THE LANCET

Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

Supplement to: Kivimäki M, Nyberg ST, Batty GD, et al, for the IPD-Work Consortium. Job strain as a risk factor for coronary heart disease: a collaborative meta-analysis of individual participant data. *Lancet* 2012; published online Sept 14. http://dx.doi.org/10.1016/S0140-6736(12)60994-5.

IPD-Work Consortium

Web Appendix 1. Studies and participants

Details of the design and recruitment of the participants in the studies included in our meta- analyses are presented below. Participants were eligible for our meta-analyses if they were in employment and had available data on job strain.

Belstress

Belstress is a prospective cohort study set up to investigate the associations between work-related stress and health outcomes. Between 1994 and 1998, 21 419 people aged 35-59 were recruited into the study from the payroll records of 25 large companies or public administrations (1, 2). Of these, 21 024 men and women had data on job strain and were eligible for our meta-analyses. The ethics committees of the University Hospital of Ghent and the Faculty of Medicine of the Université Libre de Bruxelles approved the Belstress study.

Copenhagen Psychosocial Questionnaire version I (COPSOQ-I)

The COPSOQ-I is a prospective cohort study of a random sample of Danish residents selected from the Danish population register. The participants were aged 20-60 years of age and were in paid employment at the study baseline in 1997. A baseline questionnaire and an invitation to take part was posted to 4 000 people and 2 454 individuals agreed to participate (3). Of the 1 858 gainfully employed participants, 1 776 men and women had data on job strain and were eligible for our meta-analyses. In Denmark, questionnaire- and register-based studies do not require approval from the Danish National Committee on Biomedical Research Ethics (Den Centrale Videnskabetiske komité). COPSOQ-I was approved by and registered with the Danish Data protection agency (registration number: 2008 - 54 - 0553).

Danish Work Environment Cohort Study (DWECS)

DWECS is a split panel survey of working age Danish people. The cohort was established in 1990, when a simple random sample of men and women, aged 18-59, was drawn from the Danish population register. The participants have been followed up at five year intervals and data from the year 2000 was used for the IPD-Work. That year 11 437 individuals were invited to participate and 8 583 agreed to do so (4, 5). Of the 5 606 individuals who were employed, 5 574 had data on job strain and were eligible for our meta-analyses. In Denmark, questionnaire- and register-based studies do not require ethics committee approval. DWECS was approved by and registered with the Danish Data protection agency (registration number: 2007-54-0059).

Finnish Public Sector study (FPS)

The Finnish Public Sector study is a prospective cohort study comprising the entire public sector personnel of 10 towns (municipalities) and 21 hospitals in the same geographical areas. Participants, who were recruited from employers' records in 2000-2002, were individuals who had been employed in the study organisations for at least six months prior to data collection (6). 48 592 individuals (9 337 men and 39 255 women aged 17 to 65) responded to the questionnaire. Of these, 48 034 had data on job strain and were eligible for our meta-analyses. Ethical approval was obtained from the ethics committee of the Finnish Institute of Occupational Health.

Gazel

Gazel is a prospective cohort study of 20 625 employees (15 011 men and 5 614 women) of France's national gas and electricity company, Electricité de France-Gaz de France (EDF-GDF) (7, 8) . Since the study baseline in 1989, when the participants were aged 35–50 years, they have been posted an annual follow-up questionnaire to collect data on health, lifestyle, individual, familial, social, and occupational factors. Job strain was measured in Gazel in 1997, which we treated as a baseline year for our analyses. 11 448 individuals participated that year and 11 362 of them had data on job strain and were eligible for our meta-analysis. The GAZEL study received approval from the national commission overseeing ethical data collection in France (Commission Nationale Informatique et Liberté).

Health and Social Support (HeSSup)

The Health and Social Support (HeSSup) study is a prospective cohort study of a stratified random sample of the Finnish population in the following four age groups: 20–24, 30–34, 40–44, and 50–54. The participants were identified from the Finnish population register and posted an invitation to participate, along with a baseline questionnaire, in 1998 (9). Job strain was measured in 1998 and of the 25 898 individuals who responded to the questionnaire, 16 447 were in employment and had data on job strain and were thus eligible for our meta-analyses. The Turku University Central Hospital Ethics Committee approved the study.

Intervention Project on Absence and Well-being (IPAW)

IPAW is a 5-year psychosocial work environment intervention study including 22 intervention and 30 control work places in three organisations (a large pharmaceutical company, municipal technical services and municipal nursing homes) in Copenhagen, Denmark (10, 11). The baseline questionnaire was posted to all the employees at the selected work-sites between 1996 and 1997. Of the 2 721 employees who worked at the 52 IPAW sites, 2 068 men and women completed the baseline questionnaire. Interventions took place at 22 workplaces during 1996-98 at the organisational and interpersonal level. Job strain was measured in 1996-1997 and the 2 031 participants, who had data on job strain, were eligible for our meta-analysis. IPAW was approved by and registered with the Danish Data Protection Agency (registration number: 2000-54-0066).

The Netherlands Working Conditions Survey (NWCS)

The Netherlands Working Conditions Survey (NWCS) is a yearly cross-sectional survey on working conditions in the Netherlands. NWCS is conducted among employees aged 15 to 64 years. Individuals are sampled randomly from the Dutch working population database of Statistics Netherlands. This database contains information on all jobs which fall under employee national insurance schemes and are liable to income tax. Participants filled out the questionnaire with a pencil or via the Internet. Data from the surveys conducted in 2005 and 2006 are included in the IPD-Work consortium. In total, 47 511 men and women participated in the surveys of 2005 and 2006 (12, 13). No ethical approval was required.

Permanent Onderzoek Leefsituatie (POLS)

Permanent Onderzoek Leefsituatie (POLS) is a series of annual cross-sectional health and lifestyle surveys of Dutch men and women(14). The participants are a representative sample of the Dutch population, drawn form the Municipal Population Register (Gemeentelijke Basis Administratie, GBA). Only those living in a private household were included. Most of the data collection is done using computer assisted personal interviewing. At study baseline in 1997- 2002, 59 441 men and women participated in the surveys. Of these, 24 761 were in paid employment, aged 15-85 and had job strain measure available and were eligible for our meta-analyses. POLS was approved by the medical ethics committee of the Netherlands Organisation for Applied Scientific Research.

Still Working

Still Working is an ongoing prospective cohort study. In 1986, the employees (n = 12 173) at all Finnish centres of operation of Enso Gutzeit (a forestry products manufacturer) were invited to participate in a

questionnaire survey on demographic, psychosocial and health-related factors. (15, 16). At baseline, 9 282 individuals responded, and of these 9 165 had data on job strain and were eligible for our meta-analyses. The study was approved by the ethics committee of the Finnish Institute of Occupational Health.

Whitehall II

The Whitehall II study is a prospective cohort study set up to investigate socioeconomic determinants of health. At study baseline in 1985-1988, 10 308 civil service employees (6 895 men and 3 413 women) aged 35-55 and working in 20 civil service departments in London were invited to participate in the study (17). Data on job strain, measured at study baseline were available for 10 285 men of the men and women who were eligible for our meta-analyses. The Whitehall II study protocol was approved by the University College London Medical School committee on the ethics of human research. Written informed consent was obtained at each data collection wave.

WOLF (Work, Lipids, and Fibrinogen) Stockholm and WOLF Norrland studies

The WOLF (Work, Lipids, and Fibrinogen) Stockholm study is a prospective cohort study of 5 698 people (3 239 men and 2 459 women) aged 19–70 and working in companies in Stockholm county (18). WOLF Norrland is a prospective cohort of 4 718 participants aged 19-65 working in companies in Jämtland and Västernorrland counties (19). At study baseline the participants underwent a clinical examination and completed a set of health questionnaires. For WOLF Stockholm, the baseline assessment was undertaken at 20 occupational health units between November 1992 and June 1995 and for WOLF Norrland at 13 occupational health service units in 1996-98. The Regional Research Ethics Board in Stockholm, and the ethics committee at Karolinska Institutet, Stockholm, Sweden approved the study.

References

1. Pelfrene E, Vlerick P, Mak RP, De Smets P, Kornitzer M, De Backe G. Scale reliability and validity of the Karasek `Job Demand-Control-Support' model in the Belstress study. *Work & Stress* 2001;15:297-313.
2. De Bacquer D, Pelfrene E, Clays E, Mak R, Moreau M, de Smet P, et al. Perceived job stress and incidence of coronary events: 3-year follow-up of the Belgian Job Stress Project cohort. Am J Epidemiol 2005;161:434-41.
3. Kristensen TS, Hannerz H, Hogh A, Borg V. The Copenhagen Psychosocial Questionnaire--a tool for the assessment and improvement of the psychosocial work environment. *Scand J Work Environ Health* 2005;31:438-49.
4. Burr H, Bjorner JB, Kristensen TS, Tüchsen F, Bach E. Trends in the Danish work environment in 1990–2000 and their associations with labor-force changes. *Scand J Work Environ Health* 2003;29:270-9.
5. Feveile H, Olsen O, Burr H, Bach E. Danish Work Environment Cohort Study 2005: From idea to sampling design. *Statistics in Transition* 2007;8:441-58.
6. Kivimäki M, Lawlor DA, Smith GD, Kouvonen A, Virtanen M, Elovainio M, et al. Socioeconomic position, co-occurrence of behavior-related risk factors, and coronary heart disease: the Finnish Public Sector Study. *Am J Public Health* 2007, 2007;97:874-9.
7. Goldberg M, Leclerc A, Bonenfant S, Chastang JF, Schmaus A, Kaniewski N, et al. Cohort profile: the GAZEL Cohort Study. *Int J Epidemiol* 2007;36:32-9.
8. Zins M, Leclerc A, Goldberg M. The French GAZEL Cohort Study: 20 years of epidemiologi research. *Advances in Life Course Research* 2009;14:135-46.
9. Korkeila K, Suominen S, Ahvenainen J, Ojanlatva A, Rautava P, Helenius H, et al. Non-response and related factors in a nation-wide health survey. *Eur J Epidemiol* 2001;17:991-9.
10. Nielsen M, Kristensen T, Smith-Hansen L. The Intervention Project on Absence and Well-being (IPAW): design and results from the baseline of a 5-year study. *Work & Stress* 2002;16:191-206.
11. Nielsen ML, Rugulies R, Christensen KB, Smith-Hansen L, Bjorner JB, Kristensen T. Impact of the psychosocial work environment on registered absence from work: a two-year longitudinal study using the IPAW cohort. *Work & Stress* 2004;18:323-35.
12. Bossche van den S, Hupkens, CLH., Ree de, SJM., Smulders, PGW. Nationale Enquête Arbeidsomstandigheden 2005: methodologie en globale resultaten. [Netherlands Working Conditions Survey 2005: methodology and overall results]. : Hoofddorp: TNO Work & Employment; 2006.
13. Hooff van M, van den Bossche SNJ, Smulders P. The Netherlands Working Conditions Survey. Highlights 2003-2006. Hoofddorp: TNO Work & Employment; 2008.

14. de Groot W, Dekker R. The Dutch System of Official Social Surveys. Mannheim: Mannheim Centre for European Social Research; 2001. Report No.: 30.
15. Kalimo R, Toppinen S. Organizational well-being: ten years of research and development: in a forest industry corporation. In: Kompier M, Cooper C, editors. Preventing Stress, Improving Productivity: European Case Studies in the Workplace. London: Routledge; 1999. p. 52-85.
16. Väänänen A, Murray M, Koskinen A, Vahtera J, Kouvonen A, Kivimäki M. Engagement in cultural activities and cause-specific mortality: prospective cohort study. *Prev Med* 2009;49:142-7.
17. Marmot MG, Davey Smith G, Stansfeld S, Patel C, North F, Head J, et al. Health inequalities among British civil servants: the Whitehall II study. *Lancet* 1991;337:1387-93.
18. Peter R, Alfredsson L, Hammar N, Siegrist J, Theorell T, P. W. High effort, low reward, and cardiovascular risk factors in employed Swedish men and women: baseline results from the WOLF Study. *J Epidemiol Community Health* 1998;52:540-7
19. Alfredsson L, Hammar N, Fransson E, de Faire U, Hallqvist J, Knutsson A, et al. Job strain and major risk factors for coronary heart disease among employed males and females in a Swedish study on work, lipids and fibrinogen. *Scand J Work Environ Health* 2002;28:238-48.

Web Appendix 2. Analysis of job strain and coronary heart disease based on alternative job strain definitions

We repeated analyses of job strain and incident CHD based on the five alternative definitions of job strain most often used in previous studies:

(1) Job demand component alone, modelled as study-specific quartiles

(2) Job demand component alone, modelled as a study-specific z-score (Mean=0, SD=1)

(3) Job control component alone, modelled as study-specific quartiles

(4) Job control component alone, modelled as a study-specific z-score (Mean=0, SD=1)

(5) Quadrant definition, that is: high strain job (high demands and low control), active job (high demands and high control), passive job (low demands and low control) and low strain job (low demands and high control) with definition of low and high based the study-specific median score.

Table S1 shows the results for the associations between alternative job strain measures and incident CHD. They support the concept that a combination of high demands and low control,[1] rather than either of these components alone,[2,3] is associated with an increased coronary risk.

Table S1. The association between job strain and incident coronary heart disease, based on alternative job strain definitions.*

Alternative measures of job strain	Age- and sex-adjusted hazard ratio
1. Job demands category	
Q1, bottom quartile	1.00 (reference)
Q2	1.05 (0.84-1.31)
Q3	1.08 (0.95-1.22)
Q4, top quartile	1.07 (0.92-1.25)
2. Continuous job demands (z-score)	1.02 (0.96-1.08)
3. Job control category	
Q1, bottom quartile	1.00 (reference)
Q2	1.00 (0.86-1.15)
Q3	0.89 (0.78-1.03)
Q4, top quartile	0.80 (0.67-0.97)
4. Continuous job control (z-score)	0.93 (0.89-0.98)
5. Job strain quadrants	
Low strain (low demands-high control)	1.00 (reference)
Passive (low demands-low control)	1.12 (0.99-1.27)
Active (high demands-high control)	1.06 (0.94-1.19)
High strain (high demands-low control)	1.28 (1.11-1.48)

*These analyses are based on individual-level data from all constituent studies for which the IPD-team had full access (Belstress, FPS, Gazel, HeSSup, Still Working, Whitehall II, Wolf-N, Wolf-S). The age- and sex-adjusted hazard ratio for the association between job strain, defined as in the main analysis, and incident CHD was 1.23 (95% CI 1.08-1.39) in this dataset, that is, the same as in all 13 cohorts.

References

1. Karasek RA, Theorell T, Schwartz JE, Schnall PL, Peiper CF, Michela JL. Job characteristics in relation to the prevalence of myocardial infarction in the US Health Examination Survey (HES) and the Health and Nutrition Examination Survey (HANES). *Am J Public Health* 1988;78:910-918.
2. Eller NH, Netterstrøm B, Gyntelberg F, Kristensen TS, Nielsen F, Steptoe A, Theorell T. Work-related psychosocial factors and the development of ischemic heart disease: a systematic review. Cardiol Rev 2009;17:83-97.
3. Everson-Rose SA, Lewis TT. Psychosocial factors and cardiovascular diseases. Annu Rev Public Health 2005;26:469-500.