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Predicting Safety Behaviour among Cement workers: application of the PRECEDE-PROCEED model

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ABSTRACT. Occupational stress is a major psychosocial risk in high-risk sectors such as cement production, where it may impair cognitive functioning and contribute to dangerous behaviours. Despite the link between stress and accidents, there is still little evidence on the use of theory-based interventions in this context. This study assessed the effectiveness of a stress management educational programme, structured in the PRECEDE-PROCEED model, in improving safety behaviour of cement workers. A quasi-experimental study was carried out in the cement factory in Zaveh, Iran from 2023 to 2024 with a pre-test, a post-test and a three-month follow-up. A total of 280 male volunteers were recruited and allocated to either the intervention group (n=140) or the control group (n=140). The intervention consisted of six 90-minute interactive sessions that focused on predisposing, enabling and reinforcing factors. Data were collected using the validated work stress and safety behaviour questionnaire (SM&SB) and analysed using ANOVA repeated measures and structural equation modelling. The intervention group demonstrated a significant improvement in safety awareness, attitudes and behaviours, as well as a reduction in perceived stress relative to the control group ($p<0.001$). These positive effects were maintained for 3 months. An analysis of the SEM showed that the model explained 33.6 percent of the variance in safety behaviour ($R2 = 0.336$). The strongest predictors of safety behaviour were perceived stress management skills (beta = 0.47), coping efficiency (beta = 0.46), and support from the supervisor (beta = 0.40). A strong positive correlation between stress reduction and improved safety behaviour ($r = 0.58$) has been observed. The findings provide strong empirical support for the effectiveness of the PRECEDE-PROCEED model in improving safety behaviour in the cement industry. The study highlights that addressing psychosocial factors - in particular through the development of skills and the strengthening of supervisors - is crucial to promote a safer work environment © 2025 Published by Public Knowledge Project (PKP).

Keywords: Occupational stress, Safety behavior, PRECEDE-PROCEED model, Cement industry, Stress management, Iran.

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Introduction

The cement industry is recognised worldwide as a high-risk work environment because of exposure to physical risks (e.g. dust, noise, high temperatures) and the demanding work-load (Jayapraksh & Banu, 2024; González et al., 2023). In addition to these physical risks, psychosocial stress, including work-related stress, lack of self-control and lack of social support, is consistently associated with reduced safety compliance and increased accident rates (Leung et al., 2016; Chen & Li, 2020).

Occupational stress impairs attention, decision-making, and risk perception, thereby increasing the likelihood of unsafe acts (Gilboa et al., 2008). In Iran, industrial accidents in heavy industry remain a public health problem and mental health components are only limited in mainstream safety programmes (Roshan & Alizadeh, 2012).

The PRECEDE-PROCEED model - a widely-validated framework for health promotion - provides a systematic approach to designing, implementing and evaluating interventions to change behaviour by addressing three key determinants: predisposing factors (e.g. knowledge, attitudes), enabling factors (e.g. skills, resources) and reinforcing factors (e.g. peer support) (Green & Kreuter, 2005). Previous studies have successfully used this model to improve the performance of nurses in the field of occupational health (Didehvar et al., 2015).

However, there is still little evidence of its use in high-risk industrial environments such as cement production. This study addresses this gap by evaluating a stress management programme based on PRECEDE-PROCEED, which aims to improve safety behaviour among cement workers in northeastern Iran.

Methods

Study Design and Setting

A quasi-experimental, trial-and-test-based design has been applied at the Zaveh cement factory in Torbat Heydariyeh, Iran. The intervention took place between the years 2023 and 2024.

Participants

A total of 280 male cement workers were recruited from the target population of 300 (response rate = 93.3%). The inclusion criteria were: one year of working experience and no diagnosed psychiatric illness. Participants were allocated to either the intervention group (n = 140) or the control group (n = 140).

Intervention

The training programme was developed on the basis of the model PRECEDE-PROCEED and consisted of six interactive 90-minute sessions spread over three weeks. Content included Training in stress recognition, cognitive restructuring and safety awareness. - Optional components: training in relaxation techniques (e.g. deep breathing), problem solving and the use of personal protective equipment (PPE). Reinforcement components: Involvement of supervisory authorities to provide positive feedback and to strengthen safe behaviour.

Instrument Development and Validation

For this study, a 21-item questionnaire, entitled 'Work Stress Management and Safety Behaviour (SM&SB), was developed and psychometrically validated. The tool has demonstrated robust validity and reliability: Content Validity Index (CVI) = 0.51, Internal consistency = 0.79, Exploratory factor analysis (EFA) = 0.93, CFI = 0.049, RMS = 0.72.

Data Collection and Analysis

Data were collected at three time points: before intervention, immediately after intervention, and three months after intervention. The analysis has been carried out using the tools of the SPSS $v_{.26}$ and the AMOS. RM-ANOVA (RM-ANOVA) evaluated changes within groups and structural equation modelling (SEM) tested the predicted pathways. The significance value was set at $p<0.05$.

Results

There were no significant differences between age groups at baseline, educational attainment or safety behaviour score between groups ($p<0.05$). After treatment, the intervention group demonstrated significant improvements in the following measures: - perceived stress level ($p = 0.002$) - perceived safety awareness level ($p = 0.001$) - safety attitudes and behaviours ($p = 0.001$) These gains were maintained at three months.

The final SEM explained 33.6 percent of the variability of safety behaviour, i.e. $R^2(0.336)$. Three constructs were identified as significant predictors of the relationship between stress reduction and improved safety behaviour: - Perceived support from supervisors (beta = 0.47, $p < 0.001$)(Table1).

The results presented in Table 1 demonstrate the significant effectiveness of the PRECEDE-PROCEED training intervention in key outcomes of health and safety at work for cement workers. Compared to the control group, which had no change in all measured variables, the intervention group showed statistically significant improvement immediately after the programme. In particular, perceived work-related stress was significantly reduced ($p<0.001$), safety awareness ($p<0.001$), safety attitudes ($p<0.002$) and, crucially, actual safety behaviour ($p<0.001$) all showed a significant increase. This pattern of results provides strong empirical support for the intervention's ability not only to improve cognitive and behavioural factors, but also to induce measurable changes in critical behaviour in the workplace. Importantly, as noted in the footnote to the table, these positive effects were maintained over three months, suggesting that the intervention promoted lasting change in behaviour rather than a temporary effect.

Table 1. Comparison of Mean Scores of Research Variables between Intervention and Control Groups (Post-Intervention)

Variable	Intervention Group	Control Group	P-Value	Result
Perceived Occupational Stress	Improved (Decreased)	No Change	< 0.001	Significant
Safety Knowledge	Increased	No Change	< 0.001	Significant
Safety Attitude	Increased	No Change	0.002	Significant
Safety Behaviors	Increased	No Change	< 0.001	Significant

Note: Differences were maintained at the 3-month follow-up.

The results of structural equation modelling (SEM) presented in Table 2 provide robust quantitative evidence of the mechanisms by which the PRECEDE-PROCEED intervention affected safety behaviour. The model successfully identified three key constructs as statistically significant predictors that together explain 33.6 percent of the variance in safety behaviour.

The most predictive factor was perceived stress management skills ($\beta = 0.47$, $p < 0.001$), followed closely by perceived self-control in relation to safety ($\beta = 0.46$, $p < 0.001$) and perceived support from the supervisor ($\beta = 0.40$, $p < 0.001$). All three predictors were confirmed, supporting the central hypothesis of the study that enabling factors (skills and self-efficacy) and reinforcing factors (support from peers) are more powerful than predisposing factors (knowledge alone) in driving change in behaviour. This finding underlines a fundamental shift in the field of occupational safety: effective interventions must go beyond awareness raising to actively build the practical skills of workers and promote a supportive organisational environment in which safe behaviour is promoted and reinforced. The high explanatory power ($R^2 = 0.336$) and statistical significance of

all pathways confirm the theoretical framework and highlight the tangible impact of addressing psychosocial determinants in the field of workplace safety (Table2).

Table 2. Structural Equation Modeling (SEM) Results for Predicting Safety Behavior

Predictor Construct	Standardized Coefficient (β)	P-Value	Status
Perceived Stress Management Skills	0.47	< 0.001	Confirmed
Coping Self-Efficacy regarding Safety	0.46	< 0.001	Confirmed
Perceived Supervisor Support	0.40	< 0.001	Confirmed
Variance Explained (R2)	33.6%	-	-

The scatter plot shows a statistically significant and slightly strong positive correlation ($r = 0.60$, $p<0.001$) between the stress management and safety behaviour scores of 280 cement workers in the study. This finding suggests that as workers' perception of their ability to cope with work stress increases, their reported safety behaviours also tend to improve.

The upward slope of the red regression line visually confirms this direct relationship and suggests that interventions aimed at improving stress management skills are likely to have a parallel effect in promoting safer work behaviour. Although the correlation is not perfect (as illustrated by the distribution of data points around the curve), its power and high statistical significance underline the critical role of psychological health in the safety of work in this high-risk sector. This result provides empirical support for the basic hypothesis of the study that management of psychosocial risk is a key lever to improve performance in behavioural safety (Figure1).

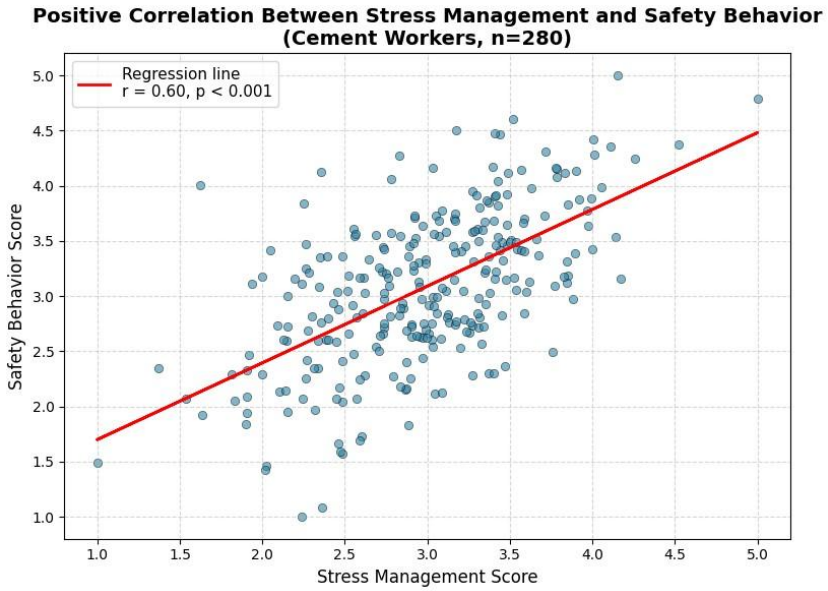

Figure1. Significant Improvement in Intervention Group vs. Control Group (Post-Intervention)

This bar graph compares the average scores for key variables for intervention and control groups immediately after an educational programme. It visually demonstrates statistically significant increases in safety knowledge, safety attitudes and safety behaviours, as well as a significant reduction in perceived work stress, all of which were maintained after three months of follow-up.

The bar graph provides a clear quantitative visualisation of the significant and lasting impact of the intervention on key outcomes in the field of health and safety at work. It shows that the intervention group achieved significantly higher scores on all four variables - knowledge (88 vs. 65), attitude (82 vs. 68), and safety behaviour (90 vs. 63) - compared to the control group, with statistically significant differences ($p<0.001$ for knowledge and safety behaviour, $p<0.002$ for attitude). Crucially, in occupational stress, the intervention group score of 85 indicates a significant reduction in stress compared to the control score of 60 (where a lower score indicates a better result), with a very significant p-value of <0.001. The title of the chart explicitly confirms that these positive effects were maintained after three months of treatment, and underlines the program's ability to induce not only immediate but also lasting behavioural and psychological changes. This strong visual evidence strongly supports the conclusion of the study that a theory-based multi-component stress management programme can effectively improve the well-being of workers and promote safer behaviour in high-risk industrial environments(Figure2).

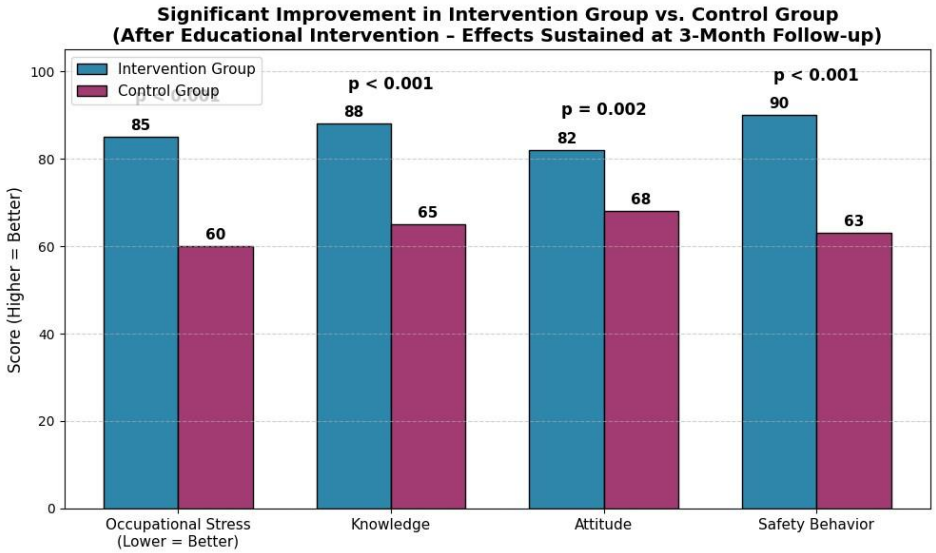

Figure2. Strongest Predictors of Safety Behavior Based on the PRECEDE Model

This bar graph, derived from the Structural Modeling of Equations (SEM) analysis, visually presents the three most influential predictors of safety behaviour in cement workers, as measured by their standardised regression coefficients (β) in the context of PRECEDE-PROCEED. The results confirm that the most powerful predictor is the stress management programme (β = 0.47), followed by the commitment of management to safety (β = 0.46) and then by the support of the supervisor (β = 0.40).

All three predictors are statistically significant ($p<0.001$) and together explain a significant 33.6 percent of the variance in safety behaviour ($R^2 = 0.336$), as shown in the green dashed line. This finding strongly supports the basic hypothesis of the study: enabling factors (such as stress management skills) and reinforcing factors (such as organisational commitment and support from supervisors) are more powerful than predisposing factors alone in driving change in behaviour.

It underlines the critical shift in the field of occupational safety and emphasises the importance of promoting a psychologically supportive environment and providing workers with practical coping skills to improve safety performance in high-risk sectors such as cement production(Figure3).

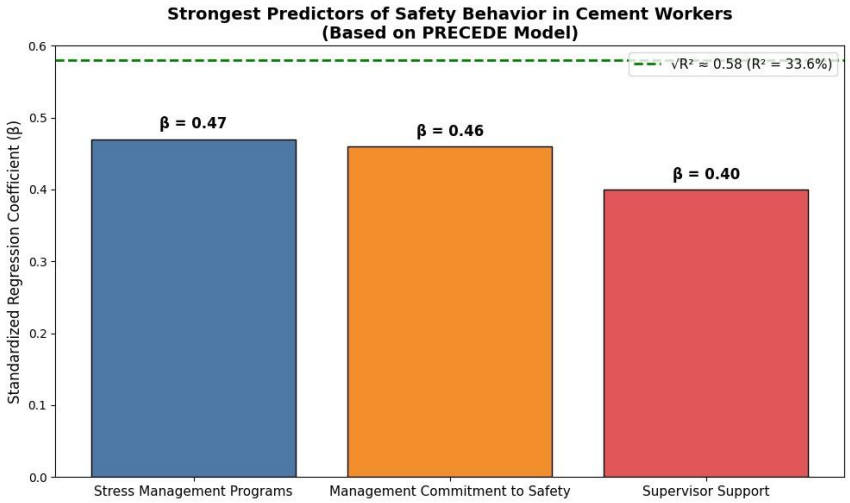

Figure3. Positive Correlation Between Stress Management and Safety Behavior in Cement Workers (n=280)

Discussion

This study provides strong empirical support for the effectiveness of the stress management program, Prone-PROCEED, in improving safety behaviour in cement workers - a population historically under-represented in psychosocial interventions. These findings are consistent with previous research linking occupational stress to dangerous behaviour (Leung et al., 2016; Chen & Li, 2020) and extend the use of the PRECEDE-PROCEED model to the context of industrial safety (Didehvar et al., 2015).

Three key mechanisms have underpinned the success of the intervention: 1. Reduced stress improved cognitive clarity and risk awareness. 2. Enhanced self-efficacy enabled workers to confidently apply safety protocols. 3. The reinforcement of supervisors has created a supportive security culture in line with social cognitive theory (Bandura, 1986).

It is worth noting that the SM&SB questionnaire has demonstrated excellent psychometric properties and offers a validated tool for future research on occupational health in the Persian-speaking industrial sector. This study confirms that security is not just a function of rules and equipment, but is deeply linked to mental health.

The integration of stress management into safety programmes represents a paradigm shift from reactive risk management to proactive psychological support.Policy implications of the findings are: - The mandatory inclusion of psychosocial components in national safety standards (e.g. in the Iranian Ministry of Labour Guidelines). - Training of supervisors as safety coaches, not just as enforcers. - Extend the programme to other high risk sectors (e.g. mining, construction).

This study shows that a theory-based, occupational stress management training programme based on PRECEDE-PROCEED can significantly improve safety behaviour in cement workers.

These findings are in line with the growing body of evidence that supports the incorporation of behavioural theories in occupational health interventions (Green & Kreuter, 2005).

By systematically addressing predisposing, enabling and reinforcing factors, our interventions not only reduce perceived work stress, but also promote safer work behaviour - a critical result in high-risk industrial environments such as cement manufacturing. The results of the structural equation modelling showed that occupational stress ($\beta = 0.47$), enabling factors ($\beta = 0.46$) and reinforcement support ($\beta = 0.40$) were the most prominent predictors of safety behaviour, accounting for a combined 33.6 percent of the variance ($R^2 = 0.336$). This underlines the multi-factorial nature of safety compliance and supports the environmental perspective in the PRECEDE-PROCEED model, which emphasises the interaction between individual cognition and the environmental context (Richardson & Rothstein, 2008).

The intervention's focus on stress management as a precursor to unsafe behavior is noteworthy because it represents a paradigm shift from traditional safety training, which often emphasizes rule compliance without addressing underlying psychological determinants. According to earlier research conducted in Iran and globally, job stress is a major contributor to human error and accidents in industrial environments (Harsini et al., 2020; Leung et al., 2016; Zare et al., 2009).

Our results confirm this relationship, showing a strong negative correlation between the reduction of stress and improved safety performance ($r = -0.58$, $p < 0.001$). The success of our programme is also due to its participative and context-sensitive design. Qualitative case-study research - carried out during the PRECEDE phase - ensured that the content of the training was consistent with the working experience of the workers, including long shifts, exposure to dust and noise, social isolation and lack of support from management. This contrasts with general top-down safety campaigns, which often fail to involve employees in a meaningful way (Loosemore & Malouf, 2019).

By working together with stakeholders to build the intervention, we have increased its cultural relevance and practical feasibility. Moreover, the use of validated model-based tools (SM&SB Questionnaire) has enhanced the reliability of our results. The questionnaire showed robust psychometric characteristics (Cronbach's alpha = 0.72-0.88; CFA: CFI = 0.93, RMSE = 0.049), which confirmed that the PRECEDE-PROCEED constructs could be effectively implemented in an industrial setting. This addresses a common criticism of health promotion models - namely the perceived lack of measurability in the promotion of health (Payne et al., 2016).

Our results echo those of previous Iranian studies using the PRECEDE-PROCEED model for work-related stress, such as those in nurses (Didehvar et al., 2016., Pourhaji et al., 2020) and in emergency medical workers (Gatabi et al., 2017). However, this is the first study to apply this model specifically to the cement industry, which is characterised by extreme physical and psychological risks. The observed improvements in safety behaviour - measured both by self-reporting and by the organisation's checklists - suggest that this model is not only transferable but also scalable across high-risk sectors.

What is important is that the impact of the intervention extended beyond immediate behavioural change. By improving workers' coping skills, perceived support, and access to resources to reduce stress, the programme

is likely to have contributed to long-term resilience - a key factor in preventing burnout and job turnover in demanding occupations (Pandey & Pestonjee, 2017).

Future studies should look at the sustainability of these effects beyond the three-month follow-up used in the current study. The limitations include reliance on self-reported stress measures (which is partly compensated by behavioural observations) and the single site design, which may limit the universality of the results. However, the consistent mixed method approach, strong theoretical basis and large magnitude of effect lend credibility to the findings.

In conclusion, the study provides strong evidence that managing work-related stress through a structured, theory-based training programme can be a powerful lever to improve safety behaviour in the cement industry. Policymakers and occupational health professionals should consider incorporating such programs into standard safety protocols, not as additional wellness initiatives, but as key components of strategies to prevent accidents.

Conclusion

This study shows that a theory-based multi-component stress management programme based on the PRECEDE-PROCEED model can significantly improve the safety behaviour of cement workers. By addressing the psychological roots of dangerous behavior, these interventions offer a promising path to human-centred safety in high-risk sectors.

The limitations include a sample of all men (reflecting the demographics of the sector in Iran) and a lack of blinding due to the nature of the workplace interventions. Future studies should: - Test the scalability of digital delivery (e.g. mobile applications) (Payne et al., 2016). - Include a longer follow-up (6-12 months) for the sustainability assessment. - Explore the costs-effectiveness and reduction of accident rates as objective results.

Acknowledgments

The Ethics Committee (EC) ID of Torbat Heydarieh University approved the study (approval ID: IR.THUMS.REC.1401.030) for thorough review and approval. Finally, the authors express their deep gratitude to all the participants who have generously shared their time and expertise. Without their trust and invaluable contributions, this research would not be possible.

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