

Research Article

Effect of Risk Perception on Safety Behavior among Chinese Frontline Construction Workers: The Roles of Social Support and Job Satisfaction

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There has been a great controversy about the impact of risk perception influence on safety behavior. This study aimed to go a step further understands how risk perception can affect safety behavior and of how job satisfaction and social support may influence that relationship, based on the job demands-resources theory. Using a questionnaire survey, we collected data from 356 frontline construction workers from 12 construction sites in Chengdu, China. Risk perception was found to be a “challenge demand” that improved safety compliance, and a “hindrance demand” that reduced job satisfaction. In contrast, risk perception had no direct influence on safety participation. Job satisfaction suppressed the relationship between risk perception and safety compliance, while it mediated the relationship between risk perception and safety participation. In addition, social support moderated the impact of risk perception on job satisfaction, while job satisfaction increased both safety compliance and participation. Therefore, managers can improve safety behavior by improving social support and job satisfaction among construction workers.

Keywords: Job satisfaction; Risk perception; Social support; Safety compliance; Safety participation**Introduction**

Across the world, injuries and accidents that occur in the workplace pose a serious safety concern [1,3]. The main cause of industrial accidents is unsafe work behavior [4,5], and these accidents result in substantial personal injury and economic loss [6,7]. Approximately 70% of accidents in the construction industry are associated with human error, especially unsafe behavior [8]. Therefore, in order to reduce the incidence of injuries and accidents in the construction industry, managers must focus on improving safety behavior among frontline construction workers.

Frontline construction workers are exposed to several risks, injuries, and accidents [9]. To ensure their own safety, these workers are likely to employ safety behaviors if they perceive that the task at hand poses high risk [10]. Some studies have confirmed that risk perception has a significant positive effect on safety behavior [6,10]. However, other researchers have shown that risk perception is negatively correlated with safety behavior [2,11]. Furthermore, one study involving employees on offshore oil installations reported that risk perception cannot be used to predict risk behavior, and suggested that the change of individual risk perception cannot improve the safety of the workplace [12]. Considering the inconsistencies in these findings, we believe that it is important to gain a better understanding of the factors that may affect the relationship between risk perception and safety behavior.

Two such factors may be social support and job satisfaction. One of the most important factors contributing to psychological stress among frontline construction workers is a perception of high

risk [2,13]. Social support, in the form of effective communication and assistance from others [14], can help employees cope with psychological stress [15]. Job satisfaction is another factor that affects by psychological stress caused by work: it reflects workplace attitudes [16], contributes to improving performance and productivity, and reduces the occurrence of negative organizational behavior [17,18].

The job demands-resources (JD-R) theory provides a suitable framework to address the effects of social support and job satisfaction on the relationship between risk perception and safety behavior among frontline construction workers [19-21]. Based on this theory, risk perception corresponds to job demands associated with hindrances or challenges that can decrease or increase job satisfaction and safety behavior [2,21,22]. Social support is considered to be an important job resource, since it can alleviate the negative effect of job demands on employee engagement [23]. Job satisfaction, defined as the degree to which a worker holds positive attitudes towards his or her job [24], is considered to be an important form of employee engagement that promotes safety behavior based on job demands and resources [22,25].

Therefore, we examined the effect of risk perception on two types of safety behavior - safety compliance and safety participation [26] - among Chinese frontline construction workers. Using a structural equation model based on the JD-R theory, the present study aimed to (1) understand whether risk perception constitutes a hindrance or a challenge with respect to job satisfaction and safety behavior (safety compliance and participation); (2) evaluate the role of social support in the relationship between risk perception and job satisfaction; and (3) evaluate the role of job satisfaction between risk perception and

safety behavior (compliance and participation).

Theoretical Background and Hypotheses

JD-R model

One of the basic assumptions of the JD-R model is that regardless of the type of work, the risk factors related to work-related stress can be classified into two general categories: job demands and job resources [20]. Job demands refer to the psychological and physiological costs that individuals need to pay continuously to meet the requirements of work (e.g. risk perception). Job demands tend to be two-dimensional: challenge demands and hindrance demands [27]. "Challenge demands" show positive relationships with employee engagement and work-related outcomes, while "hindrance demands" show the corresponding negative relationships [28]. Therefore, challenge demands can motivate and drive employees, while hindrance demands can cause emotional distress [29].

In contrast, job resources are characterized as physical, psychological, social, or organizational aspects of the job that may lead to reducing the associated physiological and psychological costs of job demands, achieving work goals, as well as stimulating personal growth and development [30]. Job resources foster not only extrinsic motivation in the workplace to deal with job demands, but also intrinsic motivation in employees [20,31].

The JD-R model predicts organizational outcomes by assessing the balance between job demands and job resources through the process of "health impairment" and "motivation". The health impairment process is associated with negative work outcomes such as depletion of energy, while the motivational process is associated with positive work outcomes such as employee engagement. The model also proposes an interaction between job demands and resources that is considered important for employee well-being and performance-related outcomes [21]. For example, if sufficient job resources are available, they can alleviate the negative impacts of job demands, and thereby ensuring high levels of engagement and subsequent positive outcomes [20].

In the current study, we focused on understanding how social support and job satisfaction can influence the impact of risk perception on safety behavior. We examined only the motivational process, since job satisfaction is considered to be positive employee engagement that can help improve safety performance [22,32]. In order to address these questions, we developed a model (Figure 1) based on the refined JD-R model proposed by Kwon and Kim [21].

Link between risk perception and safety behavior

Risk refers to the uncertainty and destructive consequences of activities that humans value [33], and risk perception refers to the subjective cognition and evaluation of that risk [34]. Based on protective motivation theory, if a person believes that an event is at high risk, he or she is likely to carry out protective behaviors [35]. If frontline managers believed that subordinates may face high risks in the workplace, they would actively participate in safety management [10]. However, few studies have focused on the impact of frontline employees' risk perception on two important distinct employee safety behaviors—safety compliance and safety participation [26]. Safety compliance refers to the core safety activities that need to be carried out by individuals in order to maintain workplace safety, such

as adhering to safety norms [26]. Safety participation refers to the voluntary participation of employees in safety activities or meetings for improving workplace safety [26].

Previous studies on the effect of risk perception on safety behavior remain somewhat unclear [6,10-12,36]. According to JD-R theory, when frontline construction workers perceive that certain task or environment are associated with high risk, they are likely to engage in protective behavior to avoid or mitigate those risks [9,10,13]. Based on this, we assumed that risk perception is a challenge demand affecting the safety behavior of frontline construction workers, and we proposed the following hypothesis:

H1: Risk perception positively affects safety compliance (H1a) and safety participation (H1b).

Role of job satisfaction

Job satisfaction refers to the positive and pleasant emotions generated by individuals assessing job or job experiences [37,38], which is a strong indicator of how employees feel about their jobs, work-related tasks, and the work environment [39,40]. Job satisfaction is directly related to risk [41]. McLain [42] found firefighters who perceived lower risk has a positive relationship with job satisfaction. Similarly, Nielsen [43] found high levels of risk perception negatively impacted on job satisfaction among first-line nuclear plant' managers. In addition, similar results were reported for railway workers [44] and healthcare personnel [45]. Based on these findings, we assumed that risk perception is a hindrance demand affecting the job satisfaction of frontline construction workers, and we proposed the following hypothesis:

H2: Risk perception has a negative effect on job satisfaction.

Many studies have reported a positive relationship between job satisfaction and employee behavior [25,32,46,47]. Based on the motivational process in the JD-R model, high employee engagement can promote positive work outcomes, suggesting that job satisfaction can positively influence safety behavior. Thus, we proposed the following hypothesis:

H3: Job satisfaction has a positive effect on safety compliance (H3a) and safety participation (H3b).

Based on the JD-R model developed for this study (Figure 1), we expect that job demands can influence work outcomes via employee engagement: job demands have a negative effect on employee engagement, but employee engagement can promote positive employee outcomes [21]. Additionally, we hypothesized that risk perception has a positive impact on safety behavior and a negative impact on job satisfaction, while job satisfaction has a positive influence on safety behavior. Therefore, based on the suppressor effects [48], the sign of the direct effect (positive sign) from risk perception on safety behavior opposite the indirect effect (negative sign), we proposed the following hypothesis:

H4: Job satisfaction has a suppressing effect on the relationship between risk perception and safety compliance (H4a) and safety participation (H4b).

Role of social support

Social support refers to the various ways in which members of

one's social network provide help and assistance [49], including listening, offering advice, expressing viewpoints, providing positive feedback, as well as expressing care and concern [50]. Social support plays a key role in the operation of various social groups and the prevention or reduction of social problems [51]. It is an important resource that can promote individual well-being, relationship satisfaction, and social system functions [51].

Previous studies have reported that social support is a predictor of job satisfaction [52,53], and it can reduce or mitigate the impacts of stressors on employees [54]. Based on JD-R theory, social support is an important job resource that (1) has a direct positive relationship with employee engagement [20], and (2) can buffer the negative effect of hindering demands on employee engagement and performance [21]. Therefore, we assumed that social support can promote job satisfaction among employees, as well as buffer the effect of perceived stress on job satisfaction. Based on these assumptions, we hypothesized that:

H5: Social support has a positive effect on job satisfaction.

H6: Social support moderates the relationship between risk perception and job satisfaction.

Conceptual Model

Based on the above mentioned findings, we proposed a conceptual model to explain the hypothesized relationships among risk perception, social support, job satisfaction, safety compliance, and safety participation in Chinese frontline construction workers (Figure 2). We hypothesized that: (1) Risk perception positively affects safety compliance (H1a) and safety participation (H1b), and negatively affects job satisfaction (H2); (2) job satisfaction has a positive effect on safety compliance (H3a) and safety participation (H3b); (3) job satisfaction suppresses the effect of risk perception on safety compliance (H4a) and safety participation (H4b); and (4) social support has a positive effect on job satisfaction (H5), and it moderates the relationship between risk perception and job satisfaction (H6).

Methods

Procedures and participants

Between December 24, 2020 and February 2, 2021, we distributed 500 questionnaires among frontline construction workers on 12 randomly selected construction projects/sites in Chengdu, China. Participants voluntarily participated in the survey and could withdraw from the survey at any time during the survey process. At the beginning of the survey, we asked the participants to answer the questions as honestly as possible, and assured them that there was no right or wrong answers. We also assured all the participants that their responses would remain confidential, and would be used only for academic research purposes. The following demographic information was collected from all participants: sex, age, level of education, number of working hours per day, and work experience in the construction industry.

Measures

Risk perception: Risk perception was measured using a 9-item scale developed based on Hayes et al. [55], which has shown good reliability and validity [2]. Each item was rated on a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). In

the present study, Cronbach's alpha was 0.939.

Social support: Social support was measured with respect to three dimensions: family, friends, and "significant others", and the significant others included leaders, colleagues, or relatives [56]. Each item was rated on a 7-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). In the current study, Cronbach's alpha was 0.918.

Job satisfaction: We used a 24-item scale based on Ni et al. [57] to assess job satisfaction among construction workers in terms of their satisfaction with work, salary, co-workers, leaders, and work environment. It has shown good reliability and validity [57]. Each item on the scale was rated using a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). In the present study, Cronbach's alpha was 0.943.

Safety behavior: Safety behavior was assessed using a scale developed by Neal and Griffin [58], which included safety compliance and safety participation. Safety compliance (e.g., "I ensure the highest levels of safety at work") and safety participation (e.g., "I voluntarily perform tasks or activities that help improve workplace safety") is measured based on three items, respectively. Each item was rated using a 5-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Cronbach's alpha was 0.862 for safety compliance and 0.876 for safety participation.

Statistical analyses

We used SPSS 26.0 (IBM, Chicago, IL, USA) for descriptive analysis, correlation analysis, and reliability testing. Scale scores showed normal distributions: the highest skewness was 1.473, and the highest kurtosis was 2.525.

Additionally, we conducted confirmatory factor analyses (CFA) with our main variables using Mplus 8.5 [59]. We treated items in the risk perception and job satisfaction scales as ordinal variables, and analyzed them using polychoric covariance matrices, weighted least-squares estimation with a mean- and variance-adjusted chi-square (WLSMV) [60]. We treated items associated with all other factors as continuous variables, and analyzed them using maximum likelihood estimation (ML) [61]. One-factor models were used to independently analyze risk perception [2], safety compliance [58], and safety participation [58], while three lower-order constructs were used for social support [56], and five lower-order constructs were used for job satisfaction [57]. We assessed goodness of fit including comparative fit index (CFI > 0.90), Tucker-Lewis Index (TLI > 0.90), root mean square error of approximation (RMSEA < 0.08) and standardized root mean square residual (SRMR < 0.08) [62].

Next, we tested the conceptual model (Figure 2) using the WLSMV estimation. In these tests, the predictor variable was risk perception; the moderator, social support; the mediator/suppressor, job satisfaction; and the dependent variables, safety compliance and safety participation. The role of job satisfaction in mediating / suppressing the effect of risk perception on safety behavior was assessed by estimating the cross-product of two direct path coefficients [63].

Results

A total of 391 frontline construction workers participated in

Table 1: Characteristics of frontline construction workers who participated in the survey (n=356).

Characteristic	n	%
Sex		
Male	299	83.99
Female	57	16.01
Age (years)		
≤25	43	12.08
26-35	120	33.71
36-45	83	23.31
46-55	93	26.12
≥56	17	4.78
Level of education		
Primary school or below	62	17.42
Junior high school	161	45.22
Certificate or associate's degree	82	23.03
Senior high school	49	13.76
Junior college or above	2	0.56
Number of working hours per day		
<8	23	6.46
8-10	272	76.4
>10	61	17.13
Work experience (years)		
≤5	117	32.87
6-10	105	29.49
11-15	75	21.07
16-20	28	7.87
≥21	31	8.71

our survey. After excluding questionnaires that were incomplete or unclear, we analyzed data collected from 356 valid questionnaires submitted by frontline construction workers working in Chengdu; this corresponds to a response rate of 71.2%. A large majority of these workers were men (83.99%) who were older than 25 years (87.92%) (Table 1).

CFA

The risk perception model yielded evidence of adequate fit, giving WLSMV χ^2 (27, N = 356) = 400.408, $p < 0.001$, CFI = 0.963, TLI = 0.950, RMSEA = 0.077 (90% CI 0.18-0.214), and SRMR = 0.033. The social support model yielded evidence of adequate fit, showing ML χ^2 (51, N = 356) = 258.353, $p < 0.001$, CFI = 0.924, TLI = 0.902, RMSEA = 0.078 (90% CI 0.094 - 0.12), and SRMR = 0.050. The job satisfaction model also yielded evidence of adequate fit, giving WLSMV χ^2 (225, N = 356) = 939, $p < 0.001$, CFI = 0.929, TLI = 0.921, RMSEA = 0.064 (90% CI 0.088 - 0.101), and SRMR = 0.066. The safety compliance model fit well, giving ML χ^2 (0, N = 356) = 0, $p < 0.001$, CFI = 1.000, TLI = 1.000, RMSEA = 0.000 (90% CI 0.000 to 0.000), and SRMR = 0.008. The safety participation measurement model yielded evidence of adequate fit, showing ML χ^2 (0, N = 356) = 0, $p < 0.001$, CFI = 1.000, TLI = 1.000, RMSEA = 0.000 (90% CI 0.000 to 0.000), and SRMR = 0.055.

Table 2: Analysis of the ability of job satisfaction to mediate/suppress the relationship between risk perception and safety behavior.

Indirect effect	β	SE	z	p
RP → JS → SC	-0.124	0.057	-2.169	0.03
RP → JS → SP	-0.179	0.077	-2.337	0.019

RP: Risk Perception; JS: Job Satisfaction; SC: Safety Compliance; SP: Safety Participation; SE: Standard Errors.

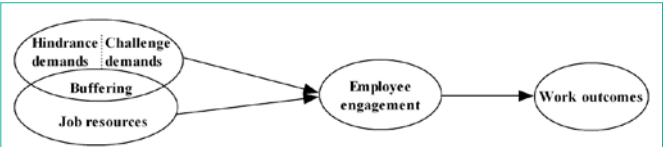


Figure 1: Modified job demands-resources model based on Kwon and Kim [21], examining the effect of risk perception vis-à-vis hindrance and challenge demands on employee engagement and safety-related work outcomes in Chinese construction workers.

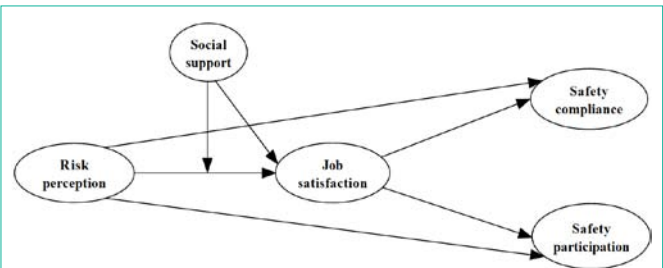


Figure 2: Conceptual model and hypotheses examining the mediating role of social support and job satisfaction on the impact of risk perception on safety behavior.

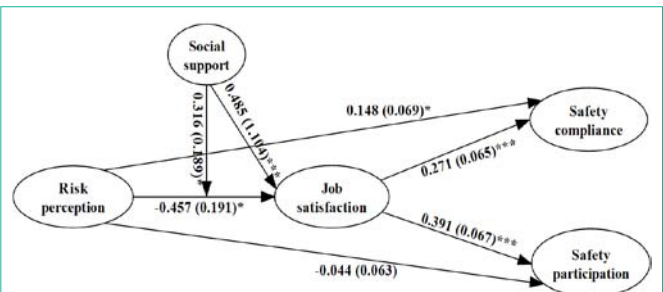


Figure 3: Structural model examining the relationships among risk perception, job satisfaction, social support, and safety behavior. Values are standardized path coefficients and standard errors (in parentheses). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Hypothesis testing

The structural model (Figure 3) fit well based on the following indices: WLSMV χ^2 (1691, N = 356) = 2872.295, $p < 0.001$, CFI = 0.925, TLI = 0.922, RMSEA = 0.044 (90% CI 0.042 - 0.047), and SRMR = 0.07. In terms of direct effects (Figure 3), we found that risk perception had a significant positive relationship with safety compliance ($\beta = 0.148$, $p = 0.033$), supporting H1a; a significant negative relationship with job satisfaction ($\beta = -0.457$, $p = 0.017$), supporting H2; and no effect on safety participation ($\beta = -0.044$, $p = 0.484$), leading to rejection of H1b. In contrast, job satisfaction had a significant positive relationship with safety compliance ($\beta = 0.271$, $p < 0.001$), supporting H3a; and safety participation ($\beta = 0.391$, $p < 0.001$), supporting H3b. Furthermore, social support had a significant

positive influence on job satisfaction ($\beta = 0.485, p < 0.001$), supporting H5; and its interaction with risk perception promoted job satisfaction among construction workers ($\beta = 0.316, p = 0.044$), supporting H6 (Figure 3).

In terms of indirect effects, we found that job satisfaction played an important role in the relationship between risk perception and safety behavior. Under the influence of job satisfaction, risk perception had a significant negative relationship with safety compliance ($\beta = -0.124, SE = 0.057, z = -2.169, p = 0.030$; Table 2). This negative relationship, inverse to the positive relationship of direct effects ($\beta = 0.148$), suggests that job satisfaction could play the role of a suppressor in the relationship between risk perception and safety compliance, supporting H4a. Likewise, risk perception exerted a significant negative indirect effect on safety participation via job satisfaction ($\beta = -0.179, SE = 0.077, z = -2.337, p = 0.019$; Table 2). The direct effect of risk perception on safety participation showed the same negative sign ($\beta = -0.044$), even if it was not significant ($p = 0.484$), leading us to reject H4b and conclude that job satisfaction could play a mediating role in this relationship.

Furthermore, social support had a significant positive effect on job satisfaction ($\beta = 0.485, p < 0.001$), supporting H5; and its interaction with risk perception promoted job satisfaction among construction workers ($\beta = 0.316, p = 0.044$), supporting H6 (Figure 3).

Discussion

In the present study, we examined the direct impact of risk perception on safety behavior in Chinese frontline construction workers, as well as the indirect role played by job satisfaction on this relationship. In addition, we examined the role of social support in moderating the relationship between risk perception and job satisfaction. Our study is unique because we were able to broaden the scope of the JD-R model by drawing on the duality of job demands, and by proposing that risk perception can be considered as a hindrance or challenge demand depending on the outcome/dependent variable being analyzed. Our results revealed that risk perception was a hindrance demand that reduced job satisfaction and a challenge demand that promoted safety compliance, and that it had no direct significant influence on safety participation. When we examined the effects of job demands on employee engagement and subsequent work outcomes, we found that job satisfaction suppressed the relationship between risk perception and safety compliance, but had a mediating effect on the relationship between risk perception and safety participation. In addition, we found that social support had a positive effect on job satisfaction, and it moderated the relationship between risk perception and job satisfaction.

Theoretical contributions

This study expands our understanding of job demands in terms of hindrance/challenge demands by examining the effect of risk perception on job satisfaction and safety behavior among frontline construction workers. First, considering the contradictory information available on the impact of risk perception on safety behavior [1,6], we proposed that risk perception must be analyzed empirically based on both job hindrance and challenge demands. In the present study, we found that perceived risk acted as a job challenge, positively affecting safety compliance among frontline

construction workers. In contrast, risk perception acted as a job hindrance, negatively affecting job satisfaction. Our findings indicate that risk perception as a challenge or hindrance demand depends on the outcome/dependent variable.

Second, this study broadens our understanding of the relationship between risk perception and safety behavior. In terms of direct effects, risk perception has a significant positive effect on safety compliance, but no effect on safety participation. In terms of indirect effects, we found that, under the influence of job satisfaction, risk perception has a significant negative effect on both safety compliance and safety participation. These findings suggest that the effect of risk perception on safety behavior is dependent on the mediating factor and the type of safety behavior being analyzed. Furthermore, we found that job satisfaction acts as a suppressor of risk perception, leading to a reduction in safety compliance; it also acts as a mediator of risk perception, leading to a reduction in safety participation.

Third, this study addressed the role of social support in protecting and boosting employee safety. Previous studies have reported the role played by social support in preventing unsafe behavior and promoting safety behavior [64-66]. Our findings support these results and confirm that social support can promote job satisfaction despite perceived risk, which in turn has a positive effect on safety behavior. Therefore, we believe that social support can buffer the impact of risk perception on job satisfaction and promote safety behavior among construction workers. This finding supports the theory that job resources such as social support can alleviate the negative effects of hindrance demands on employee engagement [67].

Finally, our study also contributes to extending the scope of the JD-R model. Considering risk perception as a challenge demand on safety compliance, and as a hindrance demand on job satisfaction, we used the JD-R framework to demonstrate that job demands can act as challenge demands that affect work outcomes, and as hindrance demands that affect employee engagement. That is, the role of job demand (hindrance/challenge demand) is not consistent with employee engagement and positive work outcomes. With respect to the relationships among job demands, employee engagement, and work outcomes, we found that employee engagement (i.e., job satisfaction) suppressed the relationship between job demands (i.e., risk perception) and positive work outcomes (safety compliance). Employee engagement also had a mediating effect on the relationship between job demand and positive work outcomes (safety participation). Further research is required to gain a better understanding of the role of employee engagement (suppression or mediation) on job demands and positive work outcomes.

Practical implications

First, in order to promote safety compliance behavior, we recommend that managers can help improve the risk perception of construction workers by putting up safety warning signs in the construction site, sharing information on safety accidents, checking safety equipment regularly, and testing safe operation knowledge. However, since high risk perception leads to a decrease in job satisfaction, which in turn contributes to reduced safety behavior, very high risk perception is unlikely to promote safety behavior among construction workers.

Second, since job satisfaction can promote both safety compliance and safety participation, managers must take the necessary measures to increase job satisfaction, such as providing more help and social support, taking the initiative to resolve confusion or ambiguity at work, providing suitable accommodation and meals, as well as promoting a friendly working atmosphere. Increased support can promote job satisfaction and improve safety behavior among construction workers.

Limitations and future directions

Our findings must be considered in the light of certain limitations. There is considerable bias in our research design, based on self-reported data. Even though we were able to identify that job satisfaction suppressed the effect of risk perception on safety compliance, while it mediated the effect of risk perception on safety participation, further research must be conducted to understand whether employee engagement mediates or suppresses the relationship between job demand and positive work outcomes. Our findings show that risk perception among Chinese frontline construction workers can act as a challenge demand on safety compliance. Further studies must be conducted to assess whether these findings are generalizable to other high-risk industries and geographic areas. As far as we know, this is the first study examining the relationships among job demands, employee engagement, and work outcomes based on the JD-R model. In order to gain a better understanding of the impact of job demands, further studies must be conducted to evaluate the relationship between hindrance demands and engagement, as well as between challenge demands and positive work outcomes.

Conclusions

In this study, we developed a conceptual model based on the hindrance/challenge job demand concept to test the impact of risk perception on safety behavior among Chinese frontline construction workers. Based on empirical data collected using a questionnaire, we confirmed that risk perception served as a hindrance demand, resulting in a negative effect on job satisfaction; it also served as a challenge demand, resulting in a positive effect on safety compliance. Considering the job demands, employee engagement, and work outcomes in the framework of the JD-R model, we found that job satisfaction had a significant suppressing effect on the relationship between risk perception and safety compliance, as well as a significant mediating effect on the relationship between risk perception and safety participation. Furthermore, our findings show that social support can help buffer the effect of risk perception on job satisfaction, which can in turn promote safety behavior. Therefore, safety behavior among construction workers can improve as long as they have sufficient social support and job satisfaction.

Declaration

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Compliance with ethical standards: Ethical Approval All

procedures performed in studies involving human participants comply with the ethical standards of the Institutional Research Committee and the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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