Effect of Changing Work Stressors and Coping Resources on the Risk of Type 2 Diabetes: The OHSPIW Cohort Study

Yulong Lian,[1,2] Qing Sun,[1] Suzhen Guan,[2] Hua Ge,[2] Ning Tao,[2] Yu Jiang,[2] YanXia Zhang,[2] Li Ning,[2] Jing Xiao,[1] and Jiwen Liu[2]

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OBJECTIVE

Little is known about the relationship between changing psychosocial work conditions and type 2 diabetes. We determined whether changing work stressors and coping resources affect the risk of type 2 diabetes.

RESEARCH DESIGN AND METHODS

In this prospective cohort (2003–2014) of 3,740 workers without diabetes (OHSPIW [Occupational Health Study of Petroleum Industry Workers]), participants completed an evaluation of work-related stress and coping resources and type 2 diabetes diagnosis at baseline and 12 years follow-up (two waves). The changes in work stressors and coping resources were measured with the Occupation Stress Inventory–Revised and the Instrument for Stress-Related Job Analysis (Version 6.0). Type 2 diabetes was diagnosed on the basis of an oral glucose tolerance test supplemented by physician report.

RESULTS

Increased task stressors (relative risk [RR] 1.57 [95% CI 1.03–2.63]) and decreased coping resources (RR 1.68 [95% CI 1.02–2.83]) were associated with risk of type 2 diabetes. The main risk factors were increased role overload, increased role insufficiency, increased physical environment stressors, decreased self-care, and decreased rational coping. Increased coping resources also had a buffering effect on increased task stressors and type 2 diabetes.

CONCLUSIONS

Changes in work stressors and coping resources have an influence on the risk for type 2 diabetes, highlighting the importance of preventive measures against adverse psychosocial work conditions and reduced coping resources for diabetes prevention in the workplace.

Diabetes is a growing problem that poses a major public health challenge globally (1), and the epidemic is particularly notable in China (2). Diabetes may account for up to 20% of national health care budgets in some countries (3). To date, the focus of preventive efforts has been on lifestyle and pharmacological interventions (4); however, interest in the role the psychosocial work environment plays in the onset of type 2 diabetes, including job strain (5–12), occupational stressors (13), workload (14), job insecurity (15), and justice at work (16), has been growing. Evidence of a psychosocial work environment-diabetes association is limited and inconsistent (17,18). For

[1]Division of Occupational and Environmental Health, College of Public Health, Nantong University, Nantong, Jiangsu, China
[2]Division of Occupational and Environmental Health, College of Public Health, Xinjiang Medical University, Urumqi, Xinjiang, China

Corresponding author: Yulong Lian, lianyulong444@163.com.

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example, no association between job strain on the basis of the demand latitude model (19) and diabetes was found in the Nurses' Health Study II (NHS II) (8), the Canadian Community Health Survey (CCHS) (7), and Japanese studies (10), whereas Whitehall II (6), the Augsburg studies (5), and the Individual-Participant Data Meta-analysis of Working Populations (IPD-Work) consortium studies (11) have reported that job strain is a risk for diabetes. In addition, a sex difference ineffect was found in Whitehall II and the Stockholm Diabetes Prevention Program (SDPP) (12) but not in the IPD-Work study.

These inconsistent findings may result from methodological limitations, such as various means of confirming the diagnosis of type 2 diabetes (self-report [5,6,8,11], hospital registries [11], physician report [7], and oral glucose tolerance tests [6,10–12]), and not adjusting for important confounding factors, such as mental health (5,6,8,10) and various exposure assessments among studies (dichotomous [5,6,11], tertiary [12], and quadrantal [10] categorization). Moreover, all previous studies only assessed exposure at baseline and may have under- or overestimated the true effect of the psychosocial work environment on the risk of diabetes if psychosocial work factors are relatively unstable (11).

In addition to these work-related psychosocial factors, psychosocial resources, such as social support (20), self-care (21), and social network (22), have been shown to be associated with type 2 diabetes. The effect of workplace psychosocial factors on diabetes may be influenced by coping resources. In the Whitehall II study, job strain was associated with a 60% higher risk for type 2 diabetes, and isostrain was associated with a twofold higher risk (6); however, the effect of coping resources was not found in one recent Chinese cohort study (13).Thus, the synergistic interaction effect on type 2 diabetes is poorly understood and does not provide evidence that changing these factors would result in changes in the risk of type 2 diabetes.

The petroleum industry plays an important role in driving the global economy and makes the identification of factors that influence the health of personnel who work in this industry essential (23). Previous findings showed that petroleum industry workers report more psychosocial stressors and health problems (23,24), but knowledge is still lacking about the factors that cause diabetes in this occupational setting. From both an organizational and a public policy perspective, knowledge about changes in these conditions is associated with a subsequent risk for type 2 diabetes, which could have important implications for prevention. In addition, the aforementioned studies have focused primarily on adverse changes in psychosocial working conditions, and type 2 diabetes might be reduced by promoting favorable changes instead of merely preventing adverse changes.

In the current 12-year prospective study, we evaluated whether changes in work stressors, including task stressors, organization stressors, job control, and coping resources, were significantly associated with type 2 diabetes among Chinese petroleum industry workers. In addition, we evaluated the potential modifying effects of coping resources in the workplace.

RESEARCH DESIGN AND METHODS

Study Design and Participants

This study was part of the OHSPIW (Occupational Health Study of Petroleum Industry Workers), which investigated the effects of occupational risk factors on health (24). The baseline data collection was performed between January and December 2003. A total of 4,500 workers were invited to participate, and 4,251 (94.5%) responded to the initial clinical examination, which included fasting blood glucose testing and questionnaires about medically diagnosed diseases, sociodemographic factors, lifestyle factors, work stressors, coping resources, and psychological distress. We excluded 521 workers with diabetes (n = 267), pregnancy (n = 19), cardiovascular disease (n = 113), long-term sick leave (n = 34), and unemployment or career change (n = 88). We invited all respondents to participate in a follow-up interview (between January and December 2014) about work stressors, coping resources, and diagnosis of type 2 diabetes. In the follow-up, 239 participants were excluded as a result of insufficient or missing information about psychological work factors (n = 125), retirement (n = 19), moving out of the city (n = 9), declining further participation (n = 61), and unemployment or career change (n = 25). Thus, the final sample comprised 3,740 participants (Fig. 1). The research protocol for this cohort study was approved by the ethics committee of Xinjiang Medical University. Written informed consent was obtained from all participants.

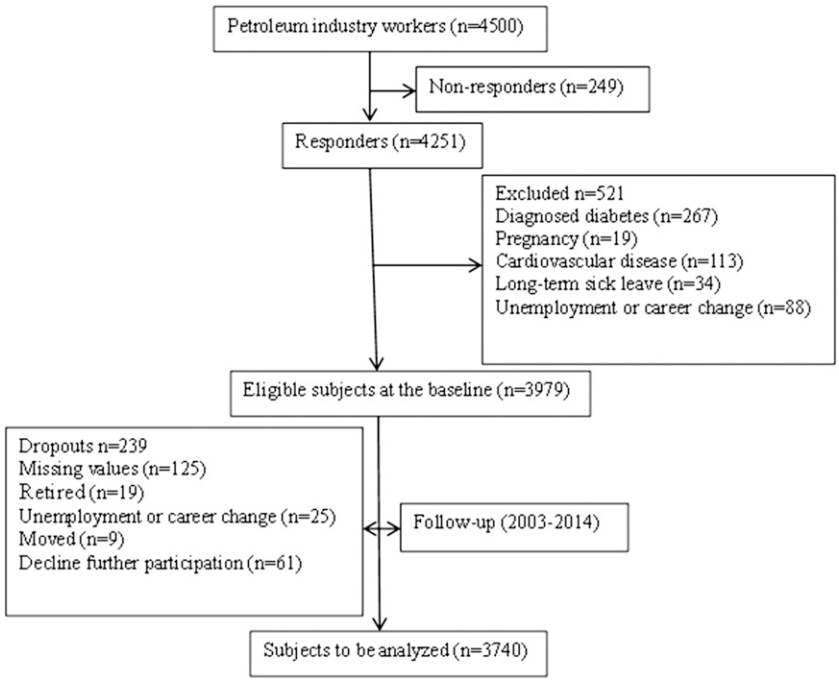

Figure 1—Flow of included and excluded individuals in the cohort study, 2003–2014.

Measures

Confirmation of Diagnosis of Type 2 Diabetes

The diagnosis of type 2 diabetes was made according to World Health Organization criteria (25) at baseline and China guidelines for type 2 diabetes at follow-up (fasting glucose ≥7.0 mmol/L and/or 2-h postload glucose ≥11.1 mmol/L) (26). We used the World Health Organization diagnostic criteria at baseline because the analytic cohort preceded the first China guidelines for type 2 diabetes. For participants without a prior diabetes diagnosis, venous blood samples were obtained from those who fasted 8 h, and individuals with a fasting plasma glucose >6.1 mmol/L were invited for a standard 2-h 75-g oral glucose tolerance test the next day. For participants with a clinical diagnosis of type 2 diabetes and/or use of diabetic medication between 2004 and 2013, medical records were reviewed by an endocrinologist blinded to patient information. On the basis of the China guidelines for type 2 diabetes, the diagnosis was confirmed in 26 of 26 (100%) participants. Eighty-five participants with type 2 diabetes were identified.

Work Stressors

Work stressors included task stressors, job control, and organization stressors. Task stressors were measured by using the occupational role subscales from the Chinese version of the Occupational Stress Inventory–Revised (OSI-R) (27) originally developed by Osipow (28). The OSI-R is a reliable and valid method for measuring work stressors in China (24,28). The subscales assessed role overload, role insufficiency, role ambiguity, role boundary, responsibility, and physical environment, with each item scored on a Likert scale ranging from 1 (never) to 5 (always). Role overload measures the extent to which the demands of a job exceed resources and the degree to which the individual is able to complete the workload. Role insufficiency measures the degree to which an individual's training, education, skills, and experience are appropriate to the job requirements. Role ambiguity defines the extent to which the expected priorities, expectations, and evaluation criteria are clear to the employee, whereas role boundary analyzes conflicting role demands and loyalties in the work setting. Responsibility is measured by how responsible the individual feels for the performance and welfare of his or her colleagues. Physical environment measures the degree to which the individual is exposed to high levels of environmental toxins or extreme physical conditions. Each subscale contains 10 items, and the item scores for each scale were summed. The scale scores were then summed to generate the total task stressor score as previously described (24,28). Higher scores indicated more task stressors.

Organizational stressors and job control were measured by using a stress-oriented job analysis questionnaire (Instrument for Stress-Related Job Analysis [Version 6.0]), which was originally developed in Germany (29) and has since been validated in the Chinese population (30). Job control includes task control, time control, participation, communication possibilities, and cooperation possibilities. Task control reflects the ability of employees to independently plan and organize their own work. Time control evaluates the influence of employees on their workplace and schedule. Participation measures the ability of employees to control their own work situation. Communication possibilities assess the possibility for work-related communications among colleagues, whereas cooperation possibilities address the possibilities for colleagues to support one another. Organizational stressors include organizational problems, work interruptions, closeness of cooperation, concentration requirements, and accident risk. Organizational problems were defined as dealing with inadequate devices or obsolete information. Work interruptions were defined as unexpected events caused by other employees, technical problems, and organizational problems. Concentration requirements reflect the need for a high level of concentration for prolonged periods. Closeness of cooperation and cooperation requirements are related to dependence on others and the need for mutual decisions and information. Accident risk addresses the safety of the work environment and the quality of safety instructions and accident prevention. Organizational stressor and job control scores were summed for each scale as previously recommended (24,29). Higher scores indicated a higher level of work-related psychosocial factors (27).

Coping Resources

Coping resources were measured by using the personal strain subscales from the Chinese version of the OSI-R (27). High scores indicated highly developed coping resources, including recreation, self-care, social support, and rational coping. Recreation evaluates the individual's ability to derive pleasure and relaxation. Self-care measures the extent to which the individual regularly engages in stress-relieving activities. Social support measures the degree of support perceived by the individual. Rational coping evaluates an individual's ability to apply cognitive skills to work-related stress. The scale scores were summed to generate the total coping resources score as previously described (24,27).

Changes in Work Stressors and Coping Resources

Changes in work stressors and coping resources were assessed by classifying changes greater than the minimal detectable change as described by Jacobson and Truax (31). This method incorporates both the observed variance in scores at baseline and an estimate of day-to-day variability in the measures. The day-to-day variability of a measure is estimated by test–retest reliability. Estimations of the day-to-day variability for each work stressor and coping resource were established on the basis of baseline and follow-up OSI-R and Instrument for Stress-Related Job Analysis (Version 6.0) scores of 100 manufacturing workers over a 2-week period, with coefficients ranging from 0.86 to 0.96 as previously recommended (24,31). Change was defined according to the minimal detectable change value (increased change, greater than the upper limited value; decreased change, lower than the lower limited value).

Covariates

Data on several potential confounding factors were collected at baseline, including sociodemographic variables, lifestyle factors, family history of diabetes, and psychological distress. Self-report educational level was classified as secondary school or less, college, and university. BMI was classified as underweight (<18.5 kg/m^2), normal weight (18.5–23.0 kg/m^2), and overweight (23.0–27.5 kg/m^2). Family history of diabetes was determined on the basis of the following question: Were any of your biological relatives, that is, blood relatives, including grandparents, parents, uncles, aunts, brothers, and sisters, ever told by a health professional that they had diabetes? Smoking status

was categorized as smoker (at least one cigarette per day), occasional smoker (fewer than one cigarette per day), ex-smoker, and nonsmoker. Alcohol consumption was quantified by the grams of alcohol consumed weekly as beer, wine, and hard liquor and divided into the following four categories: alcohol consumer (>8 g/week), occasional consumer (<8 g/week), ex-consumer, and nonconsumer. Physical activities were classified into four groups (three or more times per week, fewer than three times a week, irregular, and never) on the basis of the following questions: Do you engage in vigorous physical activity at work or at home or for training purposes? How many times in a normal week do you engage in vigorous physical activities? Psychological distress was assessed at baseline by using the Chinese Symptom Checklist-90-Revised (cases, global severity index ≥63) (32). At the baseline and follow-up evaluations, participants reported their medically diagnosed chronic diseases and were categorized as having no disease or one or more diseases. Full details of these variables are published elsewhere (24).

Statistical Analyses

Descriptive statistics were calculated for demographic variables compared between included and excluded workers by using Student *t* and χ^2 tests. With the use of no change as the reference group, the relationship between type 2 diabetes and a change in work stressors and coping resources and their components was analyzed by multiple logistic regression modeling controlling for the effects of sex, ethnicity, age, education, marital status, and family history of diabetes (model 1) and additionally for smoking, BMI, physical activity, alcohol consumption, psychological distress, chronic diseases, and changes in work stressors (for coping strategies as a main variable) or coping resources (for work stressors as a main variable) (model 2). Given that the effect of the psychosocial work environment on diabetes may have sex divergence (6,12), analyses were performed for men and women combined and separately. To evaluate whether the associations differed between men and women, the likelihood ratio test was used to measure interactions between psychosocial work stress variables and sex. Furthermore, the modifying effects of coping resources were evaluated by stratified analysis adjusting for the above-mentioned confounding factors. SPSS version 17.0 software (IBM Corporation, Chicago, IL) was used for the statistical analyses.

RESULTS

The group of excluded workers was less educated than the group of included participants. The prevalence of a family history of diabetes and women was also higher in excluded workers. We did not observe differences in age, ethnicity, physical activity, smoking, alcohol consumption, BMI, and marital status (Table 1).

Increased task stressors and decreased coping resources were significantly associated with incident type 2 diabetes. Neither changes in organization stressors nor a change in job control was associated with type 2 diabetes. No difference in the association between changes in work stressors and coping resources and incident type 2 diabetes was observed for males and females (*P* for sex interaction > 0.05) (Table 2). Because of no sex differences in the

Table 1—Characteristics at baseline among participants included and excluded from the analyses

Characteristic	Included (*n* = 3,740)	Excluded (*n* = 760)	*P* value
Age (years), mean (SD)	38.3 (8.1)	38.9 (7.2)	0.172
Sex			0.0004
Male	2,019 (54.0)	357 (47.0)	
Female	1,721 (46.0)	403 (53.0)	
Ethnicity			0.061
Han	3,163 (84.6)	636 (83.7)	
Uyghur	378 (10.1)	68 (8.9)	
Other	199 (5.3)	56 (7.4)	
Education			0.0001
Secondary school or less	1,026 (27.4)	250 (32.9)	
College	1,989 (53.2)	406 (53.4)	
University	725 (19.4)	104 (13.7)	
Physical activity			0.287
Never	832 (22.2)	189 (24.9)	
<3 times/week	1,326 (35.5)	254 (33.4)	
≥3 times/week	724 (19.4)	135 (17.8)	
Irregular	858 (22.9)	182 (23.9)	
Psychological distress			0.316
Yes	1,074 (28.7)	232 (30.5)	
No	2,666 (71.3)	528 (69.5)	
Family history of diabetes	597 (16.0)	152 (20.0)	0.006
Smoking status			0.067
Regular smoker	683 (18.3)	121 (15.9)	
Nonsmoker	1,753 (46.9)	387 (50.9)	
Occasional smoker	720 (19.3)	153 (20.1)	
Ex-smoker	584 (15.6)	99 (13.0)	
Alcohol consumption			0.106
Nonconsumer	1,415 (37.8)	300 (39.5)	
Consumer	392 (10.5)	60 (7.9)	
Occasional consumer	1,350 (36.1)	291 (38.3)	
Ex-consumer	583 (15.6)	109 (14.3)	
BMI			0.158
Normal weight	2,885 (77.1)	556 (73.1)	
Underweight	22 (0.6)	4 (0.5)	
Overweight	191 (5.1)	42 (5.5)	
Moderately obese	585 (15.6)	144 (18.9)	
Severely obese	57 (1.5)	15 (2.0)	
Marital status			0.053
Single	539 (14.4)	123 (16.2)	
Married	2,821 (75.4)	566 (74.5)	
Divorced	322 (8.6)	59 (7.8)	
Widowed	20 (0.5)	0 (0)	
Remarried	38 (1.0)	12 (1.6)	

Data are *n* (%) unless otherwise indicated.

Table 2—Type 2 diabetes by changes of work stressors and coping resources adjusted for covariates compared with no change

		Model 1		Model 2		Model 2 (men)		Model 2 (women)		*P* value for sex interaction
Factor	Proportion	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI	
Task stressors										
Decrease	18 of 812	1.45	0.82–1.42	1.23	0.78–1.46	1.21	0.71–1.67	1.32	0.82–2.08	0.231
Increase	38 of 1,190	1.61*	1.25–2.86	1.42*	1.13–2.53	1.36*	1.01–2.37	1.21*	1.02–2.14	0.124
Organization stressors										
Decrease	28 of 1,103	0.81	0.52–1.33	0.87	0.55–1.36	0.87	0.63–1.86	0.85	0.57–1.77	0.467
Increase	15 of 608	1.36	0.78–2.12	1.23	0.76–2.02	1.22	0.71–2.15	1.26	0.88–2.12	0.348
Job control										
Decrease	18 of 799	0.81	0.68–1.32	0.76	0.48–1.54	0.86	0.44–1.62	0.78	0.51–1.34	0.556
Increase	16 of 733	0.88	0.51–1.56	0.89	0.50–1.52	0.74	0.56–1.25	0.67	0.42–1.62	0.327
Coping resources										
Decrease	11 of 758	1.69*	1.12–2.91	1.68*	1.09–2.76	1.74*	1.03–2.79	1.82*	1.08–3.23	0.109
Increase	34 of 1,032	1.13	0.71–2.01	1.15	0.64–1.88	0.98	0.52–1.61	1.09	0.61–1.94	0.239

Model 1 adjusted for sociodemographic variables (ethnicity, age, education, marital status) and family history of diabetes. Model 2 additionally adjusted for smoking, BMI, physical activity, alcohol consumption, chronic disease, psychological distress, and work stressors (for each coping strategy as a main variable) or coping resources (for each work stressor as a main variable). *$P < 0.05$.

effect, we combined men and women into one group for further analyses. We examined the changes in the components of work stressors and coping resources in relation to the risk for type 2 diabetes (Table 3). Participants with increased role overload, increased role insufficiency, or increased physical environment stressors were at an increased risk for type 2 diabetes, with relative risk (RR) values of 2.25 (95% CI 1.26–4.17), 1.73 (1.08–2.85), and 1.83 (1.10–3.01), respectively. In addition, an increased risk for type 2 diabetes existed with decreased self-care (2.06 [1.08–3.89]) and decreased rational coping (2.27 [1.14–4.28]). Again, the associations did not change after adjustment for lifestyle factors, psychological distress, and chronic disease.

On the basis of the findings on the independent effect of task stressors and coping resources on type 2 diabetes, we also analyzed the interaction between coping resources and task stressors on the risk for type 2 diabetes (Table 4). The presence of both increased task stressors and decreased coping resources increased the risk for type 2 diabetes by ~300% (RR 2.72 [95% CI 1.27–5.76]) compared with no change. Increased task stressors with decreased coping resources was not associated with a significantly increased risk of type 2 diabetes (1.06 [0.47–2.34]).

CONCLUSIONS

This prospective study is the first to our knowledge to show that increased task stressors and/or decreased coping resources place workers at a substantially higher risk for type 2 diabetes. Increased coping resources had a protective effect for increased task stressors on type 2 diabetes. The main risk factors were increased role overload, increased role insufficiency, increased physical environment stressors, decreased self-care, and decreased rational coping.

Evidence linking work-related stress to the risk of type 2 diabetes is conflicting (17,18). One Chinese study that was based on the same transactional model of stress showed that occupational stressors are associated with abnormal glucose metabolism (13). Although the current results cannot easily be compared with previous studies because of a difference in the measurement of exposure assessment (single vs. cumulative), we observed a similar effect of increased task stressors on the risk for type 2 diabetes; however, we did not find that positive changes in the psychosocial work factors reduced the risk for type 2 diabetes. In addition, a 3-month stress management intervention among U.S. Latinos with type 2 diabetes showed that each additional session resulted in a 0.21 decrease in HbA_{1c} level (33). Therefore, our failure to find this positive effect suggests that the benefits of positively changing psychosocial work conditions may require that a strict and higher-intensity intervention be realized. Indeed, several studies have shown the effect of work-related stress on type 2 diabetes only in females (6,7,18), and the authors speculated that the different effect may be attributable to the roles often assumed by females outside the workplace, such as household responsibilities and child care. However, these stressful life events related to social relationships and home life were reported to be unrelated to impaired glucose tolerance on the basis of the Botnia Study (34). In one IPD-Work study (11), sex divergence of the effect was not found. We also found support for this evidence through the observation of no sex difference in the relation. Our findings regarding the association between role overload/insufficiency and type 2 diabetes also confirmed a U-shaped relationship between workload and type 2 diabetes as reported by Toker et al. (14). Compared with medium workload, both under- and overworkload may increase the risk for diabetes. In a previous study, we found that the burden of a permanent negative workload was associated with an increase in blood pressure (24), and blood pressure has been closely related to abnormal glucose metabolism, which may then result in the development of type 2 diabetes (35). Another possible explanation is that adverse workload might reduce physical activity of workers during work hours and then influence the risk for type 2 diabetes. With respect to physical environment, epidemiology studies have demonstrated that exposure to physical environmental risk factors (e.g., noise, particulate matter) increases the risk for diabetes (36). We also found an effect of increased physical environment stressors on type 2 diabetes. However the assessment of physical environment was based on the

Table 3—Type 2 diabetes by changes in components of work stressors and coping resources adjusted for covariates compared with no change

		Model 1		Model 2	
Factor	Proportion	RR	95% CI	RR	95% CI
Task stressors					
Role overload					
Decrease	28 of 1,163	1.21	0.79–2.28	1.14	0.86–1.90
Increase	18 of 463	2.25*	1.26–4.17	2.26*	1.20–4.01
Role ambiguity					
Decrease	22 of 927	1.59	0.91–2.79	1.42	0.83–2.46
Increase	31 of 1,148	1.58	0.90–2.62	1.56	0.92–2.60
Responsibility					
Decrease	30 of 1,139	1.50	0.90–2.50	1.46	0.88–2.41
Increase	21 of 844	1.37	0.79–2.40	1.31	0.76–2.30
Role boundary					
Decrease	18 of 766	1.35	0.78–2.41	1.35	0.75–2.42
Increase	34 of 1,135	1.41	0.85–2.31	1.30	0.76–2.14
Role insufficiency					
Decrease	20 of 780	1.07	0.59–2.08	1.08	0.58–1.94
Increase	36 of 1,189	1.73*	1.08–2.85	1.67*	1.03–2.72
Physical environment					
Decrease	23 of 872	1.39	0.76–2.42	1.36	0.78–2.41
Increase	27 of 1,072	1.83*	1.10–3.01	1.77*	1.02–2.88
Organization stressors					
Organizational problems					
Decrease	9 of 400	1.10	0.61–2.01	1.11	0.63–2.06
Increase	17 of 729	0.55	0.25–1.22	0.52	0.29–1.28
Closeness of cooperation					
Decrease	12 of 541	0.68	0.29–1.41	0.66	0.39–1.48
Increase	7 of 319	1.57	0.79–2.90	1.49	0.71–2.81
Accident risk					
Decrease	14 of 625	0.92	0.53–1.55	0.91	0.53–1.59
Increase	9 of 404	1.11	0.61–1.27	1.12	0.61–2.02
Work interruptions					
Decrease	13 of 579	0.90	0.52–1.56	0.89	0.54–1.55
Increase	7 of 307	1.48	0.87–2.55	1.54	0.55–0.99
Job control					
Task control					
Decrease	10 of 447	0.87	0.51–1.72	0.95	0.51–1.79
Increase	7 of 331	1.23	0.57–2.23	1.15	0.58–2.17
Participation					
Decrease	13 of 570	1.10	0.64–1.85	1.08	0.64–1.85
Increase	12 of 531	1.02	0.58–1.84	1.03	0.46–1.83
Time control					
Decrease	11 of 472	0.61	0.31–1.23	0.61	0.32–1.23
Increase	12 of 496	1.15	0.56–2.43	1.16	0.55–2.45
Communication possibilities					
Decrease	11 of 550	0.84	0.52–1.27	0.84	0.51–1.33
Increase	8 of 336	1.20	0.67–2.23	1.22	0.76–2.28
Cooperation possibilities					
Decrease	11 of 488	0.78	0.35–1.72	0.79	0.36–1.78
Increase	12 of 574	0.76	0.39–1.71	0.77	0.44–1.73
Coping resources					
Recreation					
Decrease	4 of 182	1.72	0.72–4.08	1.68	0.78–3.90
Increase	17 of 745	1.57	0.93–2.61	1.60	0.92–2.61
Self-care					
Decrease	10 of 300	2.06*	1.08–3.89	2.07*	1.07–3.79
Increase	9 of 325	1.21	0.57–2.57	1.23	0.58–2.52
Social support					
Decrease	4 of 167	1.80	0.82–1.06	1.81	0.79–4.20
Increase	4 of 179	0.56	0.34–2.32	0.58	0.24–2.07
Rational coping					
Decrease	8 of 238	2.27*	1.14–4.28	2.29*	1.14–4.04
Increase	4 of 176	1.10	0.54–2.70	1.18	0.48–2.07

Model 1 adjusted for sociodemographic variables (ethnicity, age, education, marital status) and family history of diabetes. Model 2 additionally adjusted for smoking, BMI, physical activity, alcohol consumption, chronic disease, psychological distress, and work stressors (for each coping strategy as a main variable) or coping resources (for each work stressor as a main variable). *$P < 0.05$.

OSI-R, and more-objective measures of physical environments are needed to validate our conclusions.

We found no association between changes in job control and type 2 diabetes, which is consistent with findings by most previous studies (6,7,18) but inconsistent with the Västerbotten Intervention Program (VIP) (9) and SDPP (12). These two studies associated low job control with an elevated risk for diabetes among women. The divergence may be due to methodological differences in the assessment of job control. Previous studies were based on a demand-control model (19), whereas our assessment was based on a transactional model of stress extended to work psychology (27). Another explanation may be a result of the high dropout rate in SDPP and small sample size of VIP. In addition, we focused on work-related changes, whereas the previous studies did not consider these in the work environment. In VIP and SDPP, job control was assumed to be relatively stable during long-term follow-up. In considering the rapid progress of the petroleum industry, these studies may have over- or underestimated the true effect of job control on the risk for type 2 diabetes, and the effect has been confirmed in studies of cerebrovascular disease (37). We found no relationship between organization stressors and type 2 diabetes, which is in partially accords with findings from the Whitehall II study (16) that suggested that a high level of justice at work is related to reduced HDL cholesterol, elevated triglycerides, a large waist circumference, and elevated blood pressure but not with elevated glucose. Ideally, the observed reduced risks of diabetes result in a low-risk for diabetes, but such an effect was not found in our study.

We also have found that decreased coping resources increased the risk for type 2 diabetes but not for positive change, which disagrees with a Chinese cohort study (13). This divergence may be explained by the fact that we focused on type 2 diabetes occurring within 12 years of the change in coping resources, whereas the previous study examined type 2 diabetes in 4-year postbaseline coping resources (13). In addition, the association may be divergence among various types of coping resources. One review showed that self-care activities were associated with improved glycemic control (21). A previous meta-analysis has

Table 4—Moderating effects of coping resources on the relationships of work stressors and diabetes adjusted for covariates

Factor	Model 1	Model 2
Task stressors × coping resources		
No change × no change	1.00	1.00
Increase × decrease	2.75 (1.25–5.09)*	2.72 (1.27–5.76)*
Increase × increase	1.04 (0.48–2.45)	1.06 (0.47–2.34)

Data are RR (95% CI). Model 1 adjusted for sex, ethnicity, age, education, family history of diabetes, and marital status. Model 2 additionally adjusted for smoking, BMI, physical activity, alcohol consumption, chronic diseases, and psychological distress. *$P < 0.05$.

proven that social support is not an important risk factor for type 2 diabetes (17). We also confirmed that decreased self-care and decreased rational coping are related to type 2 diabetes but not changes in social support and recreation. However, two other cohort studies showed a significant association between high social integration and poor structural social support and diabetes in men but not women (20,22). The discrepancies could be explained partly by the aforementioned various indices used to measure social support and how they were categorized. These inconsistent findings might point to poor use of social support on the basis of traditional Chinese culture. In China, the individual reflects on the family; thus, stressful events or any behavior that indicates a lack of self-control may produce shame and guilt. As a result, Chinese workers may be reluctant to accept social support when facing stressful events. Essentially, the change of social support did not change social support use. Fukunishi et al. (38) found that poor use of social support rather than the existence and perception of social support per se was correlated with deranged glucose tolerance. However, how various types of social support influence diabetes requires further investigation.

The important role coping resources play in the work stress-suicide relationship is of particular interest. Work-related psychosocial stress may increase the risk for type 2 diabetes through activation of the hypothalamus-pituitary-adrenal axis and the sympathetic nervous system, lead to the release of sympathetic hormones and glucocorticoids and then to increased hepatic glucose output, decreased insulin secretion, and insulin resistance (39); however, active and problem-focused coping strategies may have positive effects on physiological responses, particularly hypothalamus-pituitary-adrenal activity and the sympathetic nervous system (40), which may reduce the risk for type 2 diabetes.

The current study has a number of strengths, including a prospective design, the control of most known confounders, a wide variety of psychosocial working conditions, elimination of day-to-day variability, and evaluation of coping resources. However, some limitations should be considered. Recall and reporting biases were possibly due to self-reported work characteristics. The study population comprised petroleum industry workers; thus, the results may not be generalizable to other populations. Although we assessed most known covariates, other risk factors such as dietary intake were not examined. Furthermore, because BMI and lifestyle factors and psychological distress were measured only at baseline, changes in these factors might have contributed to an under- or overestimation of the associations. We found some differences between participants and nonparticipants with regard to sex and family history of diabetes, but a nonsex difference in the effect of psychosocial work characteristics on diabetes was found. Thus, we believe that the selection bias is minimal. Finally, reverse causation remains a potential source of bias. The participants' health status may have affected their perceptions of stress. In this study, however, stratum analytics did not change the association (Supplementary Table 1), suggesting that reverse causation is likely to explain little, if any, of the observed association. Although we used well-established constructs, research has indicated that a more comprehensive assessment of the psychosocial work environment is needed (e.g., demand latitude model) (18,37). Most of these Chinese versions of instruments emerged after the 2003 survey of OHSPIW. We will assess these psychosocial work environment measurements in a future follow-up study.

This study shows that increased task stressors and decreased coping resources are independently associated with type 2 diabetes. Increased coping resources buffer the negative effect of these factors on type 2 diabetes. These findings pinpoint the importance of effective preventive measures against adverse psychosocial work characteristics, especially regarding workload and physical environment in workplace diabetes prevention. Moreover, the findings suggest the importance of employers providing more coping resources, such as increased adherence to self-care and problem-focused coping strategies, to reduce the diabetes risk of employees who experience adverse work conditions in the petroleum industry.

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