Original Article

Co-effect of Demand-control-support Model and Effort-reward Imbalance Model on Depression Risk Estimation in Humans: Findings from Henan Province of China*

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Abstract

Objective To investigate the co-effect of Demand-control-support (DCS) model and Effort-reward Imbalance (ERI) model on the risk estimation of depression in humans in comparison with the effects when they are used respectively.

Methods A total of 3 632 males and 1 706 females from 13 factories and companies in Henan province were recruited in this cross-sectional study. Perceived job stress was evaluated with the Job Content Questionnaire and Effort-Reward Imbalance Questionnaire (Chinese version). Depressive symptoms were assessed by using the Center for Epidemiological Studies Depression Scale (CES-D).

Results DC (demands/job control ratio) and ERI were shown to be independently associated with depressive symptoms. The outcome of low social support and overcommitment were similar. High DC and low social support (SS), high ERI and high overcommitment, and high DC and high ERI posed greater risks of depressive symptoms than each of them did alone. ERI model and SS model seem to be effective in estimating the risk of depressive symptoms if they are used respectively.

Conclusion The DC had better performance when it was used in combination with low SS. The effect on physical demands was better than on psychological demands. The combination of DCS and ERI models could improve the risk estimate of depressive symptoms in humans.

Key words: Depression; Work-related stress; Demand-control-support; Effort- reward imbalance

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INTRODUCTION

Psychosocial factor at work has been believed to be a risk factor to mental health, especially to the depression, in recent two decades. Most psychosocial studies in developed countries revealed a strong association between work environment and depression[1-11]. Among some studies, two main theoretical models were used to measure psychological factors at work, i.e., job strain model[12] and the effort–reward imbalance model[13]. Some studies found that

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depressive symptoms were more prevalent in workers with high demand[14-18], low job control[14-19], low social support[14-15,18,20], or high effort-reward imbalance[21-25]. Two previous investigations have studied the all scales of the job strain model and effort-reward imbalance model simultaneously[26-27], and another three previous studies have studied the main dimensions of the job strain model and effort-reward imbalance model simultaneously in order to test their effects on depressive symptom prediction[28-30]. Since both models measure different aspects of psychological factors, the combination of two models should has stronger explanatory power for predicting depressive symptoms than one model alone. However, no study has been conducted on the co-effect of these two models on depression risk estimation so far.

The purpose of this study was to investigate each dimension of the DCS model and the ERI model as to their association with depression, to compare the DCS and ERI models as to their associations with depression, and to evaluate whether the combination of DCS and ERI models enhance the risk estimation for depression as compared the effect when each model is used alone.

METHODS

Study Population

This cross-sectional study was conducted in Henan Province, located in the central region of China, from November 2008 to June 2009. A total of 5 338 subjects were recruited from 13 factories or companies, in which 274 were from a diamond production plant, 771 from a diesel engine plant of a tractor factory, 405 from an electrolyte aluminum plant, 335 from a chemical fiber production factory, 264 from a battery plant, 1 772 from a high voltage electric equipment factory, 209 from an environment protection equipment factory, 200 from an oil equipment factory, 176 from a garment plant, 329 from a mechanical equipment fabrication plant, 181 from a chemical processing plant, 218 from a refractory plant, and 204 from a train transportation company. The subjects were engaged in a variety of jobs, including managers, technicians, workers and auxiliary workers. The informed consents were signed by the subjects and the study protocol was approved by the Medical Ethics Committee of the Henan Provincial Institute of Occupational Health. Each subject was given a questionnaire at his/her workplace and required to complete the questionnaire within 45 min. The questionnaire was designed to collect following information: gender, age, education level, service year and type, smoking and alcohol use histories, psychosocial factors at work and depression symptoms.

Of the 6 711 potential eligible subjects, 5 909 (88.1%) agreed to participate the study. The subjects missing variables for ≥three items (9.6%) were excluded from the analyses, so 5 338 subjects were left, the final response rate was 79.6%.

Measurement Methods

Job Stress Psychological demands, physical demands, job control, social support (SS) dimensions of the DCS model were used in this study[31]. The reliability and validity of the questionnaires (Chinese version) have been established[27]. Cronbach's α coefficient for psychological demands, physical demands, job control social support scales in this sample were 0.60, 0.77, 0.70, and 0.65, respectively. DC indicates a ratio computed between the two scores of demands and job control, given the same weight to both variables.

The ERI questionnaire (Chinese version) was also used in this study[32]. The reliability and validity of this questionnaire have also been established[27]. It consists of the following three scales: extrinsic efforts (6 items), occupational rewards (11 items), and overcommitment (OC, 6 items). Extrinsic efforts were evaluated by measuring the psychosocial workload; occupational rewards evaluation was based on the worker's financial status (i.e. salary), self-esteem, and career opportunity (e.g. promotion prospects and job security). Overcommitment as a personal (intrinsic) factor was defined as a set of attitudes, behaviors, and emotions, reflecting excessive striving along with a strong desire for approval and esteem. Cronbach's α for effort, reward, and overcommitment scales in this sample were 0.78, 0.58, and 0.64, respectively. ERI indicates a ratio computed between the two scores of effort and reward, given the same weight to both variables.

Depressive Symptoms Depressive symptoms were measured by the Center for Epidemiological Studies Depression (CES-D) Scale (Chinese version)[33]. The CES-D scale consists of 20 items related with characteristic symptoms and behaviors of depression. We applied in this study the threshold value 19 recommended for identifying subjects with

depressive symptoms by this scale. This scale has been used extensively in China since 1980's[34]. Cronbach's α of the CES-D in this sample was 0.85.

Job Satisfaction Job satisfaction was investigated by using the Occupational Stress Indicator (12 items)[35] including questions about the job itself, achievement, organizational design and structure, organizational processes and personal relationships and questions were summed to give a 'total job satisfaction' score. The reliability and validity of this questionnaire (Chinese version) has been established[36]. Cronbach's α of questionnaire in this sample was 0.93.

Affectivity Affectivity was measured by ten items[36], which consisted of the following two scales: Positive affectivity (5 items) and negative affectivity (5 items). Cronbach's α of scales in this sample were 0.81 and 0.80 respectively. A negative item example is 'During the past few weeks did you ever feel upset because someone once criticized you?' A positive item example is 'During the past few weeks did you ever feel pleased for having accomplished something?'

Potential Confounding Variables Potential confounding variables included in this study were individual factors, i.e., gender, age (≤25 yrs, 25-30 yrs, 30-40 yrs, and >40 yrs); service years (≤5 yrs, 5-15 yrs, 15-20 yrs, and >20 yrs); education level (elementary school, junior high school, high school, and college or university).

Statistical Analysis

Logistic regression analysis was performed to estimate the associations between job stress and depressive symptoms. Multivariate odds ratios (ORs) and 95% confidence intervals (CIs) were obtained from the logistic regression models. In all the analyses, the information about subject's gender, age, educational level, job satisfaction, subjective health status, medical histories in the past six months and shiftwork were controlled. Analysis initially included scales that formed the basis of the theoretical models, i.e. demand, control and social support for the DCS models, and effort, reward and overcommitment for the ERI model. The following analysis was conducted partially according to the steps which were previously described by Peter, et al.[37]. First, the associations between each basic model (DCS and ERI) and depression symptom were estimated respectively. Second, the independent association for each exposition variable was observed, i.e. by adjusting each tested model (ERI and DC) with confounding variables and with the other model. SS and overcommitment were also considered.

Three combinations models (DC and SS, ERI and OC, and DC and ERI) were used to estimate the risk of depression these analyses followed the methods described by Griep et al.[38]. For each combination, the subjects were divided into four exposure categories: no exposure to any stressor according to the relevant model/scale (reference group), exposure only to one stressor model, exposure only to the other stressor model, and exposure simultaneously to stressors according to both models.

In logistic regression analysis, the variables were indicated as follows: Gender (1 for male, 0 for female), health status (health=1, ill-health=0), medical histories in the past six months (1 for yes, 0 for no), shiftwork (1 for yes, 0 for no), job satisfaction (1 for the first tertile of score, 0 for other), negative affectivity (1 for the third tertile of score, 0 for other), psychosocial factors were transferred to dumb variables. Age was entered as continuous variable.

All the statistical analyses were performed with SPSS for Windows (version 13.0; SPSS Inc., Chicago, IL), with *P* values <0.05 to be considered as significant. All significant statements were two-tailed.

RESULTS

Table 1 shows the demographic information of the study subjects by gender. The prevalence of depressive symptoms was 31.8%. Totally 19.3% of subjects were classified as having work stress by co-estimation of DCS and ERI models (exposed to both high job strain and high ERI), 19.7% had work stress according to the co-estimation by ERI and OC models and 19.0% had had work stress according to the co-estimation by DC and SS models

Association between Job Stress and Depression

Job Stress Analyzed through Individual Scales Table 2 shows the results from logistic regression analysis on the association between dimensions of the DC and ERI models and depression. With respect to DC model, the results showed an association between the psychological demands dimension and depression, even after adjusting for confounding variables (OR=1.49, 95% CI=1.25-1.77). Similar results was also found for physical demand dimension (OR=1.64, 95% CI=1.37-1.95). In the case of job control, an association was noted (OR=1.68, 95% CI=1.42-1.99).

Both dimensions of the ERI model were associated with depression, those classified in the third tertile of effort and the third tertile of reward presented the highest prevalence of depression.

Job Stress Analyzed through Stress Models

Table 3 shows results on associations between the DCS and ERI models/dimensions and depression. With regard to the demands/control ratio, the subjects classified in the highest tertile of exposure were more likely to report depression symptoms, even after adjusting for potential confounding variables; such associations linked to depression also retained significance after adjusting for social support at work.

Table 1. Demographics of Study Participants by Gender

Variables	Male		Female		Total	
	n	%	*n*	%	*n*	%
Gender	3 632	68.0	1 706	32.0	5338	100
Educational level						
Elementary	30	0.8	15	0.9	45	0.8
Junior high school	720	19.8	378	22.1	1 098	20.6
High school	2 071	57.0	930	54.5	3 001	56.2
College or university	811	22.4	383	22.5	1 194	22.4
Job title						
Blue collar worker	3 164	87.2	1 366	80.1	4 530	84.9
Assistant worker	161	4.4	104	6.1	265	5.0
Technician	218	6.0	161	9.4	379	7.0
Manager	89	2.4	75	4.4	164	3.1
Age						
-25	806	22.2	279	16.4	1 085	20.3
25-30	790	21.7	238	14.0	1 028	19.3
30-40	1 298	35.7	695	40.6	1 993	37.3
>40	738	20.4	494	29.0	1 232	23.1
Total	3 632	68.0	1 706	32.0	5 338	100
Years of service						
-5	1 766	48.6	744	43.6	2 510	47.0
5-15	839	23.1	376	22.0	1 215	22.8
15-20	687	18.9	392	23.0	1 079	20.2
>20	340	6.4	194	11.4	534	10.0
Total	3 632	68.0	1 706	32.0	5 338	100
Cigarette smoking						
Yes	1 935	53.3	35	2.1	1 970	36.9
No	1 697	46.7	1 671	97.9	3 368	63.1
Alcohol drinking						
Yes	2 062	56.8	80	4.7	2 142	40.1
No	1 570	43.2	1 626	95.3	3 196	59.9
Depressive symptoms	1 277	33.8	473	27.7	1 700	31.8
Simultaneous exposure to demand-control and to effort-reward imbalance						
DC and ERI present	750	20.6	278	16.3	1 028	19.3
ERI and OC present	777	21.4	274	16.1	1 051	19.7
DC and SS present	720	19.8	292	17.1	1 012	19.0

Table 2. Crude and Adjusted ORs for the Association between Psychosocial Scales of the DCS Model and the ERI Model and Depression (*n*=5 338)

Variables	*n* (%)	Crude OR (95% CI)	Adj OR (95% CI)*
DCS model			
Psychological demands			
1st tertile (low)	367 (23.1)	1.00	1.00
2nd tertile (medium)	664 (29.7)	1.41 (1.21-1.63)[b]	1.24 (1.06-1.45)[b]
3rd tertile (high)	669 (44.2)	2.63 (2.26-3.07)[b]	1.49 (1.25-1.77)[b]
	P<0.001**		
Physical demands			
1st tertile (low)	326 (22.9)	1.00	1.00
2nd tertile (medium)	635 (27.7)	1.29 (1.10-1.50)[b]	1.08 (0.91-1.27)
3rd tertile (high)	739 (45.6)	2.81(2.40-3.29)[b]	1.64 (1.37-1.95)[b]
	P<0.001**		
Job control			
1st tertile (high)	364 (22.5)	1.00	1.00
2nd tertile (medium)	587 (29.0)	1.41 (1.21-1.63)[b]	1.30 (1.10-1.52)[b]
3rd tertile (low)	749 (44.2)	2.72 (2.34-3.17)[b]	1.68 (1.42-1.99)[b]
	P=0.211**		
ERI model			
Effort			
1st tertile (low)	493 (24.4)	1.00	1.00
2nd tertile (medium)	480 (28.6)	1.24 (1.07-1.44)[b]	1.06 (0.90-1.23)
3rd tertile (high)	727 (44.3)	2.46 (2.14-2.84)[b]	1.38 (1.17-1.61)[b]
	P<0.001**		
Rewards			
1st tertile (high)	221 (14.3)	1.00	1.00
2nd tertile (medium)	487 (27.0)	2.21 (1.85-2.64)[b]	1.82 (1.51-2.18)[b]
3rd tertile (low)	992 (49.8)	5.92 (5.01-7.00)[b]	3.02 (2.50-3.66)[b]
	P<0.001**		

Note. *Adjusted for gender age, educational level, job satisfaction, negative affectivity, subjective health status, medical histories in the past six months, and shiftwork. **Linear-by-Linear Association. [b]*P*<0.01.

With respect to SS, a greater risk for depression was found among those classified in the low social support group even after adjusting for potential confounding variables and by the DCS model.

The ERI was associated with depression regardless of overcommitment to work. The association was significant for both medium ERI (OR=1.34, 95% CI=1.13-1.59) and high ERI (OR=1.73, 95% CI=1.44-2.08). In the case of overcommitment, similar results was observed after adjusting for confounding variables and ERI, the association was also significant for both medium ERI (OR=1.28, 95% CI=1.09-1.51) and high ERI (OR=1.60, 95% CI=1.35-1.89).

Job Stress Analyzed by means of Combinations of DC-SS, ERI-OC, and DC-ERI

According to Table 4, the subjects having both high DC and low SS (Model 1) were more likely to report depression symptoms, after adjustments for ERI and overcommitment, risk of depression for physical demands was greater than that for psychological demands. In the case of the combination of high ERI and high OC (Model 2), the associations were noted after adjustments for DC model and social support. For psychological demands or physical demands, a combination of high DC and high ERI (Model 3) adjusted for SS and overcommitment could estimate the risk of depression more accurately than each model was used alone.

DISCUSSION

The findings from this study showed consistent associations of all dimensions of DCS model and ERI model with depressive symptoms among workers in Henan province. DC and ERI were showed to be independently associated with depressive symptoms. The outcome of low SS and overcommitment was similar. The combinations high DC-low SS, high ERI-high overcommitment and high DC-high ERI showed greater risks for depressive symptoms than each of them did alone. In general, ERI model and SS model

in this study seem to be effective in estimating risk of depressive symptoms when they were used respectively. And the DC showed better performance when it was used in combination, particularly with low SS.

Findings from this investigation are partly consistent with those from several previous studies. Niedhammer et al.[26] found that job strain, low job control, effort-reward imbalance, and low reward were associated with depressive symptoms among men, overcommitment at work was a risk factor for both men and women, and social support at work played a role of reducing depressive symptoms for women. Yu et al.[27] found that workers reporting high job strain or high effort-reward imbalance had elevated risks of depressive symptoms. Odds ratios were generally higher in workers reporting high effort-reward imbalance. Furthermore, the low reward proved to be a important risk factor for depressive symptoms when both job stress models

Table 3. Crude and Adjusted ORs for the Associations between the DCS Model, Low Social Support (SS), the ERI Model and Overcommitment (OC), and Depression (*n*=5 338)

Variables	*n* (%)	Crude OR (95% CI)	Adj OR (95% CI)*	Adj OR (95% CI)**
DCS model (psychological demands)				
1st tertile (low)	378 (20.5)	1.00	1.00	1.00
2nd tertile (medium)	496 (28.7)	1.56 (1.34-1.82)[b]	1.23 (1.05-1.45)[a]	1.16 (0.98-1.36)
3rd tertile (high)	826 (46.8)	3.41 (2.95-3.95)[b]	1.77 (1.50-2.09)[b]	1.54 (1.30-1.83)[b]
	P<0.001			
DCS model (physical demands)				
1st tertile (low)	345 (20.0)	1.00	1.00	1.00
2nd tertile (medium)	499 (27.8)	1.54 (1.32-1.80)[b]	1.21 (1.03-1.43)[a]	1.13 (0.95-1.33)
3rd tertile (high)	856 (47.2)	3.59 (3.09-4.17)[b]	1.94 (1.64-2.30)[b]	1.79 (1.51-2.12)[b]
	P<0.001			
Low social support				
1st tertile (high)	422 (20.5)	1.00	1.00	1.00
2nd tertile (medium)	358 (27.1)	1.44 (1.22-1.69)[b]	1.18 (0.99-1.40)	1.12 (0.94-1.33)[c] 1.13 (.095-1.34)[d]
3rd tertile (low)	920 (46.9)	3.42 (2.98-3.93)[b]	2.02 (1.73-2.37)[b]	1.85 (1.57-2.17)[b,c] 1.91 (1.63-2.24)[b,d]
	P<0.001			
Effort-reward imbalance model				
ERI model				
1st tertile (low)	346 (18.0)	1.00	1.00	1.00
2nd tertile (medium)	472 (29.2)	1.88 (1.61-2.21)[b]	1.49 (1.26-1.76)[b]	1.34 (1.13-1.59)[b]
3rd tertile (high)	882 (49.0)	4.38 (3.77-5.08)[b]	2.08 (1.76-2.47)[b]	1.73 (1.44-2.08)[b]
	P<0.001			
Overcommitment				
1st tertile (high)	402 (22.2)	1.00	1.00	1.00
2nd tertile (medium)	497 (29.6)	1.48 (1.27-1.72)[b]	1.39 (1.18-1.63)[b]	1.28 (1.09-1.51)[b]
3rd tertile (low)	801 (43.4)	2.69 (2.33-3.11)[b]	1.91 (1.63-2.23)[b]	1.60 (1.35-1.89)[b]
	P<0.001			

Note. *Adjusted for gender, age, educational level, job satisfaction, negative affectivity, subjective health status, medical histories in the past six months, and shiftwork. **The DC model was additionally adjusted for SS; the SS scale was additionally adjusted for the DC model. Accordingly, The ERI model was additionally adjusted for OC; the OC scale was additionally adjusted for the ERI model. [a]*P*<0.05, [b]*P*<0.01, [c]adjusted for the DC model of psychological demands, [d]adjusted for the DC model of physical demands.

Table 4. Crude and Adjusted ORs for the Associations between Combinations of Stress Models/Scales and Depression (*n*=5 338)

Variables	*n* (%)	Crude OR (95% CI)	Adj OR (95% CI)*	Adj OR (95% CI)**	Adj OR (95% CI)**
Model 1				Adj OC	Adj ERI
Psychological demands					
DC and low SS absent	520 (19.8)	1.00	1.00	1.00	1.00
DC present	260 (34.6)	2.14 (1.79-2.56)[b]	1.46 (1.21-1.77)[b]	1.41 (1.16-1.70)[b]	1.27 (1.05-1.55)[a]
Low SS present	354 (37.3)	2.41 (2.05-2.83)[b]	1.84 (1.55-2.19)[b]	1.88 (1.57-2.24)[b]	1.71 (1.44-2.05)[b]
DC and low SS present	566 (55.9)	5.14 (4.39-6.01)[b]	2.83 (2.37-3.38)[b]	2.70 (2.26-3.23)[b]	2.39 (1.99-2.87)[b]
Physical demands					
DC and low SS absent	441 (17.8)	1.00	1.00	1.00	1.00
DC present	339 (37.4)	2.75 (2.32-3.26)[b]	1.97 (1.64-2.36)[b]	1.78 (1.48-2.14)[b]	1.68 (1.39-2.02)[b]
Low SS present	403 (38.2)	2.85 (2.42-3.34)[b]	2.16 (1.81-2.56)[b]	2.16 (1.81-2.57)[b]	2.00 (1.68-2.38)[b]
DC and low SS present	517 (57.1)	6.12 (5.18-7.23)[b]	3.32 (2.76-4.01)[b]	3.04 (2.51-3.67)[b]	2.76 (2.26-3.36)[b]
Model 2				Adj DC (Psychological demands)	Adj SS
ERI and low OC absent	897 (25.7)	1.00	1.00	1.00	1.00
ERI present	323 (43.1)	2.85 (2.40-3.39)[b]	1.66 (1.38-2.00)[b]	1.48 (1.22-1.80)[b]	1.47 (1.22-1.78)[b]
OC present	242 (30.4)	1.65 (1.38-1.97)[b]	1.53 (1.27-1.84)[b]	1.49 (1.24-1.80)[b]	1.55 (1.29-1.87)[b]
ERI and OC present	559 (53.2)	4.27 (3.67-4.98)[b]	2.43 (2.05-2.87)[b]	2.15 (1.80-2.56)[b]	2.24 (1.89-2.66)[b]
				Adj DC (Physical demands)	
ERI and low OC absent	897 (25.7)	1.00	1.00	1.00	1.00
ERI present	323 (43.1)	2.85 (2.40-3.39)[b]	1.66 (1.38-2.00)[b]	1.46 (1.20-1.76)[b]	1.47 (1.22-1.78)[b]
OC present	242 (30.4)	1.65 (1.38-1.97)[b]	1.53 (1.27-1.84)[b]	1.44 (1.19-1.73)[b]	1.55 (1.29-1.87)[b]
ERI and OC present	559 (53.2)	4.27 (3.67-4.98)[b]	2.43 (2.05-2.87)[b]	2.03 (1.70-2.42)[b]	2.24 (1.89-2.66)[b]
Model 3				Adj OC	Adj SS
Psychological demands					
DC and low ERI absent	555 (19.8)	1.00	1.00	1.00	1.00
DC present	263 (35.7)	2.25 (1.89-2.69)[b]	1.68 (1.39-2.02)[b]	1.66 (1.38-2.01)[b]	1.51 (1.25-1.83)[b]
ERI present	319 (41.3)	2.85 (2.40-3.38)[b]	1.87 (1.56-2.25)[b]	1.62 (1.34-1.95)[b]	1.73 (1.44-2.09)[b]
DC and ERI present	563 (54.8)	4.90 (4.20-5.72)[b]	2.44 (2.05-2.92)[b]	2.10 (1.75-2.52)[b]	2.08 (1.73-2.49)[b]
Physical demands					
DC and low ERI absent	566 (20.1)	1.00	1.00	1.00	1.00
DC present	252 (34.8)	2.12 (1.77-2.53)[b]	1.63 (1.35-1.96)[b]	1.54 (1.27-1.86)[b]	1.55 (1.28-1.88)[b]
ERI present	278 (39.0)	2.54 (2.13-3.03)[b]	1.61 (1.33-1.95)[b]	1.42 (1.17-1.73)[b]	1.44 (1.18-1.74)[b]
DC and ERI present	604 (55.6)	4.97 (4.27-5.77)[b]	2.58 (2.17-3.06)[b]	2.19 (1.83-2.62)[b]	2.32 (1.95-2.76)[b]

Note. *Adjusted for gender age, educational level, job satisfaction, negative affectivity, subjective health status, medical histories in the past six months , and shiftwork. **Multiple logistic regression analyses were additionally adjusted by OC and ERI for Model 1, by DC and low SS for Model 2, by OC and low SS for Model 3 respectively. [a]$P<0.05$, [b]$P<0.01$.

were simultaneously adjusted. To some extent, interaction effects were found for SS, but no interaction effects were found for overcommitment. The results from a study by Tsutsumi et al.[28] revealed that after adjustment for work environment factors, low control, effort reward imbalance and overcommitment were independently related with depression. Dragano et al.[29] found that job strain and the demand scales were no longer associated with depressive symptoms, low control, effort-reward-imbalance, and overcommitment remained significantly associated with symptoms when all components were entered simultaneously. Wang et al.[30] found that job strain, effort-reward imbalance and work-family conflicts were strongly associated with continuous depression score. Effort-reward imbalance was significantly associated with depression scores in women. Effort-reward imbalance was significantly associated with

depression scores in the subjects with job strain ratio >1, but not in those with a lower job strain ratio. Pakhart et al.[39] found the effect of low control disappeared after adjusting for socio-economic factors, whereas the effect of ERI remained significant. This research included the effort and rewards dimensions of ERI model and job control scale of DCS model but did not included overcommitment of ERI model and demands and SS scales of DCS model.

With regard to physical demands dimension of DCS model, only two previous studies have examined its effect on depressive symptoms[26-27]. One revealed that physical demands wasn't a risk factor for depressive symptoms[26]. Another one investigated psychological demands and physical demands scales of DCS model and found that they had similar effects on depression risk estimation[27]. In our present study, physical demands were found to have greater risk for depressive symptoms than psychological demands.

To our knowledge, this study is the first one in which both DCS model and ERI model were used to analyze the risk for psychosocial factors at work on depression. And findings from this study suggest that different combinations of stressors are related with depressive symptoms. A combination of job strain and ERI, adjusted for SS and overcommitment, had highest risks for depressive symptoms than each of them had alone. The full DCS model seems to be a better model than a combined job stress model as subjects exposed to both job strain and low social support showed the highest odds ratio, adjusted for ERI. Concerning the DC-ERI combination, although there is a certain amount of overlap between the two models with regard to the 'demand' and 'effort' components, the concept of DC focuses more on job cotrol and physical demands in the workplace, the ERI additionally includes organizational factors of the workplace such as fairness and justice, they measure related but different aspects of the work environment. Therefore, the information obtained from the use of the two models allows us to better understand which aspects are related to health outcomes. Findings concerning the combination of DC and SS are consistent with our detailed analyses of the model components, which indicated that low SS is a risk factor for depressive symptoms. Some previous studies of job stress and depressive symptoms excluded SS[28-30], which was important component of the DCS. And these studies may have underestimated the contribution of DC model to some extent as it did not include SS at work. In this study, each scale of the DCS and ERI models was analyzed.

Our study has several methodological limitations. First, like all cross-sectional design, we cannot make conclusions about the causality of job stress and depressive symptoms. For example, while stress at work may increase the risk for depression, depression may also cause more serious job-related stress. Generally speaking, we could not rule out the possibility that depressed people show a higher probability of reporting negative experience. Depressed persons could be more likely to report psychosocial stress at work, even if their work environment is not unfavorable actually. Second, both psychosocial factors at work and depressive symptoms were measured by using self-report and the reporting bias related with 'common method variance,' might therefore lead to inflated associations between job stress factors and depressive symptoms. However, in all logistic analysis, negative affectivity was controlled and results from our study ruled out the bias effect of negative affectivity. Furthermore overcommtment component of effort-reward imbalance model was included in this study; it also allows us at least in part to take into account information about personality. Third, the response rate of this study was 79.5% and sampling bias cannot be completely excluded. If subjects with depressive symptoms had another jobs with lower levels of job stress, such bias could lead to an underestimation of the association between job stress and depressive symptoms.

The strength of this study should also be stressed. First, the study used complete theoretical job stress models, assessed by psychometrically valid questionnaires, and included both SS and overcommitment dimensions. Second, the sample included the majority of the workforce of the factories or plants and included both men and women; the sample size was so far the largest among studies on evaluating the relationship between DCS and ERI models and depressive symptoms[26-30]. Third, our study included various confounders related, such as personal factors, occupational factors, job satisfaction, and affectivity, therefore the potential effects of confounding were reduced. Finally, to our knowledge, this is the first study using both DCS model and ERI model to analyze the risk of psychosocial factors at work on depression.

In conclusion, despite the limitations mentioned above, this study provides evidence of adverse effects of psychosocial factors at work on depressive symptoms produced by job strain and effort-reward imbalance among workers in Henan province. Effect of physical demands was larger than that of psychological demands. The combination of DC and ERI models could improve the risk estimate of depressive symptoms. Preventive efforts should be strengthened towards improving psychosocial working conditions, to increase reward, SS and job control, and reduce physical and psychological demands and effort.

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