Job demands, job resources and safety outcomes: The roles of emotional exhaustion and safety compliance

Feng Li [a,*], Li Jiang [b], Xiang Yao [c], YongJuan Li [d]

[a] Key Laboratory of Mental Health, Institute of Psychology, Chinese Academy of Sciences, No. 16 LinCui Road, ChaoYang, Beijing 100101, PR China
[b] School of Business, Soochow University, No. 5 Donghuan Road, Canglang, Suzhou 215021, PR China
[c] Department of Psychology, Peking University, No. 5 Yiheyuan Road, Hai Dian, Beijing 100871, PR China
[d] Key Laboratory of Behavioral Science, Institute of Psychology, Chinese Academy of Sciences, No. 16 LinCui Road, ChaoYang, Beijing 100101, PR China

A B S T R A C T

The aim of this study was to assess the effectiveness of the job demands–resources (JD–R) model in explaining the relationship of job demands and resources with safety outcomes (i.e., workplace injuries and near-misses). We collected self-reported data from 670 crude oil production workers from three sub-companies of a major oilfield company in China. The results of a structural equation analysis indicated that job demands (psychological and physical demands) and job resources (decision latitude, supervisor support and coworker support) could affect emotional exhaustion and safety compliance, and thus influence the occurrence of injuries and near-misses. The implications of the present findings regarding both the JD–R model and occupational safety research were discussed.

1. Introduction

Injuries and accidents in the workplace have always been a serious issue worldwide. Every day, nearly 1 million workers around the world are involved in workplace accidents, and more than 5500 workers die as a result of work-related accidents or diseases (International Labour Organization, 2009). In 2010, there were 363,383 industrial accidents in China, in which 79,552 workers lost their lives (State Administration of Work Safety, 2011). Given these high human costs, researchers have devoted efforts to studying workplace safety (Christian et al., 2009). Higher psychological job demands, for instance, have been found to be associated with a higher frequency of unsafe work behaviors (Hofmann and Stetzer, 1996) and near-misses (Goldenhar et al., 2003), as well as a higher likelihood of workplace injuries (Barling et al., 2002; Turner et al., 2010). However, few attempts have been made to relate well-established work stress models to safety outcomes (Snyder et al., 2008).

In the present study, the job demands–resources (JD–R) framework (Bakker et al., 2003a; Demerouti et al., 2001b) is used to explore how job demands and resources affect safety outcomes, specifically near-misses and injuries. In doing so, we also examine whether job strain and engagement processes work in safety context.

1.1. Overview of the job demands–resources model

The core assumption of the JD–R model is that, regardless of job type, the risk factors associated with job stress can be classified into two general categories: job demands and job resources (Bakker and Demerouti, 2007). Job demands (e.g., time pressure) are defined as "those physical, social, or organizational aspects of the job that require sustained physical and/or mental effort and are therefore associated with certain physiological and psychological costs"; job resources (e.g., supervisor and co-worker support), on the other hand, are characterized by "those physical, psychological, social, or organizational aspects of the job that may do any of the following: (a) be functional in achieving work goals; (b) reduce job demands at the associated physiological and psychological costs; (c) simulate personal growth and development" (Demerouti et al., 2001b; p. 501). Hence, resources not only foster extrinsic motivation at work to deal with job demands, but they are also intrinsically motivating for employees (Bakker and Demerouti, 2007; Hakanen et al., 2008).

Another premise of the JD–R model is that the two sets of risk factors may each evoke a dual psychological process: health impairment process and motivational process (Bakker and Demerouti, 2007; Schaufeli and Bakker, 2004). Health impairment processes, poorly designed jobs and high job demands (e.g., work overload or emotional demands) may exhaust an employee's mental and physical resources, leading to the depletion of energy (i.e., a state

* Corresponding author. Tel.: +86 10 64833852; fax: +86 10 64887162.
E-mail addresses: lifeng@psych.ac.cn (F. Li), jiangli@suda.edu.cn (L. Jiang), xyao@pku.edu.cn (X. Yao), liyj@psych.ac.cn (Y. Li).

of exhaustion) and, hence, to health problems. Empirical studies supported this mediation from job demands via burnout to various indicators of ill-health (Bakker et al., 2003b; Hakanen et al., 2008; Schaufeli and Bakker, 2004).

The motivational process is assumed to link job resources with organizational outcomes (e.g., turnover intention) through engagement. Work engagement has been proven to play a meditational role between job resources and positive outcomes, such as extra-role performance, low turnover intentions (Bakker et al., 2003a,b; Schaufeli and Bakker, 2004), and organizational commitment (Boyd et al., 2011; Hakanen et al., 2008).

Although having not considered injury and near-miss outcomes, Hansez and Chmiel (2010) extended the JD–R model to the safety context by demonstrating relationships between job strain and "routine" violations, as well as work engagement and violations, respectively. More recently, Nahrgang et al. (2011) provided preliminary support for the JD–R model in a meta-analysis of 203 independent samples across construction, health care, manufacturing/processing, and transportation industries.

However, missing data in a meta-analytic correlation matrix are not always at random since researchers often do not report all of the relevant correlations in their study. Thus, the use of meta-analytic correlation matrices in path analyses might bias the accuracy of parameter estimates and goodness of fit indices (Field, 2005; Furlow and Beretvas, 2005; Nahrgang et al., 2011). Moreover, autonomy, which has long been discussed as a key job resource, was not included in the meta-analysis review (Nahrgang et al., 2011).

We respond to Nahrgang et al.'s (2011) call that "future research should (1) examine the relationship of job demands and resources with burnout and the relationship of burnout to safety outcomes; (2) examine the relationship of autonomy to burnout, engagement, and safety outcomes; (3) investigate the JD–R model in all industries." The present study focuses on both health impairment and work engagement processes (including autonomy) and provides further support on the extension of the JD–R model to safety outcomes in crude petroleum industry in the Chinese context.

1.2. Job demands–resources' relationship with emotional exhaustion and safety compliance

According to the JD–R model, job demands and resources play roles in the development of both burnout and work engagement (Bakker et al., 2003a,b; Bakker and Demerouti, 2007). As a metaphor being commonly used to describe a state of mental weariness, burnout is most commonly conceptualized as a three-dimensional construct consisting of emotional exhaustion, cynicism, and low professional efficacy (Maslach et al., 2001; Schaufeli et al., 2008). Although there is some discussion about the nature of burnout with alternative conceptualizations in a variety of ways (Schaufeli and Taris, 2005), emotional exhaustion is included in all of them as a primary dimension with the core meaning of burnout captured (Halbesleben and Bowler, 2007; Huang et al., 2011). Moreover, some work has suggested that emotional exhaustion exhibits somewhat stronger and more consistent relationships than do the other two dimensions with outcome variables (Demerouti et al., 2001a,b; Halbesleben and Bowler, 2007; Lee and Ashforth, 1996). Therefore, emotional exhaustion is the most appropriate dimension to include as a single burnout component (Halbesleben and Bowler, 2007; Janssen et al., 2004). In the present research, we focus on the emotional exhaustion component of burnout, by referring to the feelings of being emotionally overextended and drained (Maslach et al., 2001).

In contrast to burnout, engagement is most often defined as "a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication, and absorption" (Schaufeli et al., 2002; p. 74). In the context of workplace safety, according to Nahrgang

et al. (2011), engagement is characterized by the extent of involvement, participation, and communication in safety activities and the extent to which employees conform or submit to safety expectations, rules, and procedures (i.e., safety compliance). These states are similar to dedication, which refers to being strongly involved in one's work with a sense of significance, enthusiasm, inspiration, pride, and challenge (Cole et al., 2011; Schaufeli et al., 2002). Moreover, the recent meta-analysis has shown that compliance accounts for the largest variance in safety outcomes explained by engagement and burnout, demonstrating that compliance is a key engagement construct in the JD–R model (Nahrgang et al., 2011). Thus, in the present study, we focus on the safety compliance category of engagement, by referring to the activities in which employees must engage to maintain workplace safety (Griffin and Neal, 2000).

1.2.1. Job demands–resources' relationship with emotional exhaustion

As previously noted, job demands evoke a health impairment process that exhausts employees' mental and physical resources, leading to burnout. Thus, job demands may have a direct positive relationship with burnout (Bakker and Demerouti, 2007; Crawford et al., 2010). Evidence from multiple empirical studies of various occupations confirms this positive relationship (Bakker and Demerouti, 2007; Crawford et al., 2010). In the safety context, under high demands, workers will have limited energy to handle the physical and cognitive demands of work and safety performance, and thus have their mental and physical resources depleted, which will ultimately lead to burnout (Nahrgang et al., 2011). For example, work overload and role ambiguity have been found to be positively related to job strain (Hansez and Chmiel, 2010). Because emotional exhaustion best captures the "core meaning" of burnout (Maslach, 1993) and exhibits somewhat stronger relationships with important outcome variables in comparison to other components of burnout (Huang et al., 2011; Lee and Ashforth, 1996), we expect that job demands, such as physical and psychological demands, will have a positive relationship with emotional exhaustion.

Hypothesis 1. Job demands are positively related to emotional exhaustion.

There is some evidence supporting a negative relationship between job resources and burnout, because a large pool of job resources may help employees cope with job demands and protect them from the strains of resource depletion (Bakker and Demerouti, 2007; Crawford et al., 2010; Nahrgang et al., 2011). For example, when given high autonomy, employees can decide for themselves when and how to respond to job demands, thus reducing the possibility of strain. Similarly, they may receive instrumental help and emotional support from supervisor and co-workers, which could buffer the effects of job demands on burnout (Bakker and Demerouti, 2007; Kahn and Byosiere, 1992). Bakker et al. (2005) provided direct support for these relationships in their study of 1000 employees at an institute of higher education. Similar evidence was gathered by Xanthopoulou et al. (2007) in their study of participants from two home-care organizations. Furthermore, a meta-analytic study demonstrated that social support was negatively related to anxiety, stress, burnout, and exhaustion (Halbesleben, 2006). Thus, we expect that autonomy and social support will be negatively related to emotional exhaustion, the core dimension of burnout.

Hypothesis 2. Job resources are negatively correlated with emotional exhaustion.

1.2.2. Job demands–resources' relationship with safety compliance

The JD–R model proposes that job resources have motivational potential and lead to high work engagement, low cynicism, and high performance. Job resources may play either an intrinsic motivational role, fostering employees' growth, learning and development, or an extrinsic role, acting as an instrument for achieving work goals. Thus, job resources are assumed to have a direct positive relationship with work engagement (Bakker and Demerouti, 2007; Crawford et al., 2010; Schaufeli and Bakker, 2004). We expect that autonomy and social support will be positively related to work engagement, especially safety compliance. Autonomy fulfills a basic human need for freedom and provides employees with decision latitude in their work, enabling them to achieve goals in terms of both productivity and safety outcomes (Nahrgang et al., 2011). In other words, autonomy will increase compliance as employees become more responsible and empowered (Hodson, 1991). Moreover, autonomy has been shown to be positively related to compliance with safety procedures (Parker et al., 2001). Likewise, social support satisfies the need to belong (Bakker and Demerouti, 2007), and a supportive environment indicates that workers are valued and that the organization is committed to them (Nahrgang et al., 2011). Workers may then be more motivated to participate in safety prevention activities, such as compliance. Previous studies have confirmed positive relationships between supportive environments and safety compliance (Goldenhar et al., 2003; Parker et al., 2001; Yagil and Luria, 2010). Thus, we expect autonomy and social support to be positively related to safety compliance.

Hypothesis 3. Job resources are positively correlated with safety compliance.

Although the JD–R model does not propose a relationship between job demands and engagement, there have been inconsistent and unexpected results. Xanthopoulou et al. (2007) found that emotionally dissonant demands had a significant negative correlation with engagement, while workload demands were significantly positively related to engagement. The differences were attributed to the nature of the demands (i.e., hindrances versus challenges) by a recent meta-analytic study, suggesting that challenge demands (e.g., job or role demands, workload, time pressure, job complexity, and job responsibility) were positively associated with engagement, while hindrance demands (e.g., situational constraints, hassles, role conflicts, role overload, and role ambiguity) were negatively associated with engagement (Crawford et al., 2010). In the area of occupational safety, however, challenge demands may actually constrain employees' progress toward workplace safety as stress can compel individuals to focus narrowly on only a few specific aspects of the work environment or objectives (Hofmann and Stetzer, 1996; Weick, 1990). For instance, under increased performance pressure or time constraints, employees might utilize more "short cut" work methods, perceiving there is not always enough time to follow safety procedures and resulting in a higher frequency of unsafe behaviors (Hofmann and Stetzer, 1996). Empirical research has supported this hypothesis, showing that overall stress perception, role overload, role conflicts and role ambiguity are negatively related to safety compliance (Hayes et al., 1998; Hofmann and Stetzer, 1996; Masia, 2010; Wallace and Chen, 2005). Moreover, a recent meta-analysis found that hindrance demands such as risks and hazards, physical demands, and complexity were negatively associated with safety compliance (Nahrgang et al., 2011). Taken together, we expect that both challenge demands and hindrance demands will be negatively related to safety compliance.

Hypothesis 4. Job demands are negatively correlated with safety compliance.

1.3. Relationship of emotional exhaustion and safety compliance with safety outcomes

In general, the JD–R model proposes that a state of exhaustion leads to increased absenteeism as a result of illness and decreased in-role performance (Bakker et al., 2003a,b, 2004; Schaufeli et al., 2009). Burnt-out employees are more likely to commit mistakes and injure themselves, because of a depletion of their mental and physical energy (Nahrgang et al., 2011). Research on administration service employees found that exhaustion (at year 1) positively predicted injury rates (at year 2) (Leiter and Maslach, 2009), and similar evidence was obtained in a cross-lagged panel study of health care professionals (Halbesleben, 2010). Similarly, research on construction workers in Hong Kong demonstrated that psychological distress was positively associated with near-misses at work (Goldenhar et al., 2003). Moreover, a recent meta-analysis indicated that burnout was significantly related to accidents and injuries (Nahrgang et al., 2011). Thus, we expect that emotional exhaustion will be positively associated with near-misses and injuries in the workplace.

Hypothesis 5. Emotional exhaustion is positively correlated with safety outcomes.

Rich et al. (2010) proposed that engaged employees invest their physical, cognitive, and emotional energies in their work roles to enhance both task performance and organizational citizenship behaviors. In the context of occupational safety, increased compliance with safety procedures can limit the number of accidents, injuries, and near-misses, because of heightened control over the situation (Nahrgang et al., 2011). Empirical research has suggested that safety compliance is negatively associated with near-misses and injuries (Goldenhar et al., 2003; Jiang et al., 2010; Neal and Griffin, 2006), and a similar negative relationship was found in two meta-analytic studies (Clarke, 2006; Nahrgang et al., 2011). Thus, we expect that safety compliance will be negatively associated with near-misses and injuries in the workplace.

Hypothesis 6. Safety compliance is negatively correlated with safety outcomes.

1.4. Mediating role of emotional exhaustion in safety compliance

Existing studies support the dual psychological processes proposed by the JD–R model; related data suggest that job demands and resources can predict important organizational outcomes by such dual pathways (Bakker and Demerouti, 2007). In the literature on occupational safety, a direct correlation between job demands/resources and safety outcomes has been found; situational constraints, time pressures and work overload have all shown positive relationships with injuries and near-misses (Goldenhar et al., 2003; Jiang et al., 2010; Nahrgang et al., 2011; Snyder et al., 2008). Conversely, supportive environments and job autonomy have shown negative associations with injuries and near-misses (Barling et al., 2003; Goldenhar et al., 2003; Jiang et al., 2010; Nahrgang et al., 2011). In this study, utilizing the JD–R model, we propose that job demands and resources will be related to emotional exhaustion and safety compliance (Hypotheses 1–4) and that emotional exhaustion and safety compliance will be related to safety outcomes (Hypotheses 5 and 6). Given that emotional exhaustion and safety compliance are dual psychological processes that may connect job demands and resources to organizational outcomes, they are assumed to mediate the relationship between job demands and resources and safety outcomes.

Hypothesis 7a. Emotional exhaustion mediates the relationship between job demands and safety outcomes.

Hypothesis 7b. Emotional exhaustion mediates the relationship between job resources and safety outcomes.

Hypothesis 8a. Safety compliance mediates the relationship between job demands and safety outcomes.

Hypothesis 8b. Safety compliance mediates the relationship between job resources and safety outcomes.

2. Methods

2.1. Participants

A survey was administered to crude oil production workers from three sub-companies of a major oilfield company in China. The core job responsibility of these workers is to ensure effective execution and completion of the oil production plan by working as a crew. Specifically, their job duties are to inspect and resolve equipment failure (e.g., pumping unit vibration and deviant noise of retarder), to operate and maintain all kinds of equipment (e.g., starting or shutting electrical pump), to adjust or replace mechanical components according to workflow, to handle emergency, to collect oil samples from pumping units, and so on. During work hours, these workers might be subject to various risks, such as harsh physical environments, being injured by machines, being struck by objects, falling from a high place, fire, and chemical corrosion.

A total of 936 copies of the survey were distributed; 670 valid responses were returned, resulting in a response rate of 71.6%. Of the respondents, 44.8% were male. This percentage of male respondents may seem unusual for oilfield workers. One explanation is that male workers had a lower response rate than female workers. Also, job responsibilities of these workers are limited to oil production, which tends to be less physically demanding than oil exploration or drilling; therefore, more women may choose or be assigned to this type of position. Participants had an average age of 35.9 years (SD = 7.62); they had been working at the company for an average of 12.2 years (SD = 8.77) and had been in their current job positions for an average of 8.6 years (SD = 8.37).

2.2. Measures

All measures were translated into Chinese and back-translated to guarantee the equivalence of the measures (see Table 1 for items of each measure).

2.2.1. Job demands

In the present study, job demands were defined as physical demands (4 items) and psychological demands (7 items), using the Job Content Questionnaire (JCQ; Karasek et al., 1998). Two factors supported the use of this measure. First, physical exposure (e.g., working with heavy equipment) is the most frequent stressor experienced by crude oil production workers. Second, the psychological demands subscale includes mental and cognitive workloads and time constraints, which have demonstrated positive relationships with injuries and near-misses (Goldenhar et al., 2003; Jiang et al., 2010; Nahrgang et al., 2011; Snyder et al., 2008).

2.2.2. Job resources

According to the literature, supportive environments and job autonomy have both shown negative associations with injuries and near-misses (Barling et al., 2003; Goldenhar et al., 2003; Jiang et al., 2010; Nahrgang et al., 2011). Thus, in the current study, job resources were measured by decision latitude (9 items), supervisory support (5 items) and coworker support (6 items), according to the JCQ. As a variable often used to describe control on the job (i.e., autonomy; Westman, 1992), decision latitude was divided into the

two theoretically distinct, although often highly correlated, subdimensions of skill discretion and decision authority (Karasek et al., 1998).

All items from the JCQ were rated by the respondents using a 4-point scale: strongly disagree (1), disagree (2), agree (3), and strongly agree (4).

2.2.3. Emotional exhaustion

The Maslach Burnout Inventory – General Survey (MBI-GS; Maslach et al., 1996) is the most commonly used instrument in burnout research on non-human service workers (Schaufeli and Taris, 2005). It has also been validated by Li and Shi (2003) in a Chinese context. The emotional exhaustion subscale of the MBI-GS was used to measure emotional exhaustion. Its 5 items were rated on a 7-point scale, ranging from 0 (never) to 6 (every day).

2.2.4. Safety compliance

A 3-item scale by Neal and Griffin (2006) was adopted to assess safety compliance in terms of core safety activities that should be carried out by employees to maintain workplace safety. All items were rated on a 5-point scale, with responses ranging from 1 (strongly disagree) to 5 (strongly agree).

2.2.5. Safety outcomes

Self-reported injuries and near-misses were used to assess safety outcomes. Specifically, injuries were indicated by a summation of the employees' responses regarding whether any major body parts had been injured during the past year, including the head, neck, eyes, shoulders, arms, wrists, hands, upper back, lower back, legs, ankles, feet and other (Goldenhar et al., 2003; Jiang et al., 2010). Participants were also asked to recall the total number of near-misses (i.e., incidents that could have resulted in an injury, but did not) that they had experienced during the past year (Goldenhar et al., 2003; Jiang et al., 2010).

2.3. Analyses

Maximum likelihood structural equation modeling (SEM) was used to test our proposed model with Lisrel 8 (Joreskog and Sorbom, 1996). Based on Anderson and Gerbing's (1988) suggestions, a two-step approach to SEM was adopted. First, the factor structure of the variables in this study was tested to confirm that the model specifying the posited structure of the underlying constructs would fit the observed data. Second, the proposed structural model was compared with an alternative model to assess which one better accounted for the covariances observed between the model's exogenous and endogenous constructs.

3. Results

3.1. Measurement model testing

The overall factor structure of the research variables was tested. The CFA results indicated that our hypothesized measurement model provided a good fit for the data, after deleting an item measuring decision authority as a result of nonsignificant factor loading ($\chi^2[636] = 1983.03$, $p < .001$; comparative fit index [CFI] = .94; incremental fit index [IFI] = .94; relative fit index [RFI] = .90; standardized root mean square residual [SRMR] = .076; root mean square error of approximation [RMSEA] = .058). Moreover, as evidenced by the results shown in Table 1, each indicator was significantly loaded on its posited underlying construct factor, confirming the convergent validity of the constructs (Anderson and Gerbing, 1988).

Table 2 presents descriptive statistics and correlations among the research variables, providing primary support for the

Table 1
Item loadings for confirmatory factor analyses of all research measures.

Items	Factor loading
Psychological demands	
1. My job requires working very hard.	.28
2. I have enough time to get the job down.	−.16
3. My tasks are often interrupted before they can be completed, requiring attention at a later time.	.43
4. My job requires long periods of intense concentration on the task.	.35
5. I am not asked to do an excessive amount of work.	−.24
6. My job is very hectic.	.62
7. Waiting on work from other people or departments often slows me down on my job.	.49
Physical demands	
1. My job requires lots of physical effort.	.42
2. I am often required to move or lift very heavy loads on my job.	.39
3. I am required to work for long periods with my head or arms in physically awkward positions.	.77
4. I am often required to work for long periods with my body in physically awkward positions.	.81
Decision latitude: skill discretion	
1. My job requires a high level of skill.	.49
2. I have an opportunity to develop my own special abilities.	.45
3. My job requires me to be creative.	.60
4. I get to do a variety of different things on my job.	.13
5. My job requires that I learn new things.	.60
Decision latitude: decision authority	
1. On my job, I have very little freedom to decide how I do my work.	.53
2. My job allows me to make a lot of decision on my won.	−.65
3. I have a lot of say about what happens on my job.	−.72
Supervisor support	
1. My supervisor is concerned about the welfare of those under him.	.71
2. My supervisor pays attention to what I am saying.	.77
3. I am exposed to hostility or conflict from my supervisor.	−.41
4. My supervisor is helpful in getting the job done.	.68
5. My supervisor is successful in getting people to work together.	.78
Coworker support	
1. People I work with are competent in doing their jobs.	.58
2. People I work with take a personal interest in me.	.75
3. I am exposed to hostility or conflict from the people I work with.	−.39
4. People I work with are friendly.	.76
5. The people I work with encourage each other to work together.	.86
6. People I work with are helpful in getting the job done.	.84
Emotional exhaustion	
1. I feel burned out from my work.	.82
2. I feel emotionally drained from my work.	.83
3. I feel fatigued when I get up in the morning and have to face another day on the job.	.91
4. Working with people all day is really a strain for me.	.93
5. I feel frustrated by my job.	.79
Safety compliance	
1. I use the correct safety procedures for carrying out my job.	.71
2. I use all the necessary safety equipment to do my job.	.85
3. I ensure the highest levels of safety when I carry out my job.	.85

Note: $N = 670$.

discriminant validity of the research constructs. Both job demand variables and all three job resource variables were significantly related to emotional exhaustion, whereas only the job resource variables were positively correlated with safety compliance. There was a moderate correlation between supervisor and coworker support ($r = .52$, $p < .01$). Lastly, both emotional exhaustion ($r = .09$, $p < .05$) and safety compliance ($r = −.09$, $p < .05$) were significantly related to near-misses.

Table 2
Means, standard deviations, and intercorrelations among the research variables.

Variables	M	SD	1	2	3	4	5	6	7	8	9
1. Psychological demands	2.75	.32	**.58**								
2. Physical demands	2.53	.55	.43**	**.70**							
3. Decision latitude	2.63	.36	−.12**	−.22**	**.61**						
4. Supervisor support	2.92	.58	−.18**	−.24**	.49**	**.80**					
5. Coworker support	3.23	.50	−.05	−.11**	.31**	.52**	**.85**				
6. Safety compliance	4.26	.69	−.02	−.02	.26**	.21**	.32**	**.84**			
7. Emotional exhaustion	2.00	1.48	.35**	.37**	−.34**	−.37**	−.24**	−.13**	**.93**		
8. Near-miss	1.38	.69	.06	.06	−.04	−.01	−.01	−.09*	.09*	–	
9. Injuries	2.84	2.86	.02	.03	−.11**	−.04	−.03	−.07	.04	.34**	–

Note: $N = 670$. Bold figures on the diagonal are alpha reliabilities of scales.
* $p < .05$.
** $p < .01$.

An alternative measurement model, combing supervisor and coworker support items into a single support dimension because of their moderate correlation, was tested. Compared with our hypothesized measurement model, the chi-square value of this alternative model was significantly higher ($\Delta\chi^2 = 676.17$, $\Delta df = 7$, $p < .001$), suggesting that our hypothesized measurement model provided a better fit to the data. Additionally, the distinctiveness of both psychological and physical demands was confirmed. The chi-square difference test ($\Delta\chi^2 = 118.76$, $\Delta df = 7$, $p < .001$) indicated that our hypothesized measurement model was better than the alternative model, where the items measuring psychological and physical demands were combined into one dimension.

3.2. Structural model testing

We proposed a mediating effect of emotional exhaustion and safety compliance on the relationship between job demands and resources and safety outcomes. The SEM results indicated that a full mediation model adequately fit the data ($\chi^2[82] = 154.78$, $p < .001$; $\chi^2/df = 1.89$; CFI = .99; IFI = .99; RFI = .97; RMSEA = .036; SRMR = .032). On the basis of this full mediation model, the connection between job demands and safety compliance was deleted in the alternative model, because of a nonsignificant correlation coefficient (shown in Table 2). This revised model without the path between job demands and safety compliance exhibited a significant increase in goodness of fit ($\Delta\chi^2 = 5.86$, $\Delta df = 1$, $p < .05$), suggesting that the proposed full mediation model provided a better fit to the data.

Fig. 1 presents the estimated coefficients for the structural model. Hypothesis 1 predicted that job demands would be positively related to emotional exhaustion. Results showed that job demands characterized by psychological and physical demands were positively related to emotional exhaustion ($\gamma = .44$, $p < .01$), Hypothesis 1 was strongly supported. Job resources, as composed of decision latitude, supervisor support, and coworker support, were negatively related to emotional exhaustion ($\gamma = -.31$, $p < .01$). Thus there was also support for Hypothesis 2, indicating that the higher job resources the workers perceived, the lower exhausted they felt.

Hypothesis 3 predicted that job resources would be positively related to safety compliance. There was strong support for this hypothesis in that job resources were significantly related to safety compliance ($\gamma = .44$, $p < .01$). Hypothesis 4 predicted that job demands would be negatively related to safety compliance. Instead, results showed that there was a small positive correlation between job demands and safety compliance ($\gamma = .14$, $p < .05$); thus Hypothesis 4 was not supported. In addition, both emotional exhaustion ($\gamma = 11$, $p < .05$) and safety compliance ($\gamma = -.11$, $p < .05$) were significantly related to near-miss and injuries. These two significant correlations supported our hypotheses that emotional exhaustion was negatively related to safety outcomes (Hypothesis 5) and that safety compliance was positively related to safety outcomes (Hypothesis 6).

The indirect effects of job demands and resources on safety outcomes, as revealed by the SEM test, provided more evidence for full mediation relationships (Williams et al., 2009). The standard errors and 90% confidence intervals for these effects were generated by the bootstrapping option in AMOS 7.0. Table 3 presents the indirect effect through emotional exhaustion and safety compliance, confidence intervals, and decomposed indirect effect. Results showed that the indirect effect of job resources on safety outcomes was significant ($\beta = -.086$, $p = .003$), supporting our proposition that emotional exhaustion and safety compliance would fully mediate the relationship between job resources and safety outcomes. A further Sobel (1982) test indicated that both the indirect effect of job resources on safety outcomes through emotional exhaustion ($\beta = -.05$, $p = .047$) and the corresponding indirect effect

through safety compliance ($\beta = -.035$, $p = .038$) were significant. Thus, Hypotheses 7b and 8b were supported. Furthermore, the indirect effect of job demands on safety outcomes through emotional exhaustion was significant ($\beta = .05$, $p = .036$). Thus, Hypothesis 7a was supported.

4. Discussion

The JD–R model was used to frame the relationships between job demands (psychological and physical demands), job resources (decision latitude, supervisor support, and coworker support), safety compliance, emotional exhaustion, and safety outcomes (near-misses and injuries). The SEM results showed that the JD–R model could be extended to safety outcomes. Specifically, job demands and resources could act through emotional exhaustion and safety compliance, and influence the rates of injuries and near-misses. Unexpectedly, contrary to the proposed negative relationship, there was a small positive correlation between job demands and safety compliance. One possible explanation is that the effects of job demands and safety compliance might be contingent on organizational factors. An empirical study suggested that the relationship between job insecurity and safety compliance was moderated by safety climate (Probst, 2004). Likewise, when production is emphasized, job demands could lead employees to take shortcuts. When safety is valued, however, employees may take shortcuts in areas other than the safety realm.

4.1. Theoretical implications

The findings of our research have theoretical implications for both the JD–R model and occupational safety research. First, our findings provide empirical support for the applicability of the JD–R model to safety in an Eastern society. As an overarching model specifying how health impairment, motivation, and involvement in an organization may result from two types of risk factors associated with job stress (Bakker et al., 2003a,b; Bakker and Demerouti, 2007), the JD–R model has been supported by empirical evidence produced by multiple studies in various Western cultures. The present research contributes to the JD–R literature by investigating occupational safety in the Chinese culture, as well as by exploring the effects of job demands on engagement and the effects of job resources on job strain (Hansez and Chmiel, 2010).

Our finding that health impairment plays an important role in workplace safety is worth noting. This discovery is valuable, as most models of occupational safety focus on either motivation or involvement without recognizing the possible role that the job strain process might play (Christian et al., 2009; Nahrgang et al., 2011). This study provides support on these relationships, suggesting that job demands and resources are positively and negatively, respectively, related to emotional exhaustion, which in turn is negatively correlated with near-misses and injuries.

Additionally, we found that decision latitude had a negative effect on safety outcomes, through its negative relationship with emotional exhaustion and its positive relationship with safety compliance. This conclusion is important, as relatively few studies have examined these mechanisms in a safety context, although autonomy has long been discussed as a key job resource (Karasek et al., 1998; Parker et al., 2001; Nahrgang et al., 2011).

4.2. Managerial implications

The results of our study have some managerial implications. First, the indirect effects of psychological and physical demands on injuries and near-misses, as mediated by emotional exhaustion, should be communicated to managers working in high-risk organizations. These demands are important risk factors for workplace
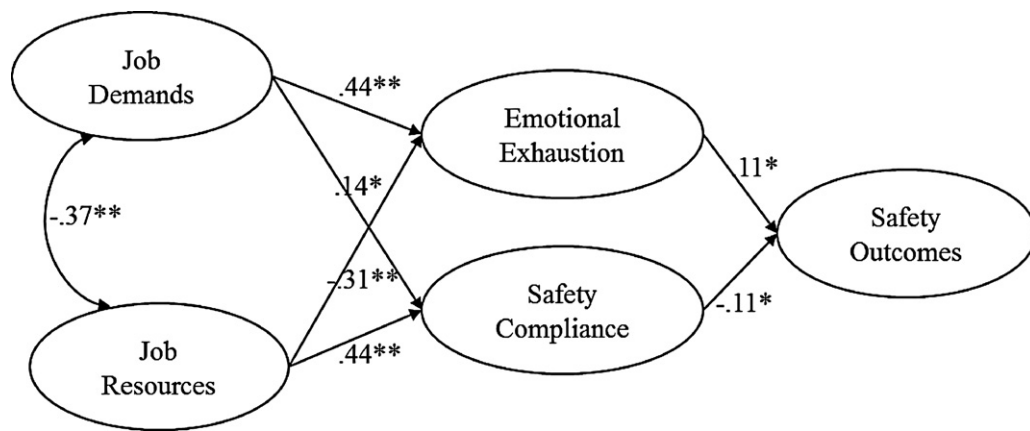
Fig. 1. Estimated coefficients for the structural model. Standardized pathway coefficients and factor loadings are reported. Model fit indices: χ^2/df = 1.89; comparative fit index = .99; incremental fit index = .99; relative fit index = .97; root mean square error of approximation = .036; standardized root mean square residual = .032. $^{**}p < .01$; $^{*}p < .05$.

health and safety. Managers could then, for instance, redesign work roles in organizations, with fewer assignments given in an allotted time interval (Hofmann and Stetzer, 1996), or create work environments conducive to concentration in work tasks. Workplace could also be redesigned to be more comfortable, if possible.

Second, similar to findings in previous research (Nahrgang et al., 2011; Turner et al., 2012), our results confirm the importance of creating a supportive environment for employees by providing both supervisor and coworker support. Organizations can develop a supportive environment by training and developing supportive qualities in supervisors and adopting a coaching-oriented supervisory style (Parker et al., 2001), as well as by providing employees with team-building training to emphasize the importance of teamwork and mutual support (Nahrgang et al., 2011). Findings based on state-owned companies might also benefit private and joint-venture companies. As qualitative studies have suggested, personal connections are more important for employees in private companies than for those in state-owned or collective hybrid companies (Jiang et al., 2010; Xin and Pearce, 1996). Therefore, employees in these types of companies may be even more dependent on supportive environments. Future research should examine whether these findings can be replicated in private or international companies.

Third, although safety-focused training is believed by executives to be a key safety intervention (Huang et al., 2007), our findings suggest that organizations should consider the potentially important role of job autonomy in promoting safety. Organizations can enrich productivity by enhancing autonomy, which has shown effectiveness in a Chinese context (Yan et al., 2011). Moreover, because job autonomy focuses on personal perceptions about one's potential control over the current task (Karasek, 1979), organizations could develop methods to alter employees' perceptions. For instance, suggestions for workplace safety improvement could be gathered from employees during on-the-job interventions, in order to increase employees' perceptions of job autonomy (Snyder et al., 2008).

4.3. Limitations and future research

Several limitations are worth noting when interpreting the findings of this study and contemplating future research. First, the use of a cross-sectional design limits causal inferences based on the data. For example, it is possible that employees who experience injuries would show high levels of safety compliance (Clarke, 2006) or that the promotion of safety would create greater perceptions of autonomy (Turner et al., 2012). A longitudinal or experimental design is necessary to distinguish such causal explanations in future studies.

A second limitation is that the use of self-reported measures to assess the variables of interest increases the possibility of common method variance. During the safety surveys, variance among safety outcomes could have been suppressed, as employees might under-report injuries and near-misses due to social perceptions (Hofmann and Stetzer, 1996). Thus, the relationships between such outcomes and their predictors could be attenuated (Probst and Brubaker, 2001). Additionally, following the suggestion by Turner et al. (2010) to assess potential overinflation, we specified an additional factor, with all items loaded on it except for the dimensions of the research variables. The CFA results indicated that the revised model (8 substantive factors + 1 method factor) explained only an additional 2% of the total variance, although it did provide a better fit for the data ($\Delta \chi^2$ = 488.4, Δdf = 45, $p < .001$). Because the average amount of method variance in similar research is 25% (Williams et al., 1989), the benefit of the current method factor is comparatively small. In other words, the observed relationships are substantive rather than artifactual. Future research could incorporate multiple data sources, such as objective records and behavioral observations, to examine and validate the relationships suggested in the present study.

Furthermore, future research should investigate extensions of the JD–R model, especially the inclusion of personal resources

Table 3
Indirect effects through emotional exhaustion and safety compliance.

Relationship	Indirect effects (90% confidence interval; mediation by emotional exhaustion and safety compliance)	Indirect effect through	
		Emotional exhaustion	Safety compliance
Job demands → safety outcomes	.035 (−.041, .088)	.050*	−.015
Job resources → safety outcomes	−.086** (−.145, −.003)	−.035*	−.050*

* $p < .05$.
** $p < .01$.

(e.g., self-efficacy, organizational-based self-esteem, and optimism; Xanthopoulou et al., 2007) and the distinction of challenge and hindrance stressors (Crawford et al., 2010). Although shown by a longitudinal study to be related to job resources and work engagement over time (Xanthopoulou et al., 2009), personal resources may play an even more complex role in modifying the impact of the work environment. This includes the possible interactions between job demands, job resources, and personal resources (Demerouti and Bakker, 2011). For example, employees may demonstrate high safety compliance if their job demands, job resources, and personal resources are all substantially high. In addition, the differentiation of two types of job demands in the JD–R model (Crawford et al., 2010) led to the discovery that hindrances are negatively associated with engagement, while challenges are positively related to engagement; however, both factors are negatively correlated with burnout, according to meta-analysis research. Despite this, empirical evidence for the varying effects of the two types of stressors is not sufficient with respect to the JD–R model (Demerouti and Bakker, 2011). Thus, it is necessary to explore the effects of hindrances and challenges on safety outcomes and the corresponding mechanisms, within the framework of the JD–R model.

Last but not least, two measurement issues might undermine the current findings. The low internal consistency reliability of psychological demands and decision latitude scales may attenuate their relationships with emotional exhaustion, safety compliance, and safety outcomes (Schmitt, 1996). Besides, although having been frequently used in previous research (Barling et al., 2002; Goldenhar et al., 2003; Jiang et al., 2010; Landen and Hendricks, 1995), a one-year reference period indeed biases the accuracy of self-report workplace injuries, while a five-week reference period has statistical and analytical appeal for injuries (Landen and Hendricks, 1995; Warner et al., 2005). In future research, a shorter reference period with specific dates would help ensure more accurate recall of injuries and near misses (Landen and Hendricks, 1995; Snyder et al., 2008).

Acknowledgements

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