

Investigating the effect of educational interventions and safety climate factors on improving risk perception of hazardous situations of working at height and working in confined spaces among workers employed in grain storage silos

Extended Abstract

Introduction: Occupational accidents remain a significant concern in developing countries, particularly in industries involving high-risk activities such as working at height and in confined spaces. According to global reports, approximately 3.5 million people die annually from work-related incidents, with substantial economic losses estimated at 500 billion USD. In Iran, official data from 1403 (2024) indicate 26,548 injuries and 1,986 fatalities from occupational accidents, with falls from height accounting for 46% of deaths. The grain storage silo industry is particularly hazardous due to activities like maintenance on elevator towers, conveyors, and hive structures, as well as silo cleaning, which exposes workers to dust and confined space risks. Safety climate, defined as workers' shared perceptions of safety policies and priorities, plays a crucial role in influencing safe behaviors. Poor risk perception and unsafe acts contribute to 80% of accidents, underscoring the need for educational interventions to enhance awareness and culture. This study investigates the impact of educational interventions and safety climate factors on improving risk perception of hazardous situations in working at height and confined spaces among grain silo workers.

Materials and methods: This quasi-experimental study employed a pre-test and post-test design conducted in a grain silo facility in 1403 (2024). The target population consisted of 15 technical engineering and operations personnel exposed to high-risk tasks, such as preventive maintenance on elevator towers, conveyors, and storage hives, as well as silo floor cleaning. Data were collected using a two-part questionnaire: the first part assessed safety climate with 10 items adapted from McDonald and Harry's 2001 questionnaire (Cronbach's alpha = 0.83), covering dimensions like personnel competence, safety prioritization, communication, and management commitment. The second part evaluated risk perception of 8 height-related hazards (e.g., working on scaffolds without guardrails) and 1 confined space hazard (dust and trapped gases in hives) using a Likert scale. Educational interventions were delivered over 6 two-hour weekly sessions, including lectures, group discussions, brainstorming, and materials on hazard identification, PPE usage, ergonomics, and safe decision-making. Statistical analysis was performed using SPSS 21, including factor analysis (Varimax rotation, KMO = 0.72), Bonferroni-adjusted pairwise comparisons, and binary logistic regression to examine the effects of safety climate on risk perception. Exposure risk to dust and gases was assessed using Singapore's semi-quantitative method.

Results: Participants had a mean age of 35.6 years (range: 27-49), mean work experience of 9.41 years, and education levels of 72.3% bachelor's, 2.38% master's, and 25.32% diploma. Safety climate factors explained 53% of variance, with organizational commitment and management dedication scoring lowest pre-intervention. Pre-intervention mean safety culture score was 143 ± 21.6 (below optimal), improving to 249.31 ± 27.6 post-intervention ($p < 0.05$).

Risk perception increased significantly, with workers showing better recognition of hazards like unscaffolded platforms and broken ladders. Binary logistic regression revealed inverse significant relationships between safety climate factors and all 9 hazardous situations post-intervention, with working on unscaffolded platforms (Wald = 5.026) and confined space dust exposure (Wald = 7.022) as strongest predictors of safe behavior. Bonferroni tests confirmed significant differences in safety culture and risk perception pre- and post-intervention.

Discussion and Conclusion: The findings demonstrate that educational interventions, combined with technical measures, significantly enhance safety culture and risk perception among silo workers, leading to safer behaviors and reduced accident potential. Post-intervention improvements align with prior studies (e.g., Mortazavi et al., 2010; Asivandzadeh et al., 2020), emphasizing the role of training in fostering positive attitudes toward safety. Workers with higher education exhibited superior safety performance, consistent with literature linking knowledge to better outcomes. Limitations include the small sample size; future research should involve larger cohorts and longitudinal follow-up. Recommendations include forming risk assessment committees, developing fall protection programs, and promoting experience-sharing among workers. Overall, targeted education fosters a proactive safety climate, ultimately minimizing occupational hazards in high-risk industries like grain silos.

Keywords: Safety climate, Risk perception, Educational interventions, Work at height, Confined spaces, Confined spaces, Occupational hazards.