ORIGINAL ARTICLE

FACTORS ASSOCIATED WITH UNSAFE BEHAVIOURS AMONG CONSTRUCTION WORKERS IN QATAR: A CROSS-SECTIONAL STUDY

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ABSTRACT

Unsafe behaviours remain an important occupational safety concern in construction because of dynamic work environments, simultaneous operations, exposure to multiple hazards and the involvement of diverse workforces. This study examined factors associated with safety and health behaviours among construction workers in Qatar. A cross-sectional study was conducted among 456 consenting construction workers recruited from infrastructure construction projects in Qatar using project-site stratification. Data were collected using a structured questionnaire covering safety-risk frequency, severity, workplace-risk exposure, risk perception, safety and health behaviours, management of unsafe behaviours and behavioural-based safety (BBS). Internal consistency was acceptable to excellent across the principal scales (Cronbach's α=0.685-0.910). Descriptive statistics, Pearson correlation and multiple linear regression were performed using Jamovi 2.6. Mental stress had the highest perceived frequency (mean=4.12±0.74), while working at heights had the highest perceived severity (mean=3.61±0.74). Safety-risk frequency, severity and exposure were positively correlated with safety and health behaviours (r=0.368, 0.361 and 0.375, respectively; all p<0.001). Management of unsafe behaviours (r=0.472, p<0.001) and BBS (r=0.550, p<0.001) demonstrated stronger associations with safety behaviours. In multivariable analysis, safety-risk frequency (β=0.142, p=0.009), management of unsafe behaviours (β=0.199, p<0.001) and BBS (β=0.244, p<0.001) were independently associated with safety and health behaviours (adjusted R^2=0.424, p<0.001). Risk perception was not independently significant (β=-0.049, p=0.067). Organizational management of unsafe behaviours and effective BBS practices may therefore be more important correlates of workers' safety behaviours than risk perception alone.

***Key words**: Construction workers; Unsafe behaviours; Behaviour-based safety; Risk perception; Occupational safety; Safety management; Qatar*

INTRODUCTION

The construction industry is characterized by changing work environments, simultaneous operations, multiple contractors and subcontractors, mobile equipment, work at height, excavation, lifting activities and exposure to environmental hazards. These characteristics make construction one of the occupational sectors in which effective control of both physical and behavioural risks remains essential. The International Labour Organization estimates that millions of workers globally die annually from work-related accidents and diseases, while hundreds of millions experience non-fatal occupational injuries.[1] Construction safety is particularly relevant in Qatar because of the scale and complexity of infrastructure development and the highly diverse workforce involved in construction activities. Previous research in Gulf Cooperation Council construction environments has identified workforce diversity, communication, organizational factors and safety management as important challenges.[2] Studies of Qatari construction projects have also highlighted behavioural safety concerns and the importance of strengthening proactive approaches to occupational safety.[3]

Behaviour-based safety (BBS) focuses on identifying observable behaviours, understanding the factors that influence those behaviours and applying interventions intended to improve safe performance.[4] Evidence from construction and other high-risk industries suggests that behavioural interventions can contribute to improved safety performance when they are integrated into broader organizational safety systems rather than used solely to attribute responsibility for incidents to individual workers.[5,6] At the same time, criticism of BBS has centered on the possibility of excessive focus on worker behaviour while insufficient attention is given to organizational and environmental causes of unsafe acts.[7]

Risk perception is another potential determinant of workplace behaviour. Workers who recognize the likelihood and consequences of hazards may be more inclined to adopt appropriate precautions. Previous studies have reported relationships between safety knowledge, perceived risk and workplace behaviour.[3,8-10]

However, risk perception should not be considered independently of the organizational context in which workers operate. Leadership, training, procedures, reporting systems, supervision and responses to unsafe behaviour can all influence workers' ability and motivation to work safely.[11,12]

Despite the importance of these factors, there remains a need for empirical evidence examining their relative contribution to safety behaviours among construction workers in Qatar. The present study examined safety-risk frequency, severity and exposure, risk perception, safety and health behaviours, management of unsafe behaviours and BBS practices among construction workers. **The objective of this study was to determine the factors associated with safety and health behaviours among construction workers in Qatar, with particular emphasis on safety risks, risk perception, management of unsafe behaviours and BBS.**

METHODOLOGY

Study design and setting

A quantitative cross-sectional study was conducted among construction workers employed on infrastructure construction projects in Qatar. Data was collected using a structured self-administered questionnaire.

Participants and sampling

The study population comprised construction personnel working across participating infrastructure project sites in Qatar. Workers aged 18 years and above who were available during the study period and provided informed consent were eligible. Workers who did not provide consent were excluded from the analytical sample. Project sites were used as the principal strata because construction activities and associated hazards vary according to project and work type. Worker lists available through participating project sites constituted the sampling frame. Participants were recruited across the project strata, with efforts made to obtain representation from different project environments and occupational categories. A minimum target of approximately 35 participants per project site was used where site participation permitted. A total of 471 survey records were received. Of these, **456 participants consented to participate and constituted the final analytical sample**; 15 non-consenting records were excluded. The final sample included workers from different occupational categories, construction activities and nationalities.

Data collection and instrument

A structured closed-ended questionnaire was developed from the conceptual framework, literature review and findings from focus group discussions. The questionnaire was initially pre-tested among 10 participants to assess comprehensibility, suitability and adequacy of the items. Six subject-matter experts in behavioural-based safety subsequently assessed face and content validity. Items considered unsuitable were revised or removed following expert assessment.

The questionnaire comprised eight substantive parts:

- Part A: sociodemographic and occupational characteristics;
- Part B: frequency of safety and health hazards;
- Part C: severity of safety and health hazards;
- Part D: exposure to workplace risks;
- Part E: risk perception;
- Part F: safety and health behaviours;
- Part G: management of unsafe behaviours; and
- Part H: BBS.

Parts B-D assessed 16 occupational hazards, including airborne contaminants, asbestos, confined spaces, electrical hazards, excavation, extreme temperature, lifting operations, man-machine interface, materials handling, mental stress, moving equipment, noise, site security, slips/trips/falls, vibration and working at heights. Parts E-H used Likert-type response scales. Negatively worded safety-behaviour items were reverse scored before calculation of the composite safety-behaviour score.

The internal consistency of the principal scales was assessed using Cronbach's alpha. The resulting coefficients ranged from **0.684 to 0.910**, indicating acceptable to excellent internal consistency for the study scales.

Operational definitions

Safety and health behaviour referred to workers' reported adoption of safe practices, including completing tasks safely, avoiding shortcuts, intervening in unsafe situations and protecting colleagues.

Unsafe behaviour referred to behaviours inconsistent with established safe working procedures or that increased exposure to occupational hazards. For analysis, the safety and health behaviour scale was used as the principal behavioural outcome, with negatively worded items reverse scored.

Risk perception referred to workers' perceived understanding of workplace safety and health risks and their perceived relationship with workplace accidents and safety practices.

Management of unsafe behaviours referred to organizational processes through which unsafe acts and conditions were identified, reported, investigated and controlled, together with

relevant training, procedures and reporting arrangements.

BBS referred to the behavioural safety activities reported by participants, including observation, feedback, safety leadership and other workplace behavioural safety programs.

Statistical analysis
Data were analyzed using Jamovi version 2.6. Descriptive statistics were used to summarize participant characteristics and questionnaire responses. Composite scores were calculated as the Mean of the corresponding questionnaire items.

Cronbach's alpha was calculated to assess internal consistency. Pearson correlation coefficients were used to examine relationships among safety-risk dimensions, risk perception, safety and health behaviours, management of unsafe behaviours and BBS. Multiple linear regression was performed with the composite safety and health behaviour score as the dependent variable. Safety-risk frequency, safety-risk severity, workplace-risk exposure, risk perception, management of unsafe behaviours and BBS were entered as explanatory variables. Regression coefficients, p-values, model R^2 and adjusted R^2 were reported. Statistical significance was set at **p<0.05**.

Ethical approval
Ethical approval was obtained from the University of Cyberjaya Research Ethics Review Committee (CRERC), reference **UOC/CRERC/AL-ER (33/2024)**, dated 21 June 2024. Participants were informed about the purpose of the study, voluntary participation, confidentiality and their right to withdraw. Informed consent was obtained before questionnaire completion.

RESULTS

Participant characteristics
The final analysis included 456 consenting construction workers. Most participants were male (94.1%), aged 30-39 years (34.9%) or 40-49 years (31.4%), and had college/university education (37.1%). Indian nationals represented the largest nationality group (29.8%). More than half of participants had at least 11 years of construction experience. Roadworks was the most commonly reported principal construction activity (31.6%), and supervisors constituted the largest occupational category (39.0%).

Table 1: Sociodemographic and occupational characteristics of participants (N=456)

Characteristic	n (%)
Gender	
Male	**429 (94.1)**
Female	**27 (5.9)**
Age	
<30 years	**92 (20.1)**
30-39 years	**159 (34.9)**
40-49 years	**143 (31.4)**
≥50 years	**62 (13.6)**
Education	
No formal education	**72 (15.8)**
Primary/middle school	**146 (32.0)**
High school	**69 (15.1)**
College/university	**169 (37.1)**
Nationality	
India	**136 (29.8)**
Bangladesh	**93 (20.4)**
Pakistan	**84 (18.4)**
Nepal	**75 (16.5)**
Sri Lanka	**59 (12.9)**
Other	**9 (2.0)**
Marital status	
Single	**125 (27.4)**
Married	**264 (57.9)**
Divorced/separated/widowed	**67 (14.7)**

Characteristic	n (%)
Construction activity	
Roadworks	**144 (31.6)**
Excavation	**106 (23.2)**
Shuttering	**90 (19.7)**
Pipelaying	**69 (15.2)**
Other	**47 (10.3)**
Worker category	
Labour	**129 (28.3)**
Gang leader	**54 (11.8)**
Foreman	**54 (11.8)**
Supervisor	**178 (39.0)**
Other	**41 (9.0)**

Safety risks and hazard perceptions

Mental stress had the highest perceived frequency (mean=4.12±0.74), followed by working at heights (4.01±0.94), extreme temperature (3.90±1.07), materials and manual handling (3.85±0.94) and moving objects/equipment (3.71±1.18).

Working at heights had the highest perceived severity (3.61±0.97), followed by extreme temperature (3.43±0.91), lifting operations (3.39±0.86), moving objects/equipment (3.36±0.94) and mental stress (3.29±0.89). Mental stress also had the highest exposure score (4.05±0.96), followed by extreme temperature (3.83±1.06) and working at heights (3.81±1.02).

Table 2: Principal safety-risk dimensions and highest-rated hazards

Measure	Mean ± SD
Safety-risk frequency	3.28 ± 0.74
Mental stress	4.12 ± 0.74
Working at heights	4.01 ± 0.94
Extreme temperature	3.90 ± 1.07
Materials/manual handling	3.85 ± 0.94
Moving objects/equipment	3.71 ± 1.18
Safety-risk severity	2.98 ± 0.74
Working at heights	3.61 ± 0.97
Extreme temperature	3.43 ± 0.91
Lifting operations	3.39 ± 0.86
Moving objects/equipment	3.36 ± 0.94
Mental stress	3.29 ± 0.89
Workplace-risk exposure	3.10 ± 0.76
Mental stress	4.05 ± 0.96
Extreme temperature	3.83 ± 1.06
Working at heights	3.81 ± 1.02
Materials/manual handling	3.65 ± 0.92
Moving objects/equipment	3.50 ± 1.18

Risk perception, safety behaviour, management and BBS

The risk-perception scale had a mean of 4.86±0.65. The highest-rated item concerned management responsibility for workplace safety and health. Safety and health behaviours had a mean score of 4.96±0.48. Management of unsafe behaviours had a mean of 5.06±0.63, while BBS had a mean of 5.53±0.63.

Internal consistency was acceptable for risk perception (α=0.783) and safety and health behaviours (α=0.684), and good-to-excellent for management of unsafe behaviours (α=0.843) and BBS (α=0.894).

Table 3: Composite scale scores and internal consistency

Scale	Items	Mean ± SD	Cronbach's α
Safety-risk frequency	16	3.28 ± 0.74	0.906
Safety-risk severity	16	2.98 ± 0.74	0.905
Workplace-risk exposure	16	3.10 ± 0.76	0.910
Risk perception	10	4.86 ± 0.65	0.783
Safety and health behaviours	8	4.96 ± 0.48	0.684
Management of unsafe behaviours	8	5.06 ± 0.63	0.843
BBS	10	5.53 ± 0.63	0.894

Correlation analysis

Safety-risk frequency, severity and exposure were strongly correlated with one another (r=0.852-0.889, p<0.001). Each was positively correlated with safety and health behaviours (r=0.361-0.375, p<0.001).

Management of unsafe behaviours showed a stronger positive correlation with safety and health behaviours (r=0.472, p<0.001), while BBS demonstrated the strongest bivariate association with safety and health behaviours (r=0.550, p<0.001). Risk perception had a weak, non-significant correlation with safety and health behaviours (r=0.037, p=0.426). Risk perception was positively correlated with safety-risk frequency (r=0.130, p=0.006) and workplace-risk exposure (r=0.113, p=0.015).

Table 4: Correlations among principal study variables

Variable	Safety behaviour r	Risk perception r
Safety-risk frequency	0.368***	0.130**
Safety-risk severity	0.361***	0.069
Workplace-risk exposure	0.375***	0.113*
Risk perception	0.037	1.000
Management of unsafe behaviours	0.472***	0.051
BBS	0.550***	0.151**

*p<0.05; ** p<0.01; *** p<0.001.*

Multiple regression

The multiple regression model was statistically significant, F(6,449)=56.86, p<0.001, explaining 43.2% of the variance in safety and health behaviour (adjusted R^2=0.424). Safety-risk frequency was independently associated with safety behaviour (β=0.142, p=0.009). Management of unsafe behaviours (β=0.199, p<0.001) and BBS (β=0.244, p<0.001) were also significant independent predictors. Safety-risk severity (β=0.040, p=0.408), exposure (β=0.050, p=0.352) and risk perception (β=-0.049, p=0.067) were not statistically significant independent predictors.

Table 5: Multiple linear regression predicting safety and health behaviours

Predictor	β	p-value
Safety-risk frequency	0.142	0.009
Safety-risk severity	0.040	0.408
Workplace-risk exposure	0.050	0.352
Risk perception	-0.049	0.067
Management of unsafe behaviours	0.199	<0.001
BBS	0.244	<0.001
Model	R^2=0.432; adjusted R^2=0.424	<0.001

DISCUSSION

This study examined factors associated with safety and health behaviours among 456 construction workers in Qatar. Three findings are particularly important. First, mental stress, working at heights and extreme temperature were among the most prominent perceived occupational risks. Second, management of unsafe behaviours and BBS demonstrated substantially stronger relationships with reported safety behaviour than risk perception. Third, in

multivariable analysis, management of unsafe behaviours and BBS remained independently associated with safety behaviour, whereas risk perception did not reach conventional statistical significance. The prominence of mental stress is noteworthy because construction safety discussions frequently focus on physical hazards while psychological and organizational pressures receive less attention. The high perceived frequency of mental stress may reflect workload, time pressure, changing work conditions, supervisory demands and the complexity of construction activities. Previous research has similarly identified organizational and behavioural factors as important components of construction safety performance.[3,9]

Working at heights had the highest severity score among the hazards assessed. This finding is consistent with the established importance of falls as a major source of serious and fatal construction injuries.[3,10] The combination of relatively high frequency, exposure and severity suggests that work-at-height controls should remain a priority. Similarly, extreme temperature ranked highly for frequency and severity, demonstrating the importance of environmental conditions in construction risk management. The strong correlations among frequency, severity and exposure indicate that workers who reported greater occurrence of hazards also tended to report greater exposure and perceived severity. However, the high intercorrelations between the three risk dimensions mean that they should be interpreted as related components of an overall occupational-risk environment rather than completely independent constructs.

The relationship between risk perception and safety behaviour was weaker than anticipated. Risk perception was positively associated with some safety-risk measures but was not significantly associated with safety behaviour in the correlation analysis. Furthermore, after adjustment for the other study variables, risk perception was not an independent predictor (β=-0.049, p=0.067). This finding is important because it indicates that recognizing hazards does not necessarily translate directly into safe behaviour.

Workers may understand risks but still be influenced by organizational expectations, supervision, work pressure, availability of resources and the effectiveness of safety systems. Management of unsafe behaviours demonstrated a stronger association with safety behaviour. This finding supports the broader safety-management literature suggesting that workers' behaviour is influenced by the organizational environment in which work is performed.[11,12] Reporting systems, safety training, procedures, investigation of unsafe events and supervisory intervention can provide mechanisms through which organizations translate safety expectations into everyday practice.

BBS showed the strongest bivariate relationship with safety behaviour and remained an independent predictor in the regression model. This finding is consistent with previous research indicating that structured behavioural interventions can improve safety performance when they involve observation, feedback, participation and reinforcement.[5,6,13] Nevertheless, the finding should not be interpreted as evidence that BBS alone causes safer behaviour because the cross-sectional design cannot establish temporal or causal relationships. The high levels of reported safe behaviour should also be interpreted cautiously.

Most respondents reported favourable safety practices, including completing tasks safely, being careful and protecting colleagues. Such consistently positive responses may reflect genuine safety commitment, but they may also indicate **social desirability and self-report bias**. Workers may be reluctant to disclose unsafe practices, particularly when questionnaires are completed in employment settings. This is an important consideration when interpreting the apparent strength of reported safety behaviour.

The findings have practical implications for construction organizations in Qatar. Safety interventions should not rely exclusively on improving workers' awareness or risk perception. Instead, organizations should strengthen systems for reporting and investigating unsafe acts, ensure that workers have accessible procedures and resources, provide effective supervision and use BBS as part of an integrated safety-management system. Behavioural observations should be developmental rather than punitive so that workers can report unsafe conditions without fear of blame. The study also has several strengths. It included a relatively large sample of 456 construction workers from infrastructure projects and examined several dimensions of occupational risk and safety management simultaneously. The use of validated composite measures and quantitative reliability assessment strengthened measurement consistency.

Several limitations should nevertheless be recognized. First, the cross-sectional design prevents causal inference. Second, the questionnaire relied on self-reported information, creating potential recall and social-desirability bias. Third, the workforce comprised predominantly male migrant workers from several nationalities, and the questionnaire was administered in English; therefore, differences in language proficiency and interpretation may have influenced responses. Fourth, project-site recruitment may limit generalizability to all

construction workers in Qatar. Finally, the high intercorrelation among safety-risk dimensions and the very favourable safety-behaviour responses indicate that future studies should consider objective behavioural observations, longitudinal designs and independent incident records.

CONCLUSIONS

Among 456 construction workers in Qatar, mental stress, working at heights and extreme temperature were prominent perceived occupational risks, while working at heights had the highest perceived severity. Safety-risk frequency, management of unsafe behaviours and BBS were positively associated with reported safety and health behaviours. In the multivariable model, management of unsafe behaviours and BBS were the strongest independent correlates of safety behaviour, whereas risk perception was not independently significant. These findings suggest that improving construction safety requires more than increasing workers' awareness of hazards. Organizations should strengthen systems for reporting and investigating unsafe behaviours, provide effective safety training and supervision, ensure access to appropriate procedures and resources, and integrate BBS within broader occupational safety-management systems. Future research should use longitudinal and observational designs to determine whether improvements in these organizational and behavioural interventions lead to measurable reductions in unsafe acts and occupational incidents.

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COMPETING INTERESTS

The authors declare that they have no competing interests.

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