Karasek's Model of Job Strain

(R.A. Karasek, 1979)

Purpose

Karasek proposed that work situations be classified in terms of the balance they offer between the demands on the worker and level of control he can exert over those demands, as a way to gain insight into the connection between type of occupation and health.

Conceptual Basis

A limitation of earlier models of work and health, in Karasek's view, was that they only considered the dimension of job demands – overload or, occasionally, underload. He noted that the low morbidity of executives in challenging jobs discredits the simple idea that morbidity derives from over-arousal of the sympathetic nervous system. He also questioned explanations couched in terms of income inequality, since low control jobs may still lead to morbidity in societies that equalize incomes (2).

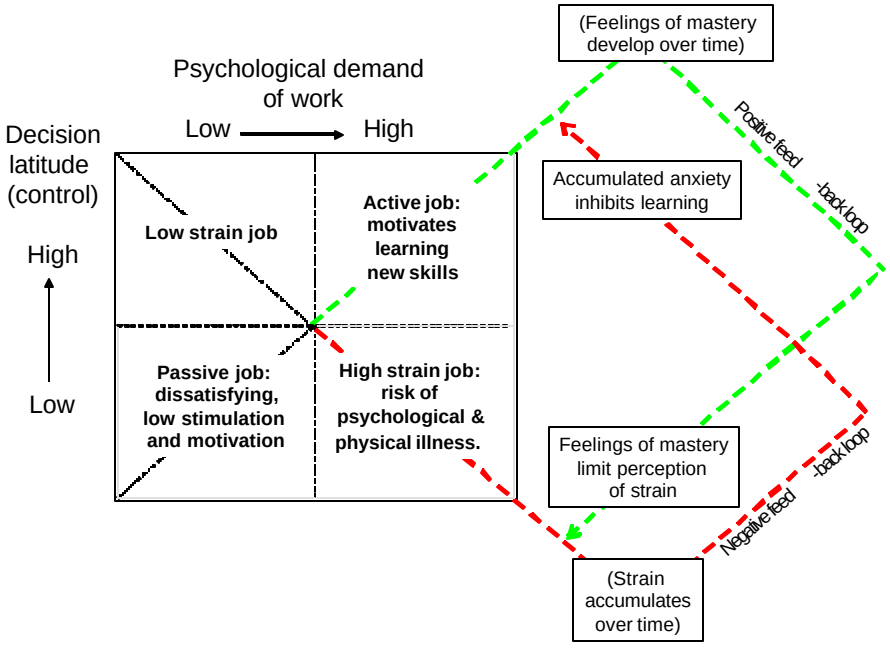
Instead, Karasek proposed a more comprehensive model that considers working conditions, rather than merely the nature of the job itself. He included a psychosocial dimension: the level of perceived control an employee has over the work situation. This idea of control derived from Karasek's earlier studies of the importance of being able to make decisions at work, from Seligman's theories of learned helplessness, from theories of active and passive coping, and from Sundbom's studies of psychological strain in challenging occupations (3). Karasek proposed that job strain results from a combination of high psychological demands (such as having to work hard and fast) with little freedom to make decisions affecting work (e.g., fixed schedules; subordinate rank; piece-work pay schedule). The resulting job strain increases the risk of disease. By contrast, if high job demands are combined with a high level of decision latitude, the stress can be positive, stimulating innovation and personal development (3). This Karasek termed an "active" job situation: typical of many managerial positions. Karasek proposed that the dimensions of demand and control might reflect different mechanisms of physiological activation (3, p14). The model was tested empirically in Sweden in the mid 1970s (3, p10), and Karasek later collaborated with Theorell in applying the model to predicting cardiovascular disease (4).

Karasek later developed a fuller stress-disequilibrium model that proposes how feelings of demand and control activate physiological regulation mechanisms that may contribute to conditions such as depression, hypertension, diabetes and musculoskeletal disorders (2). The model draws a parallel between internal homeostasis and the external environment of job control (2). CNS-mediated homeostatic control is sensitive to the perceived level of control over external demands, causing SAM arousal and parasympathetic decline, restricting insulin and increasing adrenaline.

Description

The Figure shows how Karasek's revised model classifies jobs into four categories according to level of psychological demand and of decision latitude or job control. This refers to a person's level of control over time allocation and organizational decisions; lack of job control is hypothesized to have a multiplicative interaction with the level of demand in affecting job strain. The critical categories are the active job (high demands, but with high decision latitude) and the high strain job (high demands with low latitude for decisions). The cumulative experience of working in each of these situations over time modifies a person's psychological well-being and also their coping styles. Working in a stimulating environment forms a positive feed-back loop that helps a person learn to cope with periods of overload. By contrast, a high strain job forms a negative feed-back loop that arouses feelings of lack of control which inhibit learning, further impairing confidence and self-esteem (1).

The model was subsequently extended to consider support at work: the demand-control-support, or DCS model. Work characterized by high demands, low decision latitude, and low support decreases health and well-being.



Karasek's dynamic model of job strain (adapted from (3).

Measurements. The job strain for a particular occupation can be assessed by individual self-report, or from group perceptions of a number of respondents. The former has the advantage that it can capture variations within an occupational category, but the disadvantage of potential self-fulfilling bias in the classification of strain if the person is experiencing adverse health effects. Studies using self-reported work strain tend to produce higher relative risks than those using aggregated estimates - Theorell and Karasek reported 2 - 4 versus 1.3 to 2 (3, p16).

The most common measure is Karasek's Job Content Questionnaire which has sub-scales covering physical and psychological job demands, decision latitude, personal insecurity and social support in the work place. The decision latitude sub-scale covers authority to make decisions and skill discretion (3, p18). Several validation studies have been reported (5; 6). Abbreviated versions include the 17-item Demand-Control-Support Questionnaire (7) and the Work History Questionnaire (6). Schrijvers et al. used five questions to measure job control (8):

"Can you interrupt your work when you find it necessary?"

"Can you organize your own activities at work?"

"Can you determine the beginning and end of your work day, and the timing of taking breaks?"

"Do you have a lot of monotonous work?", and

"Can you develop your abilities by working?"

Statistics Canada assessed decision latitude with two questions: "I have a lot to say about what happens in my job" and "My job allows me the freedom to decide how I do my job". [CANSIM, 2000-2001.]

The WHO-MONICA study included a questionnaire on psychosocial risk factors that covers perceived job control [I just found a Japanese reference that alludes to it - GOK what original source may be]

There is also a 52-item salutogenetic subjective work assessment (SALSA), with 13 subscales, which focuses on indicators of perceived work stress in terms of pathogenic and salutogenic descriptors of decision latitude, psychological job demands, and social support.

Validity

An extensive literature covers the validity of Karasek's model; most of the studies concern cardiovascular disease: infarctions, mortality or cardiac risk factors. The following overview is not exhaustive, and is based largely on review articles (3; 9).

Hypertension. Several studies have linked job strain has been linked to hypertension, generally showing a significant relationship(3; 10), even after adjustment for other risk factors (11). The associations between hypertension and psychological demands or decision latitude alone tend to be weak, but in combination (i.e., job strain), the association is stronger (3, p21). There is some

suggestion that job strain may not show a linear association with blood pressure, but instead show a threshold relation with the development of hypertension (12).

Heart disease. Numerous studies have been undertaken, not all of which have shown an association between job strain and cardiovascular disease. Karasek discussed 36 such studies undertaken between 1981 and 1998; 25 showed significant associations with job strain. Among the cohort studies, 11 of 19 showed a positive association (2).

As illustrations, a 25-year follow-up of the Chicago Western Electric study, after controlling for traditional coronary disease risk factors, found a marginally significant association between coronary death and the decision latitude score; job strain and psychological demand scores showed non-significant associations. Controlling for occupational class reduced the association, suggesting that at least part of the effect of occupational class on health was mediated by decision latitude (13). A three-year follow-up of a Belgian cohort (N = 14,337) found an increased incidence of heart disease among those in the high strain quadrant, but this did not reach statistical significance; however, a significant association was found between heart disease and the level of social support at work (14). In a case-control study of first infarctions, Hammar et al. reported odds ratios for 'hectic work' combined with low control ranged from 1.2 to 1.6; these were statistically significant (15).

Several studies have investigated intermediate cardiovascular outcomes. In a representative cohort of male Swedish workers, and after controlling for age, education, smoking and body weight, Karasek et al. found that a hectic and psychologically demanding job predicted the development of cardiovascular symptoms less strongly (odds ratio of 1.29) than it predicted subsequent death from heart disease or stroke (relative risk 4.0) (4). The equivalent results for low decision latitude were OR 1.4 for symptoms, and RR 6.6 for subsequent mortality. In their 1996 review, Theorell and Karasek commented on the finding that intermediate outcomes may show weaker associations than are found with eventual cardiac disease. To explain this, they suggested that the association between job strain and heart disease may be mediated chiefly through psycho-endocrine mechanisms or system disequilibrium pathways, rather than through conventional risk factors (3, p12). Some studies, however, do show associations: a small study of 36 males showed an association between job stain and disturbed cardiac regulation recorded on 48-hour Holter monitors (16). Similarly, a Korean study reported associations between decision latitude and cholesterol and triglyceride levels, while work demand was related to smoking and blood pressure levels (17). Another Korean study reported a non-significant association in the expected direction between job strain, variability in heart rate and metabolic syndrome (18). But negative findings were reported from a study of nurses: there was no association between job strain and heart rate, blood pressure, or variability in heart rate (19). Theorell and Karasek briefly reviewed the hypothesis that job strain promotes high plasma fibrinogen levels, increasing the tendency to coagulation (3, p20).

Bosma et al. reported a head-to-head comparison of the predictive validity of the job strain model and Siegrist's effort-reward imbalance model in the Whitehall II cohort (20). Of the components of job strain, only job control showed an association with cardiovascular disease (either angina pectoris or diagnosed ischemia), with an OR of 1.6. Effort-reward imbalance showed a stronger association (OR 3.1), yet job control was associated with disease outcomes even after adjusting for effort-reward imbalance (20, Table 4). This finding matched that of a review by Schnall et

al, which showed that 17 of 25 studies showed a main effect for job control, while only 8 of 23 studies found significant associations with job demands (21).

Musculo-skeletal problems. Many occupations pose a direct threat to health, in terms of physical danger, repetitive strain and so on. It is therefore not surprising that many studies have reported both direct health effects of occupation and also indirect effects that reflect Karasek's Demand-Control model. A small study of newspaper employees working at video terminals, for example, showed that posture and ergonomic variables predicted upper body stiffness and pain, but so were psychological workload, decision latitude and relationship with the supervisor (22).

Bongers has reviewed the literature on job control and musculoskeletal complaints; the results suggest a modest association (23). Neck and shoulder strain has been widely studied in relation to the quadrants of the Karasek model. A non-significant hazard ratio of 1.65 was reported for neck and shoulder symptoms among computer users in the high strain quadrant. The association was significant, however, for a sub-set of employees with no previous experience with computers (5). In a Swedish general population cohort study, neck and shoulder pain were related to level of mechanical effort required at work; job strain was also significantly associated, but only for women (24). A study of 1294 employees from 10 companies in Belgium and the Netherlands also suggested that back pain was primarily predicted by the physical demands of work, although job characteristics such as decision latitude (along with other factors) played some role in predicting whether the person would return to work (25). Leroux et al. reported that job strain clearly predicted neck and shoulder problems, but this was mediated by social support, rather than by perceived job control (26). In a separate study of nonspecific back pain, the same research group reported limited evidence of an association with job strain, and only among women (27). In a study of transit workers, elevated hazard ratios for neck pain and low back pain fell in the range 1.27 to 1.73; most, but not all, were statistically significant.

Mental health. When mental health outcomes are recorded via self-report, there is commonly a significant, but relatively modest, association with perceived job strain and control; this is especially the case in cross-sectional studies. For example, job demand, social support and effort-reward imbalance explained 19% of the variance in Short-Form-12 scores, falling to 13% after adjustment for demographics, SES and medical condition (28). Several studies have linked job control to depression in Europe and Japan (29-32). Job strain, low decision latitude, effort-reward imbalance, and low reward (especially job instability) were associated with depressive symptoms and psychiatric disorders among men (33). In a study in Eastern Europe, job strain was associated with depression in Poland and the Czech Republic, but not in Russia, and the association was reduced after controlling for socioeconomic status (29, p1479). A cross-sectional Belgian study reported associations between job control and depression (OR 1.9) and anxiety (OR 1.7). Job demands only showed an association (marginally significant) with anxiety (32, Table 4). A French prospective study showed that the DCS model predicted self-reported health outcomes at one year; there were some differences in the patterns of association for men and for women (34).

More objective indicators of mental well-being have also been linked with job characteristics.

A 2005 Japanese study of work-related suicide drew a connection between high demand, long work hours and low decision latitude with the development of depressive symptoms which, following inadequate medical attention, led to suicide (35). The Whitehall II study found that effort-reward imbalance predicted excess alcohol consumption (36).

Sickness absence (from all causes). The Maastrich Cohort Study of 45 companies studied predictors of absence from work. After controlling for demographic factors, the presence of long-term medical conditions and low levels of decision latitude formed independent predictors of absences lasting over one month (37). Similarly, a six-year French cohort study of over 13,000 employees showed that low decision latitude and poor social relations at work both significantly predicted absences from work (38). As well as studying perceptions of decision latitude, the Whitehall II study has shown that *reductions* in decision latitude and *increases* in job demands are independently associated with sickness absence; increases in social support were protective (39).

General well-being. A study of Dutch university personnel failed to show an association between decision latitude and perceived health complaints (40). Schrijvers et al., for example, recorded physical working conditions, job demands, control & social support at work in a cross-sectional study of 6,932 employed people in the Netherlands (8). They concluded that "a substantial part of the association between occupational class and perceived general health can be attributed to a differential distribution of hazardous physical working conditions and low job control across occupational classes. Job demands and social support at work did not contribute to the explanation..." (8, p1014). This result held both for men and for women. In effect, this study did not replicate Karasek's finding, for there was no interaction between job demands and job control. Similarly, data from the Whitehall II study found no effect of job demands, but did find an influence of job control on CVD incidence.

Alternative Forms

Johnson et al. incorporated social isolation and this improved the predictive ability of the model in one study (41). The study suggested that high demand and low control was especially deleterious for blue collar workers, while high demand and low social support was more important for women and for white collar men (3, p13).

Siegrist et al. proposed a model of Effort-Reward Imbalance that builds on the Karasek model. This identifies effort and social reward as the crucial dimensions: high effort without concomitant social reward is pathogenic (20; 42-46). The theme of social reward blends the ideas of decision latitude and of social support, although the model focuses chiefly on the cost-benefit features of the job, rather than the conceptually more diverse approach of the demand-control model. Theorell and Karasek have seen Siegrist's approach as a valuable addition to their model, and suggested that the effort-reward imbalance model be used as a supplement to the demand-control model (3, p14).

Commentary

The Karasek model has become very widely known and studied. It has been used in a multi-national European study (n = 38,000) of patterns of job demand and control by occupation and sex (47).

The overall impression from empirical tests of the job strain hypothesis is that the observed associations are generally modest, and many are not statistically significant. Understandably, these results vary according to the health outcome studied. Thus, the studies of musculoskeletal outcomes frequently show that the physical demands of the job form the strongest predictor, often making job strain insignificant. Cardiovascular outcomes, however, are more complex and more influenced by mental processes, and here job strain shows a more consistent relationship. However, most studies also find other variables, such as the level of social support at work, to act as significant effect modifiers; adjustment for demographic variables at times removes the association between job strain and health outcomes (e.g., reference (48)). One issue may be that adjusting for risk factors such as smoking or alcohol consumption may represent over-control, as these could form pathways for the impact of job strain.

Job strain represents a plausible pathway linking occupational status and poor health (49). Of the components of job strain, a consistent finding is that low job control may be the crucial ingredient. The Whitehall study findings, like those of Schnall's review, seem to agree on this. Bosma et al. commented "it is control over the work process rather than high job demands or job strain that increasingly emerges as the main critical component of a healthy work environment" (20, p71). Theorell and Karasek noted that job strain is influential mainly among blue-collar workers (3, p13), and lack of job control is common in blue-collar work situations, whereas the empirical results suggest that it is the ability to exert control over one's job that mitigates the impact of high demands for white collar workers. Beyond this general conclusion, however, Karasek's distillation of fine details of the work environment may also offer explanations for variations in health outcomes within occupational classes.

But there are many other ways that occupation may affect health, such as hazardous work, shift work, low social recognition, and lower pay. In terms of the overall association between occupational status and health, Fenwick and Tausig reported an interesting empirical analysis that attributed the connection between macroeconomic changes, such as recessions, and individual stress because to changes in routine job structures such as decision latitude and job demands, rather than to direct effect (50):

> "However, evidence is mounting for significant independent effects of work control and job demand on measures of health and job outcomes. Specifically, the control domain of an employee's daily work activities is likely to have the strongest impact on employee performance, attendance, productivity, and well-being. This is consistent with Karasek's model, which states that job control is the crucial factor that provides the opportunity for individuals to adjust to demands, according to their actual needs and circumstances"

Further evidence for the importance of decision latitude comes from interventions, such as holding more frequent and democratic staff meetings, which have been shown to have beneficial effects such as improved lipoprotein profiles (51), although patients may also require pharmacologic treatment for anxiety (52). Evidently, decision latitude will relate to occupational status, but other factors such as

gender, personality and coping style may affect a person's *perceptions* of decision latitude. Sjogren and Kristenson, for example, reported interaction effects between gender, education and other psychological factors in affecting perceptions of decision latitude (53). And the model may not work equally for men and for women: Theorell and Karasek commented that for women more than men, the home and work situations interact in affecting their overall health (3, p14).

There have been various criticisms of Karasek's model; most derive from the lack of precision in its formulation:

- The notion of control is not entirely clear: does this refer to objective control over the work situation, or to the person's subjective feeling that his job could be modified, or to a general belief concerning how far important outcomes are controllable? (44, p28). Kasl also discussed the imprecision of the definitions of concepts such as decision latitude and control, suggesting that the authors "need to provide sharp definitions of concepts and clear guidelines about their measurement" (54, p50).
- The measurement of the social support component seems somewhat inconsistent. Some studies have focused on social interaction, while others have included items on caring and help, or companionship. Kasl argued that "It is worth clarifying (...) which component (co-worker interaction or support) may be the more important moderator, and whether the two components are differently involved in moderating the effects of high demands versus the effects of low latitude." (54, p51).
- Siegrist observed that Karasek's approach to control focuses on objective task characteristics, and does not seem to include personal coping. And yet, variations in personal responses to ostensibly similar situations can be important (44, p21). Kasl also concurred (in 1996) that "the job strain model thus far has maintained a strong focus on the work environment and has not concerned itself with the characteristics of individuals in those jobs" (54, p50).
- Kasl noted that the form of the interaction between decision latitude and job demands was not made clear (additive effect? Multiplicative? Potentiating effect?). In consequence, empirical tests of an interaction effect have been very inconsistent between subsequent authors, such that "the evidence for an interactive relationship between demands and latitude can be characterized as somewhere between limited and unclear" (54, p49).
- Many of the empirical tests of the model used secondary analyses of existing data: practical, but tending to lead to inconsistent operationalization of the concepts (54, p50).

Notwithstanding these commentaries, Karasek's work was instrumental in focusing attention onto the active ingredients of occupations as they affect health. It was a contribution further developed by Siegrist in his model.

References.

(1) Karasek RA, Theorell T. Healthy work: stress, productivity and the reconstruction of working life. New York: Basic Books, 1990.

(2) The stress-disequilibrium theory of chronic disease development: low social control and physiological deregulation. Newport Beach, California: 2005.

(3) Theorell T, Karasek RA. Current issues relating to psychosocial job strain and cardiovascular disease research. J Occup Health Psychol 1996; 1:9-26.

(4) Karasek RA, Baker D, Marxer F, Ahlbom A, Theorell T. Job decision latitude, job demands, and cardiovascular disease: a prospective study of Swedish men. Am J Public Health 1981; 71:694-705.

(5) Hannan LM, Monteilh CP, Gerr F, Kleinbaum DG, Marcus M. Job strain and risk of musculoskeletal symptoms among a prospective cohort of occupational computer users. Scand J Work Environ Health 2005; 31:375-386.

(6) Landsbergis PA, Schnall PL, Pickering TG, Schwartz JE. Validity and reliability of a work history questionnaire derived from the Job Content Questionnaire. J Occup Environ Med 2002; 44:1037-1047.

(7) Sanne B, Torp S, Mykletun A, Dahl AA. The Swedish Demand-Control-Support Questionnaire (DCSQ): factor structure, item analyses, and internal consistency in a large population. Scand J Public Health 2005; 33:166-174.

(8) Schrijvers CTM, van de Mheen HD, Stronks K, Mackenbach JP. Socioeconomic inequalities in health in the working population: the contribution of working conditions. Int J Epidemiol 1998; 27:1011-1018.

(9) Landsbergis PA, Schnall PL, Belkic KL, Baker D, Schwartz J, Pickering TG. Work stressors and cardiovascular disease. Work 2001; 17:191-208.

(10) Landsbergis PA, Schnall PL, Warren K, Pickering TG, Schwartz JE. Association between ambulatory blood pressure and alternative formulations of job strain. Scand J Work Environ Health 1994; 20:349-363.

(11) Markovitz JH, Matthews KA, Whooley M, Lewis CE, Greenlund KJ. Increases in job strain are associated with incident hypertension in the CARDIA Study. Ann Behav Med 2004; 28:4-9.

(12) Ducher M, Cerutti C, Chatellier G, Fauvel JP. Is high job strain associated with hypertension genesis? Am J Hypertens 2006; 19:694-700.

(13) Alterman T, Shekelle RB, Vernon SW, Burau KD. Decision latitude, psychological demand, job strain, and coronary heart disease in the Western Electric Study. Am J Epidemiol 1994; 139:620-627.

(14) 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; 161:434-441.

(15) Hammar N, Alfredsson L, Theorell T. Job characteristics and the incidence of myocardial infarction. Int J Epidemiol 1994; 23:277-284.

(16) Collins SM, Karasek RA, Costas K. Job strain and autonomic indices of cardiovascular disease risk. Am J Ind Med 2005; 48:182-193.

(17) Kang MG, Koh SB, Cha BS, Park JK, Baik SK, Chang SJ. Job stress and cardiovascular risk factors in male workers. Prev Med 2005; 40:583-588.

(18) Kang MG, Koh SB, Cha BS, Park JK, Woo JM, Chang SJ. Association between job stress on heart rate variability and metabolic syndrome in shipyard male workers. Yonsei Med J 2004; 45:838-846.

(19) Riese H, Van Doornen LJ, Houtman IL, De Geus EJ. Job strain in relation to ambulatory blood pressure, heart rate, and heart rate variability among female nurses. Scand J Work Environ Health 2004; 30:477-485.

(20) Bosma H, Peter R, Siegrist J, Marmot M. Two alternative job stress models and the risk of coronary heart disease. Am J Public Health 1998; 88:68-74.

(21) Schnall PL, Landsbergis PA, Baker D. Job strain and cardiovascular disease. Annu Rev Public Health 1994; 15:381-411.

(22) Faucett J, Rempel D. VDT-related musculoskeletal symptoms: interactions between work posture and psychosocial work factors. Am J Ind Med 1994; 26:597-612.

(23) Bongers PM, de Winter CR, Kompier MA, Hildebrandt VH. Psychosocial factors at work and musculoskeletal disease. Scand J Work Environ Health 1993; 19:297-312.

(24) Ostergren PO, Hanson BS, Balogh I, Ektor-Andersen J, Isacsson A, Orbaek P et al. Incidence of shoulder and neck pain in a working population: effect modification between mechanical and psychosocial exposures at work? Results from a one year follow up of the Malmo shoulder and neck study cohort. J Epidemiol Community Health 2005; 59:721-728.

(25) Gheldof EL, Vinck J, Vlaeyen JW, Hidding A, Crombez G. The differential role of pain, work characteristics and pain-related fear in explaining back pain and sick leave in occupational settings. Pain 2005; 113:71-81.

(26) Leroux I, Brisson C, Montreuil S. Job strain and neck-shoulder symptoms: a prevalence study of women and men white-collar workers. Occup Med (Lond) 2006; 56:102-109.

(27) Leroux I, Dionne CE, Bourbonnais R. Psychosocial job factors and the one-year evolution of back-related functional limitations. Scand J Work Environ Health 2004; 30:47-55.

(28) Kudielka BM, Hanebuth D, von Kanel R, Gander ML, Grande G, Fischer JE. Health-related quality of life measured by the SF12 in working populations: associations with psychosocial work characteristics. J Occup Health Psychol 2005; 10:429-440.

(29) Pikhart H, Bobak M, Pajak A, Malyutina S, Kubinova R, Topor R et al. Psychosocial factors at work and depression in three countries of Central and Eastern Europe. Soc Sci Med 2004; 58:1475-1482.

(30) Tsutsumi A, Kayaba K, Theorell T, Siegrist J. Association between job stress and depression among Japanese employees threatened by job loss in a comparison between two complementary job-stress models. Scand J Work Environ Health 2001; 27:146-153.

(31) Stansfeld S, Head J, Marmot M. Explaining social class differences in depression and well-being. Soc Psychiatry Psychiatr Epidemiol 1998; 33:1-9.

(32) Godin I, Kittel F. Differential economic stability and psychosocial stress at work: associations with psychosomatic complaints and absenteeism. Soc Sci Med 2004; 58:1543-1553.

(33) Niedhammer I, Chastang JF, David S, Barouhiel L, Barrandon G. Psychosocial work environment and mental health: Job-strain and effort-reward imbalance models in a context of major organizational changes. Int J Occup Environ Health 2006; 12:111-119.

(34) Niedhammer I, Chea M. Psychosocial factors at work and self reported health: comparative results of cross sectional and prospective analyses of the French GAZEL cohort. Occup Environ Med 2003; 60:509-515.

(35) Amagasa T, Nakayama T, Takahashi Y. Karojisatsu in Japan: characteristics of 22 cases of work-related suicide. J Occup Health 2005; 47:157-164.

(36) Head J, Stansfeld SA, Siegrist J. The psychosocial work environment and alcohol dependence: a prospective study. Occup Environ Med 2004; 61:219-224.

(37) Andrea H, Beurskens AJ, Metsemakers JF, van Amelsvoort LG, van den Brandt PA, van Schayck CP. Health problems and psychosocial work environment as predictors of long term sickness absence in employees who visited the occupational physician and/or general practitioner in relation to work: a prospective study. Occup Environ Med 2003; 60:295-300.

(38) Melchior M, Niedhammer I, Berkman LF, Goldberg M. Do psychosocial work factors and social relations exert independent effects on sickness absence? A six year prospective study of the GAZEL cohort. J Epidemiol Community Health 2003; 57:285-293.

(39) Head J, Kivimaki M, Martikainen P, Vahtera J, Ferrie JE, Marmot MG. Influence of change in psychosocial work characteristics on sickness absence: The Whitehall II Study. J Epidemiol Community Health 2006; 60:55-61.

(40) Donders NC, van der Gulden JW, Furer JW, Tax B, Roscam Abbing EW. Work stress and health effects among university personnel. Int Arch Occup Environ Health 2003; 76:605-613.

(41) Johnson JV, Hall EM. Job strain, workplace social support and cardiovascular disease: a cross-sectional study of a random sample of the Swedish working population. Am J Public Health 1988; 78:1336-1342.

(42) Siegrist J, Siegrist K, Weber I. Sociological concepts in the etiology of chronic disease. Soc Sci Med 1986; 22:247-253.

(43) Siegrist J, Peter R, Junge A, Cremer P, Seidel D. Low status control, high effort at work and ischemic heart disease: prospective evidence from blue-collar men. Soc Sci Med 1990; 30:1127-1134.

(44) Siegrist J. Adverse health effects of high-effort/low-reward conditions. J Occup Health Psychol 1996; 1:27-41.

(45) Siegrist J, Starke D, Chandola T, Godin I, Marmot M, Niedhammer I et al. The measurement of effort-reward imbalance at work: European comparisons. Soc Sci Med 2004; 58:1483-1499.

(46) Niedhammer I, Tek M-L, Starke D, Siegrist J. Effort-reward imbalance model and self-reported health: cross-sectional and prospective findings from the GAZEL cohort. Soc Sci Med

2004; 58:1531-1541.

(47) de Smet P, Sans S, Dramaix M, Boulenguez C, de Backer G, Ferrario M et al. Gender and regional differences in perceived job stress across Europe. Eur J Public Health 2005; 15:536-545.

(48) Swaen GM, van Amelsvoort LP, Bultmann U, Slangen JJ, Kant IJ. Psychosocial work characteristics as risk factors for being injured in an occupational accident. J Occup Environ Med 2004; 46:521-527.

(49) Marmot M, Theorell T. Social class and cardiovascular disease: the contribution of work. Int J Health Serv 1988; 18:659-674.

(50) Fenwick R, Tausig M. The macroeconomic context of job stress. J Health Soc Behav 1994; 35:266-282.

(51) Orth-Gomer K, Eriksson I, Moser V, Theorell T, Fredlund P. Lipid lowering through work stress reduction. Int J Behav Med 1994; 1:204-214.

(52) Stahl SM, Hauger RL. Stress: an overview of the literature with emphasis on job-related strain and intervention. Adv Ther 1994; 11:110-119.

(53) Sjogren E, Kristenson M. Can gender differences in psychosocial factors be explained by socioeconomic status? Scand J Public Health 2006; 34:59-68.

(54) Kasl SV. The influence of the work environment on cardiovascular health: a historical, conceptual, and methodological perspective. J Occup Health Psychol 1996; 1:42-56.