SJWEH Suppl 2008;(6):22–32

Socioeconomic status, job strain and common mental disorders—an ecological (occupational) approach

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Choi BK, Clays E, De Bacquer D, Karasek R. Socioeconomic status, job strain and common mental disorders—an ecological (occupational) approach. *SJWEH Suppl.* 2008;(6):22–32.

Objectives This study attempted to determine whether an ecological association exists between job strain and common mental disorders at the occupational level and whether the association is a confounding effect of socioeconomic status.

Methods Male occupations from Belgium (N=184) and the United States (US) (N=120) were chosen from the BELSTRESS study (Belgian job-stress study) (1994–1998) and quality of employment surveys (1972–1977), respectively. Age, marital status, socioeconomic indicators, job control (skill discretion and decision authority), psychological demands, supervisory and coworker supports, physical demands, job insecurity, and symptom scales for mental disorders were all aggregated at the occupational level (detailed occupational codes). Job strain was defined as a ratio of psychological demands to job control. Simple correlations, graphic investigations, and multivariate regression analyses were conducted.

Results While job strain was significantly correlated with socioeconomic indicators in the US sample, their covariance was less than 30% in both samples. In the graphic investigations, job strain was orthogonal to all of the socioeconomic indicators. Job strain (both samples), job control (US sample), skill discretion (Belgian sample), and psychological demands (Belgian sample) were associated with mental disorders, after control for the covariates (including socioeconomic indicators). The association of decision authority with mental disorders was relatively weak in both samples. Generally, the associations were stronger in the low or middle socioeconomic group than in the high socioeconomic group.

Conclusions Job strain is associated with common mental disorders at the occupational level, and it is not explained fully in the context of the association between socioeconomic status and mental disorders.

Key terms Belgium; job control; psychological demand; United States.

Criticisms of studies on the association between psychosocial work characteristics [including job strain, the combination of job control and psychological work demands, and the demand–control model (1, 2)] with common mental disorders (hereafter referred to as mental health) have centered on two factors (3), the confounding effect of socioeconomic status and the reliance of most studies in this research area on subjective accounts of both work stressors and common mental disorders. In this study, we addressed the two seemingly separated, but methodologically and etiologically related issues by using occupation-aggregated job strain and occupation-aggregated mental health symptoms.

There has been an unrelenting suspicion that the reported association between job strain (or job control) and mental health may be a replication of the association between socioeconomic status and mental health or that high job strain (or low job control) may be another measure of low social status (4–6). However, several cross-sectional (7–10) and prospective (11–14) epidemiologic studies have shown the independent effect of job strain on mental health after control for conventional socioeconomic indicators (ie, education, income, or occupation). This case is the same for the components of job strain [job control (15–17); skill discretion (17–18); decision authority (19–20); psychological demands (16–17, 19)]. In addition, the amount of covariance between conventional socioeconomic indicators and job strain (including its components) was less than 20% for large working populations in Belgium, South Korea, and

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Japan (21). All of these criticisms imply that job strain is not interchangeable with socioeconomic status, and its association with mental health is not fully understood in the context of the association between socioeconomic status and mental health.

Nonetheless, these interpretations are not yet conclusive because job strain in all of the studies (7–14) was self-reported by workers. Self-reported job strain is not necessarily in accordance with more objectively measured job strain (22–24) because of several internal and external factors related to the perception of and response to objective job stressors (25–28). In addition, job strain was originally defined as a job characteristic in the demand–control model (1–2).

Thus such individualistic operationalization of job strain may not be appropriate in examining its relationships with both socioeconomic status and mental health. The structural relation of job strain with socioeconomic status can be underestimated, and the magnitude of the effect of job strain on (self-reported) mental health can be overestimated. Furthermore, it imposes a difficulty, namely, to improve mental health. Do we need to change adverse psychosocial work conditions or individual perception, personality, and coping style (26)?

Using group(occupation)-aggregated values of self-reported job stressor scores (group: people who do the same job) is a way to reduce self-report bias (26, 29–30). The method has been employed in some occupational cardiovascular disease studies (30–31), but only in a few occupational mental health studies (28-29, 32). And, among the few studies, no study examined the association between job strain and mental health.

Another issue is the validity of self-reported mental health measures. These measures are also vulnerable to self-report bias (33–35), as are the self-reported job stressors. Thus, again, using group-aggregated information for mental health may be more accurate—biases canceled out collectively—than individual scores, a possibility that is in line with the "shared job strain" idea (27). In addition, there have been a few studies about occupational differences in mental health, compared with the number of studies on individual differences in mental health. Several studies have shown detailed occupational differences in minor psychiatric disorders (36) or major depressive disorders (37), but none of them examined their associations with specific job stressors. Caplan et al (38) examined the occupational level correlations between job stressors and mental health, but its sample size was small (ie, 23 occupations) for a substantial analysis.

The purpose of this study was to examine whether there is an "ecological" association between job strain and adverse mental health at the occupational level and whether it is a confounding effect of socioeconomic status. This ecological analysis (ie, the unit of analysis of both exposure and outcome is an occupation) (39–41) is a conservative approach for the aforementioned two criticisms of the association between job strain and mental health at the individual level.

Study population and methods

Two datasets were used for this study, the Belgian data from the BELSTRESS study (Belgian job-stress study) (42) and the United States (US) 1972 and 1977 Quality of Employment Survey (QES) data (1–2). The Belgian data were collected in the period between 1994 and 1998 in 25 large organizations across Belgium, including diverse occupations and industries, albeit not representative of the Belgian workforce, and the response rate was 48%. Altogether 21 419 workers (16 335 men and 5 084 women) participated in the cohort study at the baseline. Their ages ranged from 35 to 59 (median 46) years. The US data came from a series of national stratified samples of housing units in 1972 and 1977 (with a 75% response rate for the 1972 data). The database included various information on 3011 workers (1984 men and 1027 women), their age span being 16–77 (median 36) years. This study, as the first of a series of analyses, was restricted only to male occupations in both datasets for a practical reason (ie, there were relatively larger numbers of occupations for the men than for the women).

Numbers of detailed occupations (unit of analysis)

The Belgian data included the four-digit occupation codes of the International Standard Classification of Occupations (ISCO) (43). Altogether 186 occupations were initially identified that concurred with the criteria, valid codes, and the number of persons with the same occupation code (ie, five or greater than five) (23). However, two agricultural occupations (1.1% of the total male workers in the original Belgian data) were finally excluded from this study in accordance with the previous individual level study (21). The number of persons in each occupation ranged from 5 to 476 (median: 31 persons). This number amounted to 82% (N=13 305) of the male workers in the original Belgian data. The US data included the 1970 US census occupational codes. Altogether 120 occupations were identified for the men on the basis of the same criteria as in the Belgian data. The number of persons in each occupation ranged from 5 to 104 (median 11). This number amounted to 89% (N=1767) of the male workers in the original US data.

Occupation-aggregated variables for the analyses

Demographic variables (age and marital status). A continuous age variable was averaged at the occupational

level. The information on individual marital status was collapsed into two categories, married versus others (single, separated, divorced, and widowed), and averaged at the occupational level. Then it was arbitrarily dichotomized at its median value for analysis simplicity.

Socioeconomic indicators. Two socioeconomic indicators for the Belgian occupations were used. The individual number of years of formal education was averaged at the occupational level. Then it was further divided into three groups with cut points of 12 years (high school graduates) and 14 years (some college graduates) for the analyses. An occupational class was additionally constructed on the basis of ISCO one-digit codes in the Belgian data, namely, managers and professionals (ISCO1); technicians, clerks, and service workers (ISCO2); craft workers, machine operators, and elementary occupations (ISCO3). Three socioeconomic indicators were used for the US occupations. The number of years of education was averaged according to the occupational level. It was further divided into three groups as in the Belgian occupations. Annual family income was aggregated according to the occupational level. It was further divided into three groups on the basis of its tertiles, INC1 (income means <USD 11 500) to INC3 (income means ≥USD 15 400). The Duncan socioeconomic index (Duncan SEI) (44), a weighted combination of occupational education and occupational income, was used for each occupation. It was further divided into three groups on the basis of its tertiles, SEI1 (score <24) to SEI3 (score ≥58).

Table 1. Sociodemographic characteristics of the Belgian (N=184) and United States (US) (N=120) male occupations used in this study. (BELSTRESS = Belgian job-stress study; ISCO = International Standard Classification of Occupations; ISCO1 = managers and professionals; ISCO2 = technicians, clerks, and service workers; craft workers, machine operators; ISCO3 = elementary occupations)

Variables	BELSTRESS (1994–1998) data			US questionnaire (1972 & 1977) data	
	%	Median	Range	Median	Range
Persons in an occupation (N)	·	31.0	5.0–476.0	11.0	5.0–104.0
Age (years)	·	46.1	39.9–52.0	38.7	27.9–55.0
Marital status [a]	·	0.1	0.0–0.4	0.2	0.0–0.8
Skill discretion	·	35.3	22.0–45.3	35.9	19.0–43.1
Decision authority	·	35.2	28.0–44.6	37.9	21.8–45.8
Job control	·	70.7	50.0–87.1	73.7	38.0–88.9
Psychological demands	·	31.0	22.6–37.0	30.8	22.7–38.0
Job strain	·	0.87	0.60–1.26	0.83	0.62–1.85 [b]
Supervisory support	·	10.8	8.1–12.9	12.6	9.0–16.0
Coworker support	·	12.1	10.3–14.0	12.9	10.7–15.8
Physical demands	·	8.7	5.7–14.1	2.5 [c]	1.0–4.0 [c]
Job insecurity	·	3.7	2.1–5.6	3.6	2.0–7.0
Education (years)	·	12.6	6.5–20.9	12.3	7.0–18.0
Annual family income (USD 1000)	·	·	·	13.1	6.9–29.1
Socioeconomic index	·	·	·	44.0	6.0–96.0
ISCO					
ISCO1	25.0	·	·	·	·
ISCO2	34.2	·	·	·	·
ISCO3	40.8	·	·	·	·
Mental disorder symptom scales	·	25.3	21.0–35.0 [d]	0.21	0.07–0.43

[a] Married = 0 and others = 1.
[b] The next highest value is 1.33.
[c] Only one item used (versus five items in the Belgian data).
[d] The next highest value is 31.8.

Psychosocial job hazards. Psychosocial job hazards were measured according to the translated Belgian–Dutch and Belgian–French versions of the job content questionnaire (JCQ) (45) in the Belgian dataset. The *skill discretion* scale comprised six items (eg, learning new things). The *decision authority* scale was created with three items (eg, decide how I do my work). The *job control* scale was the sum of the skill discretion and decision authority scores. The *psychological demands* scale comprised five items (eg, fast work, excessive work, conflicting demands). The *supervisory support* scale was made up of four items (eg, supervisor is concerned). The *co-worker support* scale was comprised of four items (eg, friendly coworkers). The *physical demand* scale had five items (eg, physical efforts). The *job insecurity* scale had two items ("My job security is good" and "How likely are you to lose your job during the next couple of years"). The same or very similar items were used for all of the JCQ scales in the US data with the exception that physical demand was measured by only one item (ie, physical effort). The factor validity and reliability of the JCQ scales at the individual level in the two datasets were satisfactory (1, 2,42, 46, 47). The psychosocial job hazards were aggregated according to the occupational level. For job strain, a continuous variable was created by the ratio of the doubled occupation-level psychological-demand score to the occupation-level job-control score (48). Its distribution (table 1) appeared to be skewed positively for the US occupations due to one occupation (ie, assemblers for electrical machinery, equipment, and supplies; US 1970 occupational code, 849); therefore, its impact on the multivariate regression analysis was examined.

Common mental disorders. A depression scale of the 18 items of the questionnaire (eg, I felt depressed in the past two weeks) was available for the Belgian data. The scale consisted of 11 items from the Radloff's Center for Epidemiologic Studies Depression (CESD) scale and 7 other items that had been used as a self-reported depression scale in the study (2). It was aggregated at

the occupational level. Its occupational level distribution (table 1) appeared to be skewed positively due to one case with extremely adverse mental health (bookbinders and related workers, ISCO code 7345). However, it was included in this study due to its marginal impact on the statistical analyses. In the US data, a psychological strain scale of eight "depression or life dissatisfaction" items [eg, Is your life: enjoyable (1) to useless (7)] of the job content questionnaire was available. This variable was scaled according to the standard formulas of the JCQ user's guide (45) and ranged from 0 to 1 (the higher score representing more psychological strain). The reliabilities of the mental health scales at the individual level in the two datasets were satisfactory (1, 21, 49). It was also aggregated at the occupational level.

Statistical analyses

The relationships among socioeconomic indicators, psychosocial job hazards, and mental health indicators were examined with the use of Spearman correlation coefficients. The correlations between the socioeconomic indicators and job strain were reviewed graphically with scatter plots, and also with the two-dimensional demand–control plots for clearer presentation. The z-scores for decision latitude and psychological demands for each occupation (using the means and standard deviations in the original individual sample—including men and women) were located on the demand–control plot. The bivariate association of job strain (or its components) with mental health was first examined (model 1), then demographic variables (age and marital status) (model 2), socioeconomic indicator (model 3), and other psychosocial job hazards (model 4, the full model) were sequentially added to the multivariate regression model. All of these variables were continuous variables, except for marital status and the ISCO occupational classes (eg, dummy variables). Due to high correlations among the socioeconomic indicators, only one indicator for socioeconomic status was used in the models. For adjustment of socioeconomic status and for checking the potential interaction effects of job strain with socioeconomic status on mental health, the multivariate regression analysis was replicated after stratification at each level of a socioeconomic indicator (eg, three educational groups). For the sensitivity test, the multivariate regression analyses were replicated for the selected subsamples of occupations [with their sample sizes of individual workers, 10 or greater in the Belgian data (N=145) and 8 or greater in the US data (N=90)]. The significance of the Spearman and regression correlation coefficients was examined at an alpha of 0.10, considering the small sample sizes of this study. The SPSS (version 11.0, SPSS Inc, Chicago, IL,USA) program was used for statistical analyses.

Results

Spearman correlations between the socioeconomic indicators, psychosocial job hazards and mental health

The correlations between job strain and the socioeconomic indicators were marginal for the Belgian occupations (table 2), but significant for the US occupations (range 0.53–0.38, P<0.001) (table 3). High job control, skill discretion, and decision authority were highly correlated with high socioeconomic status in both samples. High psychological demands had high correlations with high socioeconomic status in the Belgian sample,

Table 2. Spearman correlation coefficients between the socioeconomic indicators, psychosocial job hazards, and depression for the male occupations in Belgium (N=184). (ISCO1 = managers and professionals; ISCO3 = and elementary occupations)

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Education													
2. ISCO (three levels) [a]	–0.85												
3. Job strain	–0.12	0.07											
4. Job control	0.79	–0.76	–0.43										
5. Skill discretion	0.83	–0.78	–0.36	0.96									
6. Decision authority	0.69	–0.69	–0.48	0.96	0.86								
7. Psychological demands	0.67	–0.67	0.43	0.56	0.59	0.48							
8. Supervisory support	–0.01	–0.04	–0.29	0.21	0.14	0.26	–0.08						
9. Coworker support	0.19	–0.17	–0.12	0.29	0.25	0.29	0.16	0.40					
10. Physical demand	–0.78	0.78	0.13	–0.75	–0.75	–0.68	–0.60	–0.13	–0.17				
11. Job insecurity	0.02	0.11	0.25	–0.07	0.00	–0.13	0.19	–0.09	–0.11	–0.03			
12. Age	–0.15	0.02	–0.14	0.05	–0.01	0.11	–0.11	0.07	0.03	–0.04	–0.14		
13. Marital status (others versus married)	–0.13	0.17	0.02	–0.17	–0.18	–0.14	–0.19	–0.09	–0.12	0.24	–0.09	–0.18	
14. Depression	–0.10	0.08	0.26	–0.15	–0.18	–0.10	0.14	–0.16	–0.10	0.12	0.12	–0.03	0.30

[a] ISCO (International Standard Classification of Occupations): high-status occupations (ISCO1) versus low-status occupations (ISCO3). P<0.10 (|γ|≥0.12), P<0.05 (|γ|≥0.15), P<0.01 (|γ|≥0.19), and P<0.001 (|γ|≥0.26).

Table 3. Spearman correlation coefficients between the socioeconomic indicators, psychosocial job hazards, and psychological strain in the male occupations in the United States (N=120).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Education														
2. Family income	0.62													
3. Duncan socioeconomic index	0.83	0.68												
4. Job strain	–0.46	–0.38	–0.53											
5. Job control	0.66	0.59	0.71	–0.79										
6. Skill discretion	0.68	0.60	0.71	–0.77	0.95									
7. Decision authority	0.58	0.56	0.68	–0.77	0.96	0.82								
8. Psychological demands	0.28	0.29	0.23	0.31	0.24	0.20	0.24							
9. Supervisory support	0.04	0.03	0.11	–0.41	0.26	0.21	0.28	–0.20						
10. Coworker support	0.13	0.14	0.18	–0.45	0.37	0.36	0.36	–0.11	0.52					
11. Physical demand [a]	–0.60	–0.42	–0.67	0.45	–0.48	–0.43	–0.50	0.04	–0.13	–0.11				
12. Job insecurity	–0.27	–0.18	–0.32	0.29	–0.27	–0.24	–0.30	0.08	–0.21	–0.32	0.20			
13. Age	0.17	0.37	0.34	–0.31	0.31	0.25	0.36	–0.11	0.01	0.22	–0.41	–0.11		
14. Marital status (others versus married)	–0.07	–0.16	–0.24	0.18	–0.17	–0.21	–0.16	0.01	–0.04	–0.09	0.11	0.01	–0.32	
15. Psychological strain	–0.25	–0.24	–0.23	0.41	–0.41	–.42	–0.39	–0.02	–0.37	–0.36	0.06	–0.02	–0.04	0.11

[a] One item ("physical effort"): P<0.10 (|γ|≥0.15), P<0.05 (|γ|≥0.18), P<0.01 (|γ|≥0.23), and P<0.001 (|γ|≥0.31).

but low correlations in the US sample. Job strain was more highly associated with supervisory support, coworker support, physical demands, and job insecurity in the expected directions in the US sample (table 3). As expected, very high correlations (ie, γ>0.80) were observed between the socioeconomic status indicators in both samples, while the correlation between education and annual family income was relatively moderate in the US sample. The bivariate correlations of job strain, job control, skill discretion, psychological demands, supervisory support, physical demand, job insecurity, and marital status with depression were significant in the Belgian occupations (table 2). For the US occupations, the correlations of the socioeconomic indicators, job strain, job control, skill discretion, decision authority, supervisory support, coworker support, and marital status with psychological strain were significant (table 3).

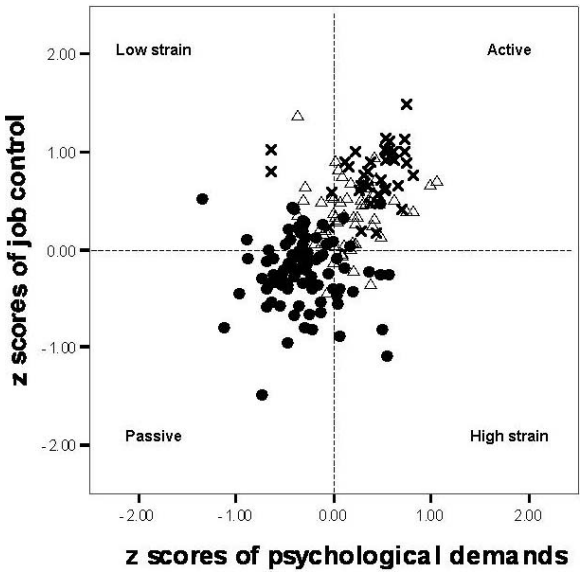
Graphic review of the relationships between the socioeconomic status indicators and job strain

Scatter plots with job strain and socioeconomic indicators confirmed the Spearman correlations. Steeper negative correlations were observed for the US occupations than for the Belgian occupations (not shown). In the two-dimensional demand–control plot of the Belgian occupations, the high-education occupations (ie, EDU3) were located mainly in the "active" (high job control plus high psychological demands) quadrant and to a less extent in the "low job-strain" (high job control plus low psychological demands) quadrant. By contrast, the low-education occupations (ie, EDU1) were located mainly in the "passive" (low job control plus low psychological demands) quadrant and to a less extent in the other three quadrants (figure 1)—including the "high job-strain" (low job control plus high psychological demands) quadrant. Thus the education gradient (running from active to passive quadrants) was "orthogonal" to the job strain axis (running from low job strain to high job strain) of the demand–control model. The same pattern was observed with the ISCO occupational class (not shown). For the US occupations, the orthogonal relationship between job strain and the socioeconomic indicators (education, family income, and the socioeconomic index) was also observed (shown only for education in figure 1), while it was not as strong as for the Belgian data, reflecting the relatively weak correlation of psychological demands with socioeconomic status.

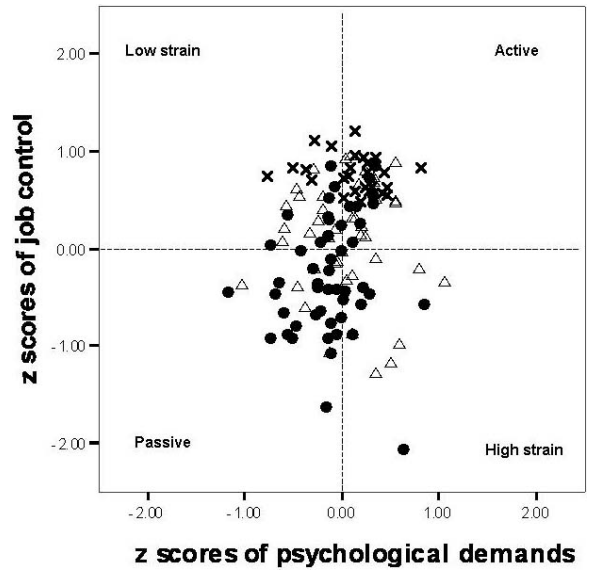
Multivariate regression analysis of job strain and mental health

Job strain was significantly associated with depression in the Belgian occupations (table 4). It was not affected substantially by age, marital status, socioeconomic indicators (only shown for education in table 4), and other psychosocial job hazards. Neither education nor ISCO occupational class was associated with depression for the whole sample (not shown). The job strain association was also observed for four of the six subsamples stratified for socioeconomic status (ie, EDU1, EDU2, ISCO3, and ISCO1) (table 4).

The association between job strain and psychological strain in respect to the US occupations was also significant and was not affected substantially by the socioeconomic status indicators (only shown for education in table 5). However, the regression coefficient for job strain decreased to some extent with respect to supervisory support and physical demand (regression coefficients: –0.02, SE=0.01, P=0.000; –0.02, SE=0.01,



	Low strain	Active	Passive	High strain
EDU1: ●	20	4	50	10
(N=84)	(23.8%)	(4.8%)	(59.5%)	(11.9%)
EDU2: Δ	9	22	2	7
(N=40)	(22.5%)	(55.0%)	(5.0%)	(17.5%)
EDU3: ×	8	51	0	1
(N=60)	(13.3%)	(85.0%)	(0.0%)	(1.7%)



	Low strain	Active	Passive	High strain
EDU1: ●	9	10	22	10
(N=51)	(17.6%)	(19.6%)	(43.1%)	(19.6%)
EDU2: Δ	12	15	7	9
(N=43)	(27.9%)	(34.9%)	(16.3%)	(20.9%)
EDU3: ×	6	20	0	0
(N=26)	(23.1%)	(76.9%)	(0.0%)	(0.0%)

Figure 1. The demand–control plots by educational levels (● = low, Δ = middle, and × = high) according to male occupations in Belgium, (N=184, left) and the United States (N=120, right).

Table 4. The unstandardized beta coefficients [standard error (SE)] of job strain for depression in the linear multivariate regression models—male occupations in Belgium (N=184). Note: EDU1/ISCO3 (low-status occupations) to EDU3/ISCO1 (high-status occupations). [model 1 = no covariates for job strain; model 2 = age and marital status as covariates; model 3 = age, marital status, and education as covariates; model 4 = age, marital status, education, and other psychosocial job hazards (supervisory support, coworker support, physical demand, and job insecurity) as covariates; EDU1 = low-education occupations; EDU2 = middle-education occupations; EDU3 = high-education occupations; ISCO = International Standard Classification of Occupations; ISCO1 = managers and professionals; ISCO2 = technicians, clerks, and service workers; craft workers, machine operators; ISCO3 = and elementary occupations]

Samples	Model 1			P-value	Model 2			P-value	Model 3			P-value	Model 4			P-value
	Beta	SE	R^2		Beta	SE	R^2		Beta	SE	R^2		Beta	SE	R^2	
Whole sample (N=184)	9.28	1.59	0.16	0.000	9.73	1.57	0.21	0.000	9.78	1.61	0.21	0.000	8.90	1.76	0.24	0.000
EDU1 (N=84)	12.00	2.10	0.29	0.000	12.03	2.12	0.30	0.000	11.67	2.15	0.30	0.000	11.41	2.38	0.41	0.000
EDU2 (N=40)	6.92	2.59	0.16	0.011	6.92	2.25	0.45	0.004	7.19	2.28	0.46	0.003	6.91	3.08	0.50	0.032
EDU3 (N=60)	1.15	4.35	0.01	0.793	3.39	4.44	0.06	0.448	3.40	4.51	0.06	0.454	3.01	4.69	0.10	0.523
ISCO3 (N=75)	11.35	2.21	0.27	0.000	11.94	2.20	0.32	0.000	11.81	2.22	0.32	0.000	10.96	2.77	0.44	0.000
ISCO2 (N=63)	5.35	3.07	0.05	0.086	5.49	3.09	0.09	0.081	5.52	3.31	0.09	0.101	5.38	3.54	0.13	0.134
ISCO1 (N=46)	6.72	3.98	0.06	0.098	8.66	3.89	0.20	0.031	8.57	3.95	0.20	0.036	9.57	4.32	0.23	0.033

P=0.020, respectively). Education and family income were negatively associated with depression in the full model as expected, but the SEI was not (not shown). The job strain association remained significant for four of the nine subsamples stratified for socioeconomic status in model 3 (with age, marital status, and socioeconomic indicators as covariates). It was, however, substantially changed by other psychosocial job hazards (ie, supervisory support, physical demand, or job insecurity). In model 4, job strain was associated with psychological strain for only two of the nine subsamples stratified for socioeconomic status (ie, EDU2 and SEI2) (table 5), while the regression coefficients of job strain were the most unstable in the groups with a high socioeconomic status. Generally, the impact of the outlier occupation (the assemblers) on these analyses was minor (table 5). However, when occupation was excluded, job strain appeared to be significantly associated with mental health in the low-education group (its regression coefficient in model 4: 0.13, SE=0.07, P=0.084).

Table 5. The unstandardized beta coefficients (standard errors) of job strain for mental health in the linear multivariate regression models—male occupations in the United States (N=120). [model 1= no covariates for job strain; model 2 = age and marital status as covariates; model 3 = age, marital status, and education as covariates in the whole sample, respective socioeconomic status indicator [education or family income or the Duncan socioeconomic index (SEI)] in the subsamples; model 4 = age, marital status, education, and other psychosocial job hazards (supervisory support, coworker support, physical demand, and job insecurity) in the whole sample; respective socioeconomic status indicator in the subsamples; EDU1 = low-education occupations; EDU2 = middle-education occupations; EDU3 = high-education occupations; INC1 = income of <USD 11 500; INC2 = income of ≥USD 11 500, but USD <15 400; INC3 = income of ≥USD 15 400; SEI1 = score of <24; SEI2 = score of ≥24, but <58; SEI3 = score of ≥58]

Samples	Model 1			P-value	Model 2			P-value	Model 3			P-value	Model 4			P-value
	Beta	SE	R^2		Beta	SE	R^2		Beta	SE	R^2		Beta	SE	R^2	
Whole sample (N=120)	0.14	0.03	0.13	0.000	0.14	0.03	0.15	0.000	0.13	0.04	0.15	0.000	0.07	0.04	0.36	0.062 [a]
EDU1 (N=51)	0.15	0.04	0.25	0.000	0.15	0.04	0.26	0.001	0.13	0.04	0.31	0.004	0.06	0.04	0.47	0.172 [b]
EDU2 (N=43)	0.07	0.06	0.04	0.233	0.05	0.07	0.17	0.482	0.05	0.07	0.17	0.459	0.15	0.08	0.35	0.062
EDU3 (N=26)	0.34	0.22	0.10	0.127	0.37	0.24	0.13	0.140	0.41	0.26	0.15	0.123	0.11	0.19	0.71	0.592
INC1 (N=40)	0.20	0.07	0.20	0.005	0.21	0.07	0.24	0.004	0.21	0.07	0.26	0.004	0.11	0.09	0.39	0.218
INC2 (N=40)	0.12	0.04	0.20	0.004	0.12	0.04	0.23	0.004	0.13	0.04	0.23	0.005	0.05	0.05	0.44	0.286 [c]
INC3 (N=40)	0.05	0.10	0.01	0.636	0.07	0.11	0.01	0.548	0.06	0.11	0.01	0.572	0.10	0.11	0.46	0.381
SEI1 (N=40)	0.07	0.05	0.06	0.143	0.08	0.05	0.12	0.122	0.07	0.05	0.14	0.137	0.02	0.06	0.24	0.727 [d]
SEI2 (N=40)	0.20	0.07	0.21	0.005	0.17	0.07	0.31	0.015	0.17	0.07	0.31	0.016	0.14	0.08	0.42	0.095
SEI3 (N=40)	0.24	0.15	0.07	0.098	0.25	0.16	0.07	0.118	0.21	0.15	0.16	0.177	0.10	0.14	0.45	0.470

[a] When one occupation (assemblers of electrical machinery, etc) was excluded, the correlation was 0.09, and the P-value was 0.073.
[b] When one occupation (assemblers of electrical machinery, etc) was excluded, the correlation was 0.13, and the P-value was 0.084.
[c] When one occupation (assemblers of electrical machinery, etc) was excluded, the correlation was 0.11 and the P-value was 0.203.
[d] When one occupation (assemblers of electrical machinery, etc) was excluded, the correlation was 0.06, and the P-value was 0.565.

Multivariate regression analysis of the components of job strain in conjunction with mental health

When used instead of job strain in the regression models, job control (ISCO classes for socioeconomic status) and psychological demands (education and ISCO classes for socioeconomic status) were also associated with depression in the full model with the Belgian occupations. When used instead of job control in the regression models, skill discretion was associated with depression, while decision authority was not, in all of the tested models. In the subsamples stratified for socioeconomic status, psychological demand was associated with depression only in the groups with a low socioeconomic status (ie, EDU1 or ISCO3). Job control was associated with depression only in the middle education group, while its association decreased substantially according to education in the groups with a low socioeconomic status (ie, EDU1 or ISCO3). Decision authority was associated with depression only in the groups with a low socioeconomic status (ie, EDU1 and ISCO3), while skill discretion was found in the groups with a low or middle socioeconomic status.

For the US occupations, job control was associated with psychological strain in the full model. It was not affected substantially by any socioeconomic indicators (education, family income, and SEI). Psychological demands and skill discretion were not associated with psychological strain, although skill discretion was associated with psychological strain in the full model (with the SEI score for socioeconomic status). Decision authority was associated with psychological strain in model 3, but it was not associated with psychological strain in the full model (through the effects of supervisory support and physical demands). In the subsamples stratified by socioeconomic status, job control was associated with psychological strain in four of the nine subsamples stratified for socioeconomic status (ie, EDU1, EDU2, INC1, and SEI2) in the full models. However, decision authority and skill discretion were found only in the group with a middle socioeconomic status (ie, SEI2) and that with a high socioeconomic status (ie, SEI3), respectively. The impact of the outlier occupation (the assemblers) on these analyses was negligible.

The R-squares of mental health explained by job strain (tables 4 & 5) were similar to those explained by its components in both occupation samples (not shown here). The results of the multivariate regression analyses of the selected samples of occupations (with relatively greater sample sizes of workers) in both datasets were similar to the results of the analyses of their full occupation samples.

Discussion

This study demonstrated the association between job strain and common mental disorders at the occupational level in the two occupation samples, one from Belgium and the other from the United States. It was, however, comparatively weaker in the US sample. To our

knowledge, this is the first study to demonstrate an ecological association between job strain and common mental disorders. Job control was more strongly associated with common mental disorders in the US sample, while skill discretion and psychological demands showed a stronger association in the Belgian sample. However, the association between decision authority and mental health was relatively weak in both samples. In general, these associations were much stronger in the groups with a low or middle socioeconomic status than in the group with a high socioeconomic status. All of these results imply that the association between job strain and adverse mental health is substantive, not spurious by either self-report bias or the confounding effect of socioeconomic status. Furthermore, they imply, if confirmed in future longitudinal studies, that unhealthy psychosocial work conditions should be targeted in attempts to reduce adverse mental health differences among occupations and also in social equality policies (eg, narrowing income inequality and equal access to higher education).

Socioeconomic status and job strain

While job strain was significantly associated with socioeconomic indicators in the US sample, their covariance was less than 30% in both samples. In the graphic investigations of both samples, job strain was orthogonal to all of the socioeconomic indicators. These results are consistent with those of the large individual male samples from Belgium and Japan (21) and a Danish representative sample (50). All of these findings suggest that job strain is distinct from conventional socioeconomic indicators and that their associations with mental health differ (ie, according to the demand–control model, the risk of psychological strain should be much larger between low job-strain and high job-strain jobs than between active and passive jobs).

On the other hand, the orthogonal relationship appeared to be much stronger in the Belgian sample of the 1990s than in the US sample of the 1970s, mainly due to a higher correlation between psychological demands and socioeconomic status in the Belgian sample. This finding may indicate that the detailed relationship between job strain and socioeconomic status is country- and time-specific. Between the 1970s and the 1990s, the dominant model or principle of the organization of work changed from Taylorism or Fordism ("control") to the so-called lean production model ("commitment") in most Western industrialized countries (51–53). As a result, work was intensified and decision authority or skill level on the job increased, but modestly or temporarily (54–55). However, we do not know whether these change patterns differed significantly according to socioeconomic status (eg, more intensified work in high status occupations) and country. If so, the difference may provide an explanation for the stronger orthogonal relationship in the Belgian sample. The heterogeneity of study samples in terms of sampling periods, demographic characteristics, and countries prevented us from addressing this issue. We also think that both job strain and socioeconomic indicators need to be viewed in broad social, economic, political, technological, and historical contexts (56–59).

Socioeconomic status, job strain and mental health

The observed association between job strain and adverse mental health at the occupational level in the two occupational samples is meaningful when the heterogeneity of samples is taken into consideration. It was also consistent with the results of the individual level analysis of the same Belgian data on men (49, 21).

The association was not a simple reflection of the association between socioeconomic status and mental health for three reasons. First, the association was consistent across the multivariate models (including several conventional socioeconomic indicators) in both samples. Second, it remained significant even in four of the six Belgian and four of the nine US subsamples stratified for socioeconomic status even though it was substantially affected by the other psychosocial job hazards in the US sample. The analysis might be considered a very conservative one (or an overadjustment of socioeconomic status). Additional adjustment of the difference in socioeconomic status (in terms of education or income or SEI score) in the subsamples stratified for socioeconomic status. Third, the association between socioeconomic status and adverse mental health was not supported in the Belgian sample, while it was supported partially (ie, with education and family income, not with the SEI) in the US sample.

In general, the effect of job strain on adverse mental health was greater in the groups with a low or a middle socioeconomic status than in the group with a high socioeconomic status. There have been few comparable studies, while several studies (22, 60) at the individual level have reported such a stronger effect of job strain on cardiovascular disease in a low-status group. One study (61) reported no substantial interaction effect between job strain (also its components) and socioeconomic status (ie, manual versus nonmanual) on diverse psychological strain symptoms at the individual level.

More studies are needed at the individual and occupational levels on the interaction effect since knowledge about it would be very informative, particularly when prevention strategies are being specified for mental health according to socioeconomic status strata (22). For instance, if confirmed, the interaction effect not only suggests the importance of work reorganization policy (increasing on-the-job decision making and learning

opportunities and manageable work demands), but also the necessity of its combination with social equality policies with respect to low-status occupations due to their greater susceptibility (22, 60).

Socioeconomic status, job control and mental health

The covariance between job control and socioeconomic indicators (eg, 58% to 62% in the Belgian data) was much higher than that (<20%) found in the individual level analyses carried out using the source data on Belgian men (21). While larger correlations in ecological studies than in individual level studies is a general tendency (39), the increased covariance suggests that the relationship between socioeconomic status and job control may be underestimated at the individual level to some extent. But it should be regarded as an upper limit for the covariance at the individual level for two reasons. First, despite the same job title, substantial variation in job control can exist within an occupation (eg, urban transit operators) (28). Second, not only job strain, but also socioeconomic indicators are operationalized extra-individually as well.

Despite the relatively high covariance between socioeconomic status and job control, an association between job control and adverse mental health was observed in several subsamples of US occupations stratified for socioeconomic status. Thus the covariance supports the assumption that the association between job control and mental health is not a simple reflection of the association between socioeconomic status and mental health. However, this assumption was partially refuted in the Belgian sample since the job control association was fully explained by education in the group with a low socioeconomic status (albeit viewed as an overadjustment of socioeconomic status). These inconsistent results may be simply ascribed to different mental health indicators between the Belgain and US samples. However, they may indicate that the relationship between socioeconomic status, job control, and mental health at the occupational level is not a fixed one, but varies to a large extent by country, time, and socioeconomic-status strata.

Interestingly, the association between job control and mental health differed from those of its components, skill discretion and decision authority, in both samples. While its components were not associated with mental health, job control was in the US sample (a synergistic effect). The opposite was true in the Belgian sample (the associations of its components were stronger than the association of job control).

Limitations of this study

First, the datasets used in this study came from cross-sectional surveys so that no causal inferences about the observed association between job strain and mental health should be made until future studies based on longitudinal data have been carried out. Second, the relationship between job strain or job control and "social class" as a Marxist term (56) was not examined in this study. While some conceptual demarcations between job control and social class have been carried out (21, 62), more theoretical and empirical studies are needed in the future. Third, the occupation–aggregation method cannot eliminate any (group-specific) self-report bias (eg, a collective bias) (30), which is based on group members' shared experiences and cultures. More objective methods for both job strain (30, 63) and mental health (32, 64) need to be employed together in the future. Fourth, this study was restricted to male occupations in two Western industrialized countries. The occupational association between job strain and mental health needs to be examined particularly for female occupations, and also for male and female occupations in non-Western industrialized countries.

Acknowledgments

We express our sincere thanks to the BELSTRESS Study Group for permitting us to use their dataset for this study.

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