. For comparison, we examine the association between overtime work and all-cause mortality.

Methods

Study sample and design

The Whitehall II study sample recruitment (Phase 1) took place between late 1985 and early 1988 among all office staff, aged 35 to 55, from 20 London based Civil Service departments.¹⁵ The response rate was 73% (6895 men and 3413 women). Since Phase 1 there have been eight further data collection phases (1989-90, 1991-4, 1995-6, 1997-9, 2001, 2002-4, 2006, 2007-9) with study phases alternating between a questionnaire only phase and one including questionnaire and a clinical examination. Informed consent was gained from all participants. The University College London Medical School Committee on the Ethics of Human Research approved the protocol.

The question on working hours was introduced to the study for the first time at phase 3 (1991-4) which is the baseline for the analyses reported here. Of the 8,637 participants at that phase, 7,684 (89%) were employed and responded to the question on working hours. Of them, 397 (5%) worked part time (less than 7 hours / day) and were excluded from the analysis, leaving a sample of 7,287 participants. Out of these, data were missing on at least one of the covariates for 1,126 participants and a further 147 had prevalent CHD at baseline and were also excluded. Thus, the final sample comprised 6,014 participants (4,262 men, 1,752 women) aged 39 to 61 years who were followed until Phase 7 (2002-4) which is the most recent phase for which clinical examination data are available for the Whitehall II study participants.

Measures

We determined working hours at baseline with the following question: "On an average weekday, approximately how many hours do you spend on the following activities (if applicable): Work (daytime and work brought home)?" Response alternatives ranged from 1 hour to 12 hours. We formulated the following categorical measure of overtime work: no overtime work (7-8 working hours /day); 1 hour of overtime work a day (9 hours /day); 2 hours of overtime work (10 hours /day); 3-4 hours of overtime work (11-12 hours /day).

We assessed the occurrence of CHD events between phases 3 (1991-4) and 7 (2002-4), a mean follow-up of 11.2 (S.D. 2.7) years. Prevalent cases, determined by using a procedure similar to that for incident CHD, were excluded from the analysis. Participants were flagged by the British National Health Service (NHS) Central Registry, who notified us of the date and cause of all deaths, classified as coronary if ICD-9 (*International Classification of Diseases*, 9th edition) codes 410–414 or ICD-10 (*International Classification of Diseases*, 10th edition) codes I20–I25 were present on the death certificate. Nonfatal CHD included first nonfatal myocardial infarction (MI) or first definite angina. Non-fatal MI was defined following MONICA criteria¹⁶ based on study electrocardiograms, hospital acute ECGs, and cardiac enzymes. Incident angina was defined on the basis of clinical records and nitrate medication use, excluding cases based solely on self-reported data¹⁷ without clinical verification and participants with definite angina at baseline. Classification was carried out independently by 2 trained coders, with adjudication in the event of disagreement.

Covariates included socio-demographic measures derived from the survey questionnaire; age, sex, marital status, and socioeconomic position indicated by British civil service occupational grade.¹⁵ Employment grade in the Whitehall II study is a comprehensive marker of socioeconomic position and is related to salary, social status and level of responsibility at work. The civil service identifies 12 non-industrial grades that, in order of

increasing salary, comprise clerical assistant, clerical officer, executive officer, higher executive officer, senior executive officer, and seven “unified grades”. Other professional and technical staff were assigned to these grades on the basis of salary. For analysis, unified grades 1–6 were combined into one group and the bottom two clerical grades into another, producing six categories; category 1 represents the highest status jobs and category 6 the lowest. In 1995, the range of annual salary was £4000 to £10 999 in the two lowest grades, £5500 to £26 000 for the two intermediate grades, and £28 975 to £150 000 for the two highest grades.

Conventional risk factors for coronary heart disease¹⁸⁻²⁰ assessed at phase 3 included diabetes, systolic and diastolic blood pressure, serum HDL and LDL cholesterol, triglycerides, and smoking status. We also included alcohol consumption,²¹ exercise level,²² daily fruit and vegetable intake,²³ body mass index,²⁴ sleeping hours,²⁵ psychological distress,^{26,27} type A behavior pattern,²⁸⁻³⁰ job demands,³¹ decision latitude at work,³¹ and sickness absence³² as potential risk factors. The following measures were assessed during a clinical examination which included a 2-hour 75g oral glucose tolerance test: Diabetes (defined by a fasting glucose ≥ 7.0 mmol/L or a 2-hour postload glucose ≥ 11.1 mmol/L, or reported diabetes or use of diabetic medication); hyperglycaemia in non-diabetic participants, classified as impaired fasting glucose (fasting glucose between 5.6 and 6.9 mmol/L) and impaired glucose tolerance (2-hour postload glucose between 7.8 and 11.0 mmol/L); systolic and diastolic blood pressure (measured twice while seated after a 5 minute rest using the Hawksley random-zero sphygmomanometer); serum HDL and LDL cholesterol and triglycerides from fasting status; and weight and height from which the body mass index (kg/m^2) was calculated. The following measures were based on responses to the questionnaire: smoking status (never, ex-, and current smoker including occasional smokers); alcohol consumption (units/week classified into three categories: none; >0 to 14 (women) / 21 (men) units; more than 14/21 units),³³

exercise level (≥ 1.5 or < 1.5 hours of moderate or vigorous exercise / week);³⁴ daily fruit and vegetable intake (yes/no);³⁴ psychological distress (yes/no, using the 30-item General Health Questionnaire, GHQ-30);^{35,36} depressive symptoms (yes/no, a subscale from the GHQ-30);^{35,36} sleeping hours (less than 7 hours, 7-8 hours, more than 8 hours);²⁵ sickness absence (the number of sick days taken in the past year categorized as 0, 1-7 and > 7 days); job demands and decision latitude at work (for both measures, scores were divided into tertiles);³⁷ and type A behavior pattern (assessed at Phase 1 by the Framingham Type A scale, scores divided into tertiles).²⁹

Statistical methods

We examined the association of overtime work with baseline socio-demographic characteristics and CHD risk factors using a chi-squared test for heterogeneity. For the continuous risk factor measures, the heterogeneity was assessed using univariate analysis of variance. We used Cox proportional hazard models with follow-up period as the time scale, to examine the association of overtime work with incident CHD disease and all-cause mortality among participants free from CHD at baseline. The time-dependent interaction term between working time and the logarithm of the follow-up period for both outcomes was non-significant confirming that the proportional hazards assumption was not violated ($p=0.41$ and $p=0.35$, respectively). Those with no overtime work formed the reference category used to calculate the hazard ratios and their 95% confidence intervals of CHD among those working 1, 2 and 3-4 hours overtime per day. The models were serially adjusted for covariates in order to examine the effect of covariates on the association. The analyses were repeated using a restricted definition of the outcome variable: only fatal CHD and non-fatal MI. No interaction between sex and hours of overtime work in relation to CHD was detected ($p=0.18$ for total CHD; $p=0.18$ for fatal CHD or non-fatal MI as the outcome), so men and women were

combined in the analysis. Interactions between occupational grade and overtime work, job demands and overtime work, and decision latitude and overtime work were also tested to assess whether the health effect of overtime work is dependent on socioeconomic position or psychosocial working conditions. In order to provide a point of comparison we also examined associations with all-cause mortality. As the exposure (overtime work) consisted of three pairwise comparisons (1 hours, 2 hours and 3-4 hours overtime vs no overtime), Bonferroni corrected *p*-values were calculated, in addition to uncorrected *p*-values, to reduce the risk of type 1 errors. Bonferroni correction is a conservative statistical adjustment to adjust for multiple comparisons. This correction was also applied when testing the associations between overtime and the covariates. All *p*-values are two-tailed, and *p*-values below 0.05 were considered to indicate statistical significance. We used SAS version 9.1 (SAS, Cary, NC, USA) for statistical analyses.

Results

Of the participants, 3256 (54%) did not usually work overtime, 1247 (21%) worked approximately one, 894 (15%) two, and 617 (10%) three or four extra hours a day. Table 1 presents associations between baseline covariates and overtime working hours. Participants working overtime were slightly younger than participants not working overtime. Men, married or cohabitating participants and those in higher occupational grades worked overtime more often than women, non-married/co-habited or lower-grade participants. Absence of pre-existing diabetes, smoking history and alcohol use exceeding recommended limits were also associated with overtime work. More of those working overtime reported daily fruit and vegetable consumption and more exercise but shorter sleeping hours and less sickness absence days. They also reported higher prevalence of psychological distress and higher

scores on measures of type A behavior, job demands, and decision latitude at work than individuals not working overtime. Overtime work was associated with lower HDL cholesterol levels compared to employees with no overtime work. After Bonferroni correction of the p -values, the significant heterogeneity in baseline characteristics between worktime groups (table 1) remained largely unchanged. The only exceptions were the differences in age and sleeping hours which became non-significant after adjusting for multiple testing (corrected values: $p=0.08$ for age and $p=0.15$ for sleeping hours)

Table 2 shows the association of overtime with incident CHD. Altogether there were 67,543.9 person-years of follow-up during which 369 new events of CHD occurred, resulting in a rate of 5.46 events per 1000 person-years. In the model adjusted for sociodemographic factors (Model A), working 3 or 4 hours (but not 1 or 2 hours) of overtime was associated with incident CHD (HR 1.60, 95% CI 1.15–2.23, $p=0.005$), compared with no overtime work. The Bonferroni corrected p -value for the excess CHD risk in this overtime category was $p=0.015$ and the association changed little after further adjustment for all potential CHD risk factors (Models B to E). The largest reduction in effect size (16%) was found after adjustment for health behaviors (Model C). Of these, smoking and body mass index were related to incident CHD. An 11% effect size reduction was found after adjustment for type A behavior pattern (Model E). The hazard ratio for incident CHD for scores in the top tertile of type A behavior was 1.46 (95% CI 1.09-1.95, $p=0.011$).

We repeated the analyses with the outcome defined as fatal CHD and new non-fatal MI, but excluding definite angina pectoris (table 3). In the model adjusted for socio-demographic characteristics, working 3-4 hours of overtime (but not 1 or 2 hours) was associated with incident fatal CHD or non-fatal myocardial infarction (HR 1.90, 95% CI, 1.17–3.06, $p=0.009$) when compared with employees with no overtime work (Model A). The Bonferroni corrected p -value for this hazard ratio was $p=0.027$. Again, the largest reduction

in the hazard ratio was found after adjustment for health behaviors (19%, Model C) and type A behavior pattern (12%, Model E). Of these covariates, smoking, alcohol use (lower risk with high alcohol use when compared with no use), and body mass index were independently associated with the outcome, and the hazard ratio for scores in the top tertile of type A behavior pattern was HR 1.43 (95% CI 0.93-2.20, $p=0.10$).

In order to examine the effect of depressive symptoms on the association between long working hours and CHD, we re-ran Model E using the depression subscale of the GHQ³⁸ and leaving out psychological distress as a covariate. We found no significant difference in the results (3-4 hours overtime work was associated with incident CHD including definite angina, HR 1.56, 95% CI 1.11-2.20; $p=0.010$ with incident fatal CHD, non-fatal MI or definite angina, HR 1.71, 95% CI 1.04-2.81 with incident fatal CHD, non-fatal MI or definite angina, $p=0.036$).

To examine whether the association between long working hours and CHD was dependent on socioeconomic position or work stress factors, we tested interaction effects. No interaction was found between occupational grade or job demands and working hours (p -values 0.50 and 0.41 for coronary death, incident non-fatal MI or definite angina pectoris; p -values 0.43 and 0.73 for coronary death or incident non-fatal MI). A significant interaction was found between decision latitude and overtime work in predicting coronary death, incident non-fatal MI or definite angina pectoris ($p=0.025$). Based on Model E adjustments, the HR for overtime work of 3-4 hours was 1.78 (95% CI 1.10-2.89, $p=0.020$) in the low-decision latitude group (2 lowest tertiles, $n=3,415$) and 1.26 (95% CI 0.77-2.04, $p=0.36$) in the high-decision latitude group (highest tertile, $n=2,599$). However, this interaction was lost in the analysis confined to coronary deaths and incident non-fatal MIs only ($p=0.46$).

Finally, we examined all-cause mortality as an outcome. In the model adjusted for age, sex, marital status, and occupational grade, employees working one hour overtime had a

HR of 1.11 (95% CI, 0.75-1.63, $p=0.60$), those working two extra hours a day had a HR of 1.27 (0.83-1.94, $p=0.27$), and those working 3-4 hours overtime a day had a HR of 1.35 (0.82-2.21, $p=0.24$) when compared with employees not working overtime.

Discussion

We examined the association between overtime work and incident CHD in a cohort of British civil servants, followed up for an average of 11 years. We found that 3-4 hours of overtime work per day was associated with a 1.56-fold risk of CHD, after accounting for the effects of demographic factors and several known risk factors for CHD. Similar association was found with an outcome comprising only coronary death and non-fatal myocardial infarction. No significant association was found between overtime work and all-cause mortality but the effects were in the expected direction. The specific strength of our study was a prospective study design with a relatively long follow-up period.

We found some evidence of associations of overtime work with smoking history and lower concentration of HDL cholesterol, both well-established risk factors for CHD.¹⁸⁻²⁰ Although these risk factors might be potential mechanisms explaining the association between overtime work and CHD, adjustment for them had no major effect on the association found in the present study. Thus, differences in these risk factors do not seem to be strong mediators of the observed relationship.

In their case-control study of Japanese men,¹³ Sokejima and Kagamimori suggested that the relationship between extended working hours and acute myocardial infarction may be explained by changes in the activity of the autonomic nervous system; through increases in sympathetic nervous activity and increased blood pressure levels; and through reduced parasympathetic nervous system which is also a risk factor for CHD. Earlier studies on these

mechanisms show mixed results,³ and our baseline assessment does not support hypertension as being on the pathway between overtime work and cardiovascular disease. However, ambulatory blood pressure monitoring might be the best way of assessing whether masked, or "hidden" hypertension³⁹ is a possible mediator. Work-related stress has been shown to be associated with hidden hypertension,³⁹ and there is also some evidence showing overtime work to be related to elevated ambulatory blood pressure.⁴⁰

Our results show working overtime to be related to type A behavior pattern, psychological distress - a correlate for depression and anxiety symptoms- and some suggestion of an association with short sleeping hours. Negative emotions, such as depression and anxiety, and reduced sleeping hours, have been found to be independent predictors of CHD.²⁵⁻²⁷ However, adjustment for these factors had little effect on the association between overtime and CHD. In turn, we found that adjustment for type A behavior pattern attenuated the hazard ratios by 11-12%, suggesting that part of the association may be explained by such behaviors. Type A behaviour pattern is viewed to represent a specific adverse behavioural style in response to environmental stress and can be a risk factor for CHD.²⁸⁻³⁰ Type A behavior is also characterized by a chronic, incessant struggle to achieve more and more in less and less time, and is also believed to be characterised by aggressiveness and irritability.²⁸

Several other factors may underlie the association between overtime work and CHD. For example, even though the association was not explained by adjustment for sleeping hours in our analysis, insufficient time for recovery in spite of increased need,⁴¹ or difficulties in unwinding after work are possible mechanisms.⁴² Employees who work overtime may also be likely to work while ill, i.e. be reluctant to be absent from work despite illness. Such sickness presenteeism has been found to be associated with increased risk of myocardial infarction in male British civil servants in the Whitehall II study.⁴³ Although overtime workers in our study were more likely to be in higher occupational grades which suggests better resources e.g. for

health care, overtime work may also be a part of a lifestyle in which symptoms of ill health are ignored and medical care not sought.⁴⁴

There is a large body of research on work stress and CHD,^{31,45} but it is not known whether work stress affects the association between long working hours and CHD. We tested interactions between long working hours and job demands, but found none. In contrast, there was some indication that decision latitude at work may modify the effect of long working hours on CHD. The excess risk of CHD was smaller for employees with high decision latitude than for those with lower decision latitude. However, this interaction was not significant when the angina pectoris cases were excluded from the outcome. Further research is therefore needed to determine whether factors, such as high decision latitude or working long hours through choice, would reduce the excess risk of CHD associated with overtime working.

Our findings should be interpreted within the context of the study limitations. First, the possibility of residual confounding by other, unmeasured or imprecisely measured predictors of coronary events can never be entirely ruled out in observational studies. A second limitation is related to modelling potential confounders as time independent covariates; we did not assess the possible impact of changes in these factors on the risk of CHD events. Third, it is not clear whether the number of working hours reported by participants at baseline was stable over the follow-up. This could be a potential source of misclassification of our exposure measure. Thus, we examined data on working hours from a questionnaire administered to participants 5 years after the baseline questionnaire. This version of the question had been modified and requested weekly working hours rather than daily working hours. 3441 participants (57%) were still in employment at this follow-up phase. Of those who worked one or more hours of overtime per day at baseline, 33% worked a maximum of 40 hours' workweek at follow-up, 18% worked 41-45 hours and 49% worked more than 45 hours per week. Thus in the Whitehall II data, working overtime appears to be a relatively stable characteristic.

Fourth, diagnosis-based depressive and anxiety disorders, potential risk factors for CHD were not examined and could therefore potentially confound our results.⁴⁶ The association between working hours and CHD did not change when either depressive symptoms alone or the GHQ-30 total score were entered into the model. The GHQ-30 covers symptoms of depression and anxiety, as well as insomnia and social impairment. It is a well established and validated screening questionnaire for psychiatric disorder.^{35,47,48} Fifth, our study was not well powered for subgroup analyses. Interaction effects should therefore be interpreted cautiously and replicated in studies with larger sample sizes. Finally, although our cohort of civil servants included several occupational grades it did not include blue collar workers. Thus, it remains unclear whether our findings are generalisable to blue-collar workers and employees in the private sector.

In conclusion, data from a large occupational cohort indicates that overtime work is associated with increased risk of CHD independently of sociodemographic characteristics, conventional coronary risk factors, sleep deprivation, psychological distress, work characteristics and type A behavior. Further research should examine whether interventions designed to reduce overtime work would alter the risk of CHD.

Conflict of interest: None declared.

Acknowledgements

The Whitehall II study has been supported by grants from the Medical Research Council; British Heart Foundation; Health and Safety Executive; Department of Health; National Heart Lung and Blood Institute (HL36310), US, NIH: National Institute on Aging (AG13196 and AG34454), US, NIH; Agency for Health Care Policy Research (HS06516); the John D and Catherine T MacArthur Foundation Research Networks on Successful Midlife Development and Socio-economic Status and Health; and the BUPA Foundation, UK.

MK and JV are supported by the Academy of Finland (Projects no. #124271, #124322, #129262 and #132944), MK is additionally supported by the BUPA Foundation Specialist research grant, AS-M is supported by a 'EURYI' award from the European Science Foundation, MJS is supported by the British Heart Foundation and MGM is supported by a MRC Research Professorship.

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Table 1 Characteristics of the participants by daily overtime hours at baseline: the Whitehall II study

Characteristics	All N (%)	Overtime Hours N (%) / Mean (SD)				P value ^a
		No Overtime	1 Hour	2 Hours	3-4 Hours	
Age, years	48.7 (5.7)	49.0 (5.8)	48.5 (5.6)	48.5 (5.4)	48.3 (5.5)	0.004
Sex						<0.0001
Male	4262 (70.9)	2081 (63.9)	965 (77.4)	685 (76.6)	531 (86.1)	
Female	1752 (29.1)	1175 (36.1)	282 (22.6)	209 (23.4)	86 (13.9)	
Marital status						<0.0001
Married/cohabitating	4610 (76.7)	2356 (72.4)	974 (78.1)	727 (81.3)	553 (89.6)	
Non-married/-cohabitating	1404 (23.4)	900 (27.6)	273 (21.9)	167 (18.7)	64 (10.4)	
Occupational grade level						<0.0001
1 highest	1056 (17.6)	223 (6.9)	291 (23.3)	289 (32.3)	253 (41.0)	
2	1353 (22.5)	577 (17.7)	372 (29.8)	257 (28.8)	147 (23.8)	
3	880 (14.6)	505 (15.5)	205 (16.4)	98 (11.0)	72 (11.7)	
4	1048 (17.4)	686 (21.1)	170 (13.6)	122 (13.7)	70 (11.4)	
5	815 (13.6)	571 (17.5)	132 (10.6)	68 (7.6)	44 (7.1)	
6 lowest	862 (14.3)	694 (21.3)	77 (6.2)	60 (6.7)	31 (5.0)	
Diabetes						<0.0001
No	5278 (87.8)	2812 (86.4)	1108 (88.9)	796 (89.0)	562 (91.1)	
Impaired fasting glucose	136 (2.3)	61 (1.9)	33 (2.7)	28 (3.1)	14 (2.3)	
Impaired glucose tolerance	459 (7.7)	292 (9.0)	77 (6.2)	55 (6.2)	35 (5.7)	
Yes	141 (2.3)	91 (2.8)	29 (2.3)	15 (1.7)	6 (1.0)	
Smoking						0.002
Never	3092 (51.4)	1730 (53.1)	629 (50.4)	436 (48.8)	297 (48.1)	
Ex	2108 (35.1)	1073 (33.0)	478 (38.3)	324 (36.2)	233 (37.8)	
Current	814 (13.5)	453 (13.9)	140 (11.2)	134 (15.0)	87 (14.1)	
Alcohol use (units / week)						<0.0001
0	1085 (18.0)	717 (22.0)	158 (12.7)	125 (14.0)	85 (13.8)	
>0 ≤ 14 / 21 (women/men)	3958 (65.8)	2073 (63.7)	871 (69.9)	605 (67.7)	409 (66.3)	
> 14 / 21 (women/men)	971 (16.2)	466 (14.3)	218 (17.5)	164 (18.3)	123 (19.9)	
Daily fruit and vegetable consumption						0.20
Yes	3691 (61.4)	1964 (60.3)	767 (61.5)	565 (63.2)	395 (64.0)	
No	2323 (38.6)	1292 (39.7)	480 (38.5)	329 (36.8)	222 (36.0)	
Moderate / vigorous exercise (hrs / week)						<0.0001
<1.5	2254 (37.5)	1334 (41.0)	412 (33.0)	315 (35.2)	193 (31.3)	
≥1.5	3760 (62.5)	1922 (59.0)	835 (67.0)	579 (64.8)	424 (68.7)	
Sleeping hours / night						0.007
<7	1587 (26.4)	825 (25.3)	306 (24.5)	262 (29.3)	194 (31.4)	
7-8	4284 (71.2)	2348 (72.1)	911 (73.1)	611 (68.3)	414 (67.1)	
>8	143 (2.4)	83 (2.6)	30 (2.4)	21 (2.4)	9 (1.5)	
Psychological distress						<0.0001
No	4680 (77.8)	2621 (80.5)	932 (74.7)	667 (74.6)	460 (74.6)	
Yes	1334 (22.2)	635 (19.5)	315 (25.3)	227 (25.4)	157 (25.5)	
Type A behavior pattern						<0.0001
Low	1833 (30.5)	1256 (38.6)	323 (25.9)	157 (17.6)	97 (15.7)	
Moderate	2169 (36.1)	1234 (37.9)	446 (35.8)	291 (32.6)	198 (32.1)	
High	2012 (33.5)	766 (23.5)	478 (38.3)	446 (49.9)	322 (52.2)	
Job demands						<0.0001
Low	1242 (20.7)	974 (29.9)	137 (11.0)	80 (9.0)	51 (8.3)	
Moderate	2751 (45.7)	1650 (50.7)	552 (44.3)	341 (38.1)	208 (33.7)	
High	2021 (33.6)	632 (19.4)	558 (44.8)	473 (52.9)	358 (58.0)	

Table 1 cont.

Overtime work and CHD

Table 1 cont.

Decision latitude at work							<0.0001
Low	1528 (25.4)	1096 (33.7)	214 (17.2)	137 (15.3)	81 (13.1)		
Moderate	1887 (31.4)	1149 (35.3)	379 (30.4)	217 (24.3)	142 (23.0)		
High	2599 (43.2)	1011 (31.1)	654 (52.5)	540 (60.4)	394 (63.9)		
Sickness absence days (past year)							<0.0001
0	2017 (33.5)	899 (27.6)	470 (37.7)	375 (42.0)	273 (44.3)		
1-7	2857 (47.5)	1589 (48.8)	595 (47.7)	403 (45.1)	270 (43.8)		
>7	1140 (19.0)	768 (23.6)	182 (14.6)	116 (13.0)	74 (12.0)		
Body mass index (kg/m ²)	25.1 (3.6)	25.1 (3.7)	25.1 (3.5)	25.3 (3.8)	25.2 (3.2)		0.48
Systolic blood pressure (mmHg)	120.0 (13.3)	120.1 (13.5)	120.3 (12.9)	119.8 (13.2)	119.7 (12.8)		0.74
Diastolic blood pressure (mmHg)	79.5 (9.3)	79.4 (9.4)	79.6 (9.2)	79.6 (9.2)	79.9 (9.0)		0.47
LDL-cholesterol (mmol/L)	4.37 (1.03)	4.37 (1.05)	4.33 (1.00)	4.38 (1.01)	4.42 (1.02)		0.25
HDL-cholesterol (mmol/L)	1.44 (0.41)	1.45 (0.41)	1.43 (0.40)	1.44 (0.41)	1.38 (0.37)		<0.001
Triglycerides (mmol/L)	1.35 (0.74)	1.36 (0.77)	1.33 (0.71)	1.33 (0.71)	1.38 (0.71)		0.39

^aP-value for the association between baseline characteristic and overtime work.

Table 2 Association between exposure to overtime work at baseline and incident coronary heart disease, as indicated by coronary death, incident non-fatal myocardial infarction or incident definite angina pectoris: the Whitehall II study

Exposure:	Fatal CHD, non-fatal myocardial infarction, or definite angina pectoris													
	N of events	N of Participants	Person-years	Rate / 1000 Person-years	Model A HR (95% CI) ^a	P value	Model B HR (95% CI) ^b	P value	Model C HR (95% CI) ^c	P value	Model D HR (95% CI) ^d	P value	Model E HR (95% CI) ^e	P value
overtime work / day														
All	369	6014	67543.9	5.46										
No overtime	189	3256	36331.7	5.20	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.
1 hour	69	1247	14185.4	4.86	1.01 (0.76-1.34)	0.94	1.06 (0.79-1.40)	0.71	1.04 (0.78-1.39)	0.78	1.06 (0.79-1.41)	0.71	1.04 (0.78-1.38)	0.81
2 hours	60	894	10115.8	5.93	1.28 (0.95-1.74)	0.11	1.32 (0.98-1.79)	0.07	1.24 (0.92-1.69)	0.16	1.29 (0.95-1.76)	0.11	1.23 (0.90-1.69)	0.19
3-4 hours	51	617	6911.0	7.38	1.60 (1.15-2.23)	0.005	1.67 (1.20-2.32)	0.002	1.56 (1.12-2.17)	0.009	1.63 (1.16-2.28)	0.005	1.56 (1.11-2.19)	0.011

HR=Hazard ratio. CI=Confidence interval.

^a Model A: Adjusted for age, sex, marital status, and occupational grade. Likelihood Ratio (df=11) for the overall model 134.1, $p < 0.0001$

^b Model B: As Model A and additionally adjusted for diabetes, systolic and diastolic blood pressure, LDL and HDL cholesterol, and triglycerides. Likelihood Ratio (df=19) for the overall model 248.3, $p < 0.0001$.

^c Model C: As Model B and additionally adjusted for smoking, alcohol use, fruit and vegetable consumption, exercise level, body mass index, and sleeping hours. Likelihood Ratio (df=28) for the overall model 283.1, $p < 0.0001$.

^d Model D: As Model C and additionally adjusted for sickness absence, psychological distress, job demands, and decision latitude at work. Likelihood Ratio (df=35) for the overall model 293.7, $p < 0.0001$.

^e Model E: As Model D and additionally adjusted for type A behavior pattern. Likelihood Ratio (df=37) for the overall model 300.3, $p < 0.0001$

Table 3 Association between exposure to overtime work at baseline and incident coronary heart disease, as indicated by coronary death or incident non-fatal myocardial infarction: the Whitehall II study

Exposure: overtime work / day	N of events	N of Parti- cipants	Person- years	Rate / 1000 Person- years	Fatal CHD or non-fatal myocardial infarction									
					Model A HR (95% CI) ^a	P value	Model B HR (95% CI) ^b	P value	Model C HR (95% CI) ^c	P value	Model D HR (95% CI) ^d	P value	Model E HR (95% CI) ^e	P value
All	159	6014	68893.0	2.31										
No overtime	81	3256	37015.1	2.19	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.	1.00	Ref.
1 hour	27	1247	14456.5	1.87	0.95 (0.61-1.49)	0.84	1.01 (0.65-1.58)	0.97	0.99 (0.63-1.55)	0.96	0.96 (0.61-1.52)	0.87	0.93 (0.59-1.47)	0.75
2 hours	27	894	10310.7	2.62	1.46 (0.93-2.30)	0.10	1.51 (0.96-2.38)	0.07	1.39 (0.88-2.18)	0.16	1.34 (0.84-2.13)	0.22	1.26 (0.79-2.02)	0.33
3-4 hours	24	617	7110.7	3.38	1.90 (1.17-3.06)	0.009	1.98 (1.22-3.20)	0.005	1.79 (1.11-2.90)	0.018	1.76 (1.07-2.88)	0.026	1.67 (1.02-2.76)	0.043

^a Model A: Adjusted for age, sex, marital status, and occupational grade. Likelihood Ratio (df=11) for the overall model 75.1, $p<0.0001$.

^b Model B: As Model A and additionally adjusted for diabetes, systolic and diastolic blood pressure, LDL and HDL cholesterol, and triglycerides. Likelihood Ratio (df=19) for the overall model 169.1, $p<0.0001$.

^c Model C: As Model B and additionally adjusted for smoking, alcohol use, fruit and vegetable consumption, exercise level, body mass index, and sleeping hours. Likelihood Ratio (df=28) for the overall model 201.9, $p<0.0001$.

^d Model D: As Model C and additionally adjusted for sickness absence, psychological distress, job demands, and decision latitude at work. Likelihood Ratio (df=35) for the overall model 208.1, $p<0.0001$.

^e Model E: As Model D and additionally adjusted for type A behavior pattern. Likelihood Ratio (df=37) for the overall model 210.8, $p<0.0001$.