The Impact of Work Alienation on Miners' Unsafe Behaviors: A Moderated Chain Mediation Model

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Abstract. To explore the mechanism of work alienation affecting miners' unsafe behaviors, we proposed a hypothetical model through theoretical and literature analysis. Using the Work Alienation Scale, Miners' Job Burnout Scale, Psychological Resilience Scale, Miners' Safety Attitude Scale, and Unsafe Behavior Scale, we randomly surveyed 460 miners and validated the model through SPSS and AMOS analyses. The results indicate that work alienation not only directly affects miners' unsafe behaviors but also indirectly influences unsafe behaviors through job burnout and safety attitude respectively, with both factors jointly demonstrating a chain mediation effect. Furthermore, psychological resilience plays a significant moderating role between job burnout and safety attitude, mitigating the negative impact of job burnout on safety attitude. These findings provide theoretical foundations for reducing miners' unsafe behaviors. Enterprises should reduce work alienation and enhance psychological resilience to decrease unsafe behaviors.

Keywords: Work Alienation; Job Burnout; Safety Attitude; Psychological Resilience; Unsafe Behaviors; Miner

1 Introduction

In recent years, despite the declining accident rates in the coal mining industry due to continuous improvements in safety management technologies, miners' unsafe behaviors remain a critical threat to coal mine safety production [1]. Unsafe behaviors not only elevate injury risks but also cause substantial property losses. Therefore, investigating the mechanisms influencing miners' unsafe behaviors and effective intervention strategies holds significant theoretical and practical value.

Work alienation refers to employees' psychological detachment from work tasks, organizational goals, and colleagues. This alienation not only diminishes job performance but also significantly increases the likelihood of unsafe behaviors [2]. According to the Conservation of Resources (COR) theory, work alienation accelerates the depletion of employees' emotional resources, thereby triggering job burnout [3]. Job burnout manifests as physical and mental exhaustion characterized by emotional drain, diminished work engagement, and cynical attitudes [4]. Burnout impairs em-

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ployees' adherence to safety protocols, escalating unsafe behavior risks[5].Safety attitude reflects employees' commitment to safety regulations and proactive hazard identification [6]. Employees with strong safety attitudes rigorously follow operational protocols and maintain vigilance against potential risks. However, job burnout may indirectly increase unsafe behaviors by eroding safety attitudes [7].

Psychological resilience — an adaptive psychological trait enabling effective stress response — mitigates burnout's detrimental effects on safety attitudes [8]. High resilience buffers the negative impact of burnout on safety attitudes, thereby reducing unsafe behaviors [9]. This study examines the chain mediation mechanism through which work alienation affects unsafe behaviors via job burnout and safety attitude, while verifying resilience's moderating role.

2 Theoretical Background and Hypotheses

2.1 Work Alienation and Unsafe Behaviors

Work alienation arises when job demands remain unmet or expectations conflict with reality, leading to psychological detachment categorized as personal or social alienation [10]. Key features include emotional indifference, disengagement, and interpersonal estrangement.

Self-Determination Theory (SDT) posits that work alienation undermines intrinsic motivation [11], eroding task ownership and responsibility. This motivational deficit induces negligence in high-vigilance environments like mining, where alienation amplifies unsafe behaviors.

Cognitive Dissonance Theory [12] further explains that alienated employees may rationalize safety violations to alleviate psychological discomfort. Such dissonance promotes risky shortcuts (e.g., skipping safety checks), exacerbating hazards. We hypothesize:

H1: Work alienation positively predicts miners' unsafe behaviors.

2.2 Mediating Role of Job Burnout

Job burnout denotes chronic stress-induced exhaustion marked by emotional depletion, cynicism, and reduced accomplishment [13]. COR theory posits that resource depletion drives burnout [14], diminishing vigilance and error avoidance capabilities. Alienation intensifies meaninglessness perception, accelerating resource exhaustion and burnout [15]. Empirical evidence confirms burnout's role in provoking unsafe acts like protocol violations [16]. Thus:

H2: Work alienation indirectly influences unsafe behaviors through job burnout.

2.3 Mediating Role of Safety Attitude

Safety attitude encompasses compliance commitment and proactive risk management [17]. Social Cognitive Theory (SCT) [18] indicates burnout-induced emotional drain

weakens safety prioritization. Alienation reduces responsibility, lowering safety commitment and increasing risk tolerance. Hence:

H3: Work alienation indirectly influences unsafe behaviors through safety attitude.

2.4 Chain Mediation Model

This study proposes a dual-mediator pathway: work alienation → job burnout → safety attitude → unsafe behaviors. COR theory explains alienation-triggered resource loss initiates burnout, which degrades safety attitudes. SCT reinforces that depleted attitudes reduce hazard vigilance, completing the mediation chain. We hypothesize:

H4: Work alienation affects unsafe behaviors via the chain mediation of job burnout and safety attitude.

2.5 Moderating Role of Psychological Resilience

Psychological resilience denotes adaptive recovery from adversity [19]. Social Support Theory suggests resilience buffers burnout's impact on safety attitudes — high resilience sustains safety commitment despite burnout, whereas low resilience exacerbates attitude deterioration. Therefore:

H5: Psychological resilience negatively moderates the burnout → safety attitude relationship.

In conclusion, this study presents the theoretical model diagram as shown in Figure 1:

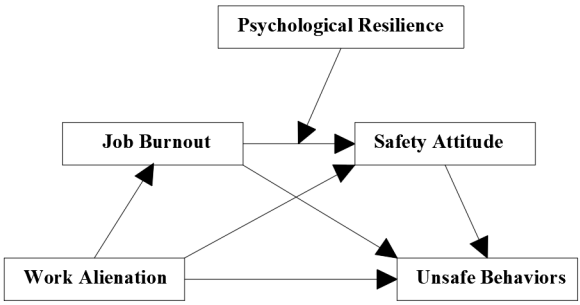

Fig. 1. Research theoretical model

3 Research Methodology

3.1 Participants

This study employed stratified random sampling to survey 460 miners across five large coal mining enterprises in Hebei, Shanxi, and Inner Mongolia, covering job

categories including mining, blasting, transportation, ventilation, and gas control. After data screening, 394 valid questionnaires were retained, yielding a response rate of 85.65%. Demographic characteristics: All participants were male, 76.23% aged 25–50 years, 68.41% held college degrees or higher, 66.84% had 2–5 years of experience

3.2 Measurement Instruments

All scales were adapted from validated instruments in international and domestic journals through a rigorous translation-back translation procedure, refined via expert reviews and miner interviews. Responses were recorded on a Likert 5-point scale (1 = "Strongly Disagree" to 5 = "Strongly Agree").Work Alienation Scale adapted from Nair & Vohra [20], this 8-item scale was contextualized for coal miners (e.g., *"I work solely to receive my paycheck"*). Job Burnout Scale modified from Li Naiwen & Niu Lixia's scale [21], 15 items were retained after removing work alienation-related questions (e.g., *"The daily workload overwhelms me"*).Psychological Resilience Scale utilized Gao JQ's validated 6-item scale [22] with two dimensions: *Recovery Capacity* and *Sense of Strength*. Safety Attitude Scale adopted Wu X et al.'s 17-item scale [17] measuring four dimensions: *Management Support*, *Perception of Accidents*, *Team Collaboration*, and *Work Pressure*. Unsafe Behavior Scale implemented Li JZ et al.'s 10-item scale [23] assessing two dimensions: *Intentional Violations* (e.g., *"I occasionally bypass rules to simplify tasks"*) and *Unintentional Errors*.

4 Data Analysis and Results

4.1 Reliability and Validity Tests

In the proposed model, the Cronbach's α coefficients for work alienation, job burnout, psychological resilience, safety attitude, and unsafe behaviors were 0.918, 0.916, 0.848, 0.927, and 0.884, respectively. All values exceeded 0.8, indicating excellent reliability. Furthermore, all scales were adapted from validated instruments, ensuring established convergent validity.

To assess discriminant validity, we followed Williams et al.'s (2009) recommendations [24]. As shown in Table 1, observational indicators were constructed as follows: Psychological resilience: 2 dimensions, Safety attitude: 4 dimensions, Unsafe behaviors: 10 items, Work alienation: 3 parceled indicators (aggregated by item correlations), Job burnout: 3 parceled indicators. Confirmatory factor analysis (CFA) using AMOS 24 revealed superior fit for the five-factor model compared to alternative models:(χ^2=204.401,df=199,χ^2/df=1.027<3;RMSEA=0.008<0.08;CFI=0.998>0.9;TLI=0.997>0.9;IFI=0.998>0.9;NFI=0.924 >0.9.These results confirm strong discriminant validity among the five core constructs.

Table 1. Confirmatory factor analysis results

model	χ^2	df	χ^2/df	RMSEA	CFI	TLI	IFI	NFI
Five-Factor Model(WA, WB, PR, SA, UB)	204.401	199	1.027	0.008	0.998	0.997	0.998	0.924
Four-Factor Model(WA+WB, PR, SA, UB)	538.508	203	2.638	0.065	0.865	0.846	0.866	0.801
Four-Factor Model(WA+WB+PR, SA, UB)	936.810	206	4.548	0.095	0.743	0.687	0.706	0.652
Four-Factor Model(WA+WB+PR+SA, UB)	1342.400	208	6.454	0.118	0.639	0.488	0.543	0.501
Four-Factor Model(WA+WB+PR+SA+UB)	1693.142	209	8.101	0.134	0.496	0.433	0.502	0.471

Note:**WA**: Work Alienation; **WB**: Work Burnout; **PR**: Psychological Resilience; **SA**: Safety Attitude; **UB**: Unsafe Behavior; +: Indicates variable combination; **χ^2/df**: Chi-square/degrees of freedom ratio; **RMSEA**: Root Mean Square Error of Approximation; **CFI**: Comparative Fit Index; **TLI**: Tucker-Lewis Index; **IFI**: Incremental Fit Index; **NFI**: Normed Fit Index

4.2 Common Method Bias Test

Given that all variables in this study were self-reported by miners, Harman's single-factor test was employed to assess common method bias. Results indicated that the first factor accounted for 28.04% of variance, well below the 40% threshold, confirming no significant common method bias.

4.3 Descriptive Statistical Analysis

SPSS 27 was utilized for descriptive statistical analysis (see Table 2). Key correlations include:work alienation positively correlated with Job burnout ($r = 0.461$, $p < 0.01$), Unsafe behavior ($r = 0.427$, $p < 0.01$), Negatively correlated with safety attitude ($r = -0.280$, $p < 0.05$)Job burnout showed: negative correlation with safety attitude ($r = -0.462$, $p < 0.01$), Positive correlation with unsafe behavior($r = 0.405$, $p < 0.001$).Safety attitude negatively correlated with unsafe behavior ($r = -0.313$, $p < 0.01$)These findings provide preliminary support for the hypothesized model.

Table 2. Mean, standard deviation and correlation coefficient of variables

Research Variables	M	SD	1	2	3	4	5
Work Alienation	3.957	0.548	1				
Job Burnout	3.872	0.716	0.573**	1			
Psychological Resilience	3.134	0.659	-0.254***	-0.218**	1		
Safety Attitude	2.345	0.930	-0.280**	-0.462**	0.453**	1	
Unsafe Behavior	4.646	0.495	0.427**	0.405***	-0.213**	-0.313**	1

Note: *** indicates $p < 0.001$; ** indicates $p < 0.01$; * indicates $p < 0.05$; M = Mean; SD = Standard Deviation.

4.4 Direct and Mediation Effect Analysis

The direct effects were tested using SPSS (see Table 3). With work alienation as the independent variable: The direct effect of work alienation on unsafe behavior was 0.259 (95% CI [0.163, 0.355]), excluding zero, indicating a significant main effect (H1 supported). The main effect of work alienation on job burnout was 0.573 (95% CI [0.642, 0.855]), excluding zero, demonstrating significance. The main effect of job burnout on unsafe behavior was 0.405 (95% CI [0.217, 0.334]), excluding zero, confirming significance.

Table 3. Results of direct effect tests between variables

Path	Effect Size	Standard Error	95% CI Lower Bound	95% CI Upper Bound
Work Alienation → Unsafe Behavior	0.259	0.049	0.163	0.355
Work Alienation → Job Burnout	0.573	0.054	0.642	0.855
Work Alienation → Safety Attitude	-0.280	0.082	-0.638	-0.341
Job Burnout → Unsafe Behavior	0.405	0.032	0.217	0.334
Safety Attitude → Unsafe Behavior	-0.313	0.026	-0.216	0.116
Job Burnout → Safety Attitude	-0.462	0.058	-0.714	-0.458

This study employed the PROCESS macro for SPSS with 5,000 bootstrapping resamples to calculate 95% bias-corrected confidence intervals (CI). The analyses proceeded as follows, (see Table 4):

1. Simple mediation (Model 4): Job burnout showed a significant mediating effect between work alienation and unsafe behavior (effect size = 0.088, 95% CI [0.007, 0.189]), supporting H2.
2. Serial mediation (Model 6): Safety attitude independently mediated the relationship (effect size = 0.026, 95% CI [0.014, 0.064]), validating H3; The serial mediation path through job burnout → safety attitude yielded a significant indirect effect (effect size = 0.013, 95% CI [0.008, 0.019]), confirming H4.

Table 4. Results of chain mediation analysis

Path	Effect Size	Standard Error	95% CI Lower Bound	95% CI Upper Bound
Total Effect: Work Alienation → Unsafe Behavior	0.386	0.041	0.305	0.467
Direct Effect: Work Alienation → Unsafe Behavior	0.259	0.049	0.163	0.355
Total Indirect Effect	0.127	0.050	0.038	0.236
Path 1: Work Alienation → Job Burnout	0.088	0.047	0.007	0.189

→ Unsafe Behavior				
Path 2: Work Alienation → Safety Attitude → Unsafe Behavior	0.026	0.013	0.014	0.064
Path 3: Work Alienation → Job Burnout → Safety Attitude → Unsafe Behavior	0.013	0.007	0.008	0.019

4.5 Moderation Effect Analysis

A hierarchical regression analysis was conducted to examine the moderating role of psychological resilience in the relationship between job burnout and safety attitude. Results revealed that: The interaction term (job burnout × psychological resilience) exerted a significant positive effect on unsafe behavior ($\beta = 0.126$, $p < 0.001$). This indicates psychological resilience negatively moderated the job burnout–safety attitude relationship, supporting H5.As illustrated in Figure 2: Under high psychological resilience, the decline in safety attitude became slower compared to low resilience conditions. The negative impact of job burnout on safety attitude was attenuated, demonstrating psychological resilience's positive buffering effect on this relationship.

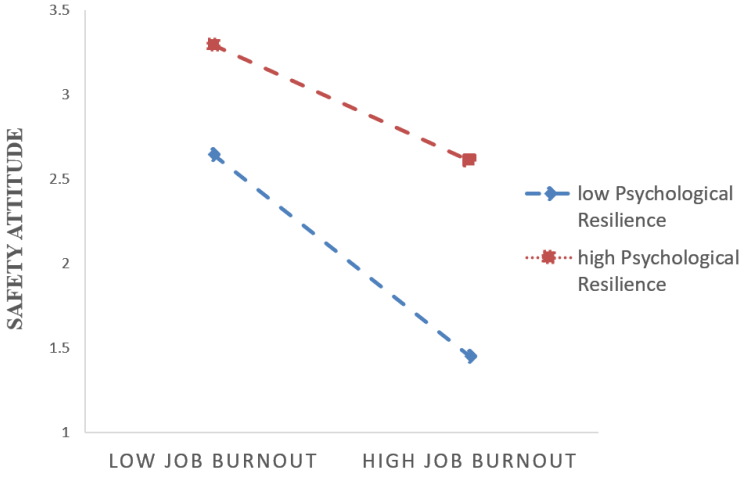

Fig. 2. The moderating effect of psychological resilience

5 Conclusions

This study reveals that work alienation in mining uniquely manifests through prolonged isolation, rigid hierarchies, and physical demands, driving unsafe behaviors via burnout and eroded safety attitudes. Key limitations include reliance on self-reported data and regional sample constraints, necessitating future cross-cultural and observational validation. Practical interventions—such as job rotation, on-site mental health support, and resilience training using VR simulations—show promise in pilot

programs (e.g., Inner Mongolia and Hebei). Compared to healthcare or manufacturing, mining's high-risk remoteness demands stricter procedural safeguards, yet lessons like worker empowerment from lean management remain adaptable. Crucially, fostering safety-centric cultures through leadership accountability (e.g., safety-linked bonuses) and transparent communication mitigates alienation. Addressing these dimensions holistically can transform safety outcomes in mining sustainably.

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