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Safety leadership and its impact on workers' safety behavior in the mining industry sector: A systematic review

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Abstract

Purpose: This study aims to systematically evaluate empirical evidence related to safety leadership domains and their influence on workers' safety behavior in the mining sector. **Methods:** A systematic review was conducted between September and December 2025 following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. Literature searches were performed in PubMed, Scopus, and BioMed Central (BMC). Eligible studies were screened according to predefined inclusion and exclusion criteria. The review protocol was registered in PROSPERO (CRD420251083287). Methodological quality was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools. **Results:** A total of 276 records were identified, of which seven studies met the eligibility criteria—the included studies comprised six quantitative and one qualitative study conducted in mining and other high-risk industries. Across studies, safety leadership was consistently associated with improved safety compliance, safety participation, safety performance, and reduced unsafe behavior. Management commitment, safety communication with feedback, and safety training emerged as the most frequently reported leadership domains associated with positive safety outcomes. Several studies also identified psychological safety and employee engagement as potential mechanisms linking safety leadership to workers' safety behavior. **Conclusion:** The available evidence suggests that safety leadership plays an important role in promoting positive safety behaviors among workers in the mining sector. Leadership practices emphasizing management commitment, active safety communication, and safety training appear to be most consistently associated with improved safety outcomes. However, interpret these findings cautiously because of the limited number of included studies and variations in study characteristics.

Keywords: leadership; mining; occupational health; safety behavior; safety management

INTRODUCTION

The mining sector is one of the largest contributors to national economic revenue. In 2024, non-tax state revenue generated from the mining sector reached IDR 269.5 trillion, highlighting its strategic role in supporting national development [1]. When managed properly, this sector has the potential to significantly improve public welfare. However, despite its substantial economic contribution, the mining industry carries a higher risk of occupational accidents than other industrial sectors. Despite its substantial economic contribution, the mining industry also carries a high risk of occupational accidents compared

with other industrial sectors. According to data from the Indonesian Ministry of Energy and Mineral Resources, 217 mining accident incidents resulting in casualties were recorded in 2023, including 48 fatal incidents [2]. These statistics demonstrate that occupational injuries and fatalities remain a persistent challenge in the mining sector and reinforce the importance of preventive safety measures. Consequently, occupational safety remains a major public health concern for mining workers. This aligns with Heinrich's accident pyramid theory, which suggests that serious injuries and fatalities are often preceded by many unsafe acts, minor incidents, and near misses, emphasizing the critical role of workers' safety behavior in accident prevention [3].

Previous studies have consistently shown that human factors predominantly cause occupational accidents in the mining industry. Research conducted in Spain identified physical and mental factors as the primary contributors to mining accidents, indicating that accident prevention efforts should focus on behavioral change among workers [4]. Other studies report similar findings, highlighting unsafe behavior as a major determinant of accidents in high-risk industries [5]. However, the mining workforce is often composed of individuals from diverse social, cultural, and educational backgrounds, which can contribute to low levels of safety awareness and inconsistent safety behavior [6]. This complexity underscores the need for systematic, sustainable approaches that effectively promote safety behavior in mining environments.

Leadership plays a crucial role in shaping workers' safety behavior and safety culture, particularly in high-risk sectors such as mining. Operational supervisors and managerial personnel occupy strategic positions that enable them to influence workers' attitudes and behaviors toward safety. Leaders who demonstrate strong commitment to safety, engage in effective safety communication, and provide consistent support for safety practices have been shown to improve workers' safety compliance and participation. This leadership approach, commonly known as safety leadership, encompasses leadership safety behaviors such as safety management commitment, safety communication with feedback, safety training, safety policy, and safety incentives that promote positive safety performance among workers [7].

Numerous studies have examined the relationship between leadership and workplace safety outcomes. For example, a study among heavy equipment operators in East Kalimantan found that safety leadership significantly influenced the safety climate [8]. Similarly, research in the Saudi Arabian electrical construction industry demonstrated that effective leadership from supervisors reduced unsafe actions among workers [9]. Despite these findings, existing studies often focus on general leadership effects or safety climate, while comprehensive analyses of safety leadership domains within the mining sector remain limited.

Although several literature reviews on safety leadership have been published, most remain general in scope and do not address the mining sector specifically. Some studies primarily summarize conceptual definitions of safety leadership derived from previous research without examining the influence of specific leadership domains [10]. Others focus on unsafe behavior variables without emphasizing the role of safety leadership [5]. Given the high risk of occupational accidents and exposure to hazardous materials inherent to mining activities, in-depth research on safety leadership in this sector is urgently needed [11]. This indicates a clear research gap, the limited availability of systematic evidence synthesizing safety leadership domains and their influence on workers' safety behavior in the mining industry.

The novelty of this review lies in its sector-specific focus on the mining industry and its systematic identification of the safety leadership domains that most strongly influence workers' safety behavior. While previous reviews have discussed safety leadership in broader occupational settings or examined related safety outcomes, they have not systematically synthesized the relative influence of specific safety leadership domains on workers' safety behavior in mining workplaces. By addressing this gap, the review provides a more targeted evidence base for developing leadership interventions aimed at improving occupational safety performance in the mining industry.

Therefore, this study systematically synthesizes empirical research on safety leadership in the mining sector, emphasizing the identification of safety leadership domains that contribute to workers' safety behavior. The findings consolidate evidence to support the development of effective safety management strategies, strengthen occupational safety practices, and ultimately enhance productivity in the mining industry.

METHODS

Protocol, registration, and eligibility criteria

This review followed the PRISMA 2020 statement. To ensure transparency and methodological rigor, we registered the review protocol in the International Prospective Register of Systematic Reviews (PROSPERO) under registration number CRD420251083287.

We selected studies according to predefined inclusion and exclusion criteria. Inclusion criteria were: a) Original empirical studies examining the relationship between safety leadership and workers' safety behavior; b) Studies conducted in mining settings; c) Quantitative, qualitative, or mixed-method studies; d) Articles published in peer-reviewed journals; e) Articles published in English between 2015 and 2025; f) Full-text articles available for review.

Exclusion criteria were: a) Review articles, conference proceedings, editorials, commentaries, and book chapters; b) Studies conducted outside the mining sector; c) Studies that did not examine safety leadership or safety behavior; d) Articles without accessible full texts; e) Duplicate publications.

Information sources and search strategy

A systematic literature search was conducted between September and December 2025 using the PubMed, Scopus, and BioMed Central (BMC) databases. We identified additional studies by manually searching reference lists from eligible articles (snowballing). The search strategy was developed using the Population Intervention Outcome (PIO) framework as shown in Table 1.

Table 1. PIO framework

Component	Object	Keyword
Population	Mining workers	Mining employees
Intervention	Safety leadership	Safety leadership, leadership, and leadership commitment
Outcomes	Safety behavior	Safety behavior, safety compliance, safety participation, safety accident

The Boolean search syntax applied in PubMed, Scopus, and BioMed Central (BMC) was: ("mining employees" OR "mining workers" OR miners) AND ("safety leadership" OR leadership OR "leadership commitment") AND ("safety behavior" OR "safety compliance" OR "safety participation" OR "safety accident"). The search was limited to articles published between 2015 and 2025.

Study selection

All identified records were imported into a reference management software, and duplicates were removed. Two reviewers independently screened titles and abstracts against the eligibility criteria. Reviewers then assessed potentially relevant studies through full-text evaluation. Reviewers resolved discrepancies through discussion until consensus was reached. We documented the study selection process using the PRISMA 2020 flow diagram.

Data extraction

Data from the included studies were extracted using a standardized data extraction form to ensure consistency and accuracy. The extracted information included the author and year of publication, country where the study was conducted, study design, study population, safety leadership dimensions assessed, safety behavior outcomes measured, and the main findings reported in each study. Two reviewers independently extracted the data and resolved disagreements by consensus. The extracted data were subsequently used to facilitate comparison across studies and support the narrative synthesis of evidence regarding the influence of safety leadership on workers' safety behavior in the mining sector.

Quality assessment/risk of bias

The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Tools according to the design of each study [12]. Two reviewers independently conducted the appraisal, and any disagreements were resolved through discussion. Each study was evaluated across multiple methodological domains and categorized as having high, moderate, or low methodological quality based on the proportion of criteria fulfilled.

Data analysis

Because of heterogeneity in study designs, safety leadership dimensions, and outcome measures, we did not perform a meta-analysis. Instead, findings were synthesized narratively. The included studies were grouped according to the safety leadership dimensions investigated, and their reported associations with workers' safety behavior were summarized and compared. Particular attention focused on identifying leadership dimensions that consistently showed significant influences on safety compliance and safety participation.

RESULTS

The article identification process was conducted through searches in three databases, PubMed, Scopus, and BioMed Central (BMC), yielding a total of 276 articles. For this review, we defined the mining sector according to the standard industrial classification. It included industries engaged in extracting mineral resources, such as coal, metal ores, and other mining and quarrying activities. After duplicate removal, 17 articles were excluded, leaving 259 articles for title and abstract screening. During this screening stage, 189 articles were excluded because they did not align with the study objectives. Subsequently, full texts were

sought for 70 articles that passed the title and abstract screening. Of these, 28 articles could not be retrieved in full text, resulting in 42 articles assessed for eligibility through full-text review. At the eligibility assessment stage, 35 articles were excluded for non-mining population, non-relevant exposure, or non-relevant outcome. Consequently, seven articles met the inclusion criteria and were included in the systematic review. Figure 1 presents the article selection process. The methodological quality of all articles included in this review was assessed as good, therefore, all were included in the systematic review report. The results of the risk of bias assessment are presented in Table 2.

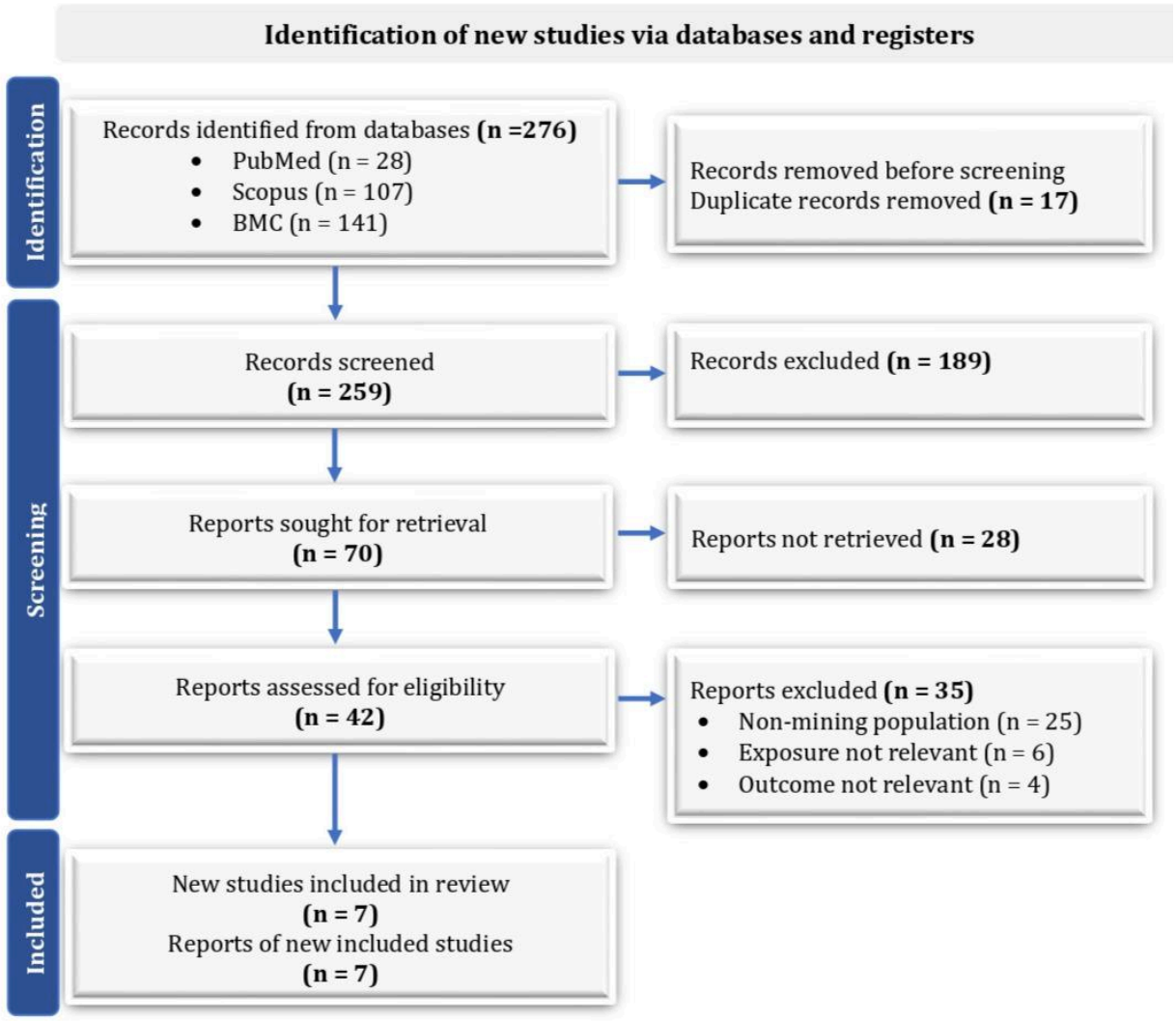


Figure 1. PRISMA flow diagram of the article selection process

Table 2. JBI critical appraisal checklist

No	Article	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1.	(Zhang et al., 2022) [7]	Y	Y	Y	Y	Y	Y	Y	Y	-	-
2.	(Niu & Liu, 2022) [13]	Y	Y	Y	Y	Y	Y	Y	Y	-	-
3.	(Cheng et al., 2020) [14]	Y	Y	Y	Y	Y	Y	N	Y	-	-
4.	(Zhu et al., 2020) [15]	Y	Y	Y	Y	Y	Y	Y	Y	-	-
5.	(Joon et al., 2025) [16]	Y	Y	Y	Y	Y	Y	Y	N	-	-
6.	(Quansah et al., 2023) [17]	Y	Y	Y	Y	Y	Y	Y	Y	-	-
7.	(Haas, 2020)* [18]	Y	Y	Y	Y	Y	Y	Y	Y	U	U

Note: Y= Yes, N= No, U= Unclear. Studies 1–5 were assessed using the *Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies* (8 items). * Whereas Study 7 was assessed using the *JBI Critical Appraisal Checklist for Qualitative Research* (10 items).

Table 3. Summary of included studies and key findings

Authors, year, country	Study design and sample	Measurement tools	Safety leadership domain	Safety behavior outcome	Key findings	JBI quality
Zhang et al., 2022, China [7]	Cross-sectional study (n=305 mining workers)	Leadership Safety Behavior Scale, Safety Performance Scale	Safety management commitment, safety communication with feedback, safety policy, safety incentives, safety training	Safety compliance, safety participation	Safety training showed the strongest effect on safety compliance (β=0.504) and safety participation (β=0.706). Safety incentives significantly influenced safety compliance (β=0.480) and safety participation (β=0.496). Safety communication with feedback significantly influenced safety compliance (β=0.377).	High
Niu & Liu, 2022, China [13]	Cross-sectional study (n=1,446 mining workers)	Leadership Safety Commitment Scale, Safety Participation Behavior Scale	Leadership safety commitment	Safety participation behavior	Leadership safety commitment significantly improved miners' safety participation behavior through psychological safety.	High
Cheng et al., 2020, China [14]	Cross-sectional study (n=428 mining workers)	Safety Leadership Questionnaire, Safety Behavior Questionnaire	Safety training, safety incentives, safety communication with feedback, safety management commitment	Occupational safety behavior, reduction of unsafe behavior	Negative leadership behavior was negatively associated with miners' safety behavior. Safety incentives demonstrated the strongest positive influence on safety behavior.	High
Zhu et al., 2020, Ghana [15]	Cross-sectional study (n=805 mining workers)	Safety Leadership Scale, Safety Performance Scale.	Safety coaching	Safety compliance, safety performance	Safety coaching had a moderate positive effect on safety compliance and safety performance among mining workers.	High
Joon et al., 2025, Malaysia [16]	Cross-sectional survey study using PLS-SEM (n=304 workers in the oil and gas industry)	Sustainable Leadership Scale (Avery & Bergsteiner), Utrecht Work Engagement Scale (UWES), Employee Performance Scale	Sustainable leadership, ethical leadership practices, leadership commitment	Indirect safety-related behavior (safety protocol adherence, safer operational practices)	Sustainable leadership significantly influenced employee engagement (t = 13.664, p <0 .001) and employee performance (t = 7.051, p <0 .001). Employee engagement significantly mediated the relationship (t = 2.962, p = 0.003). Although safety behavior was not directly measured, employee engagement was linked to adherence to safety protocols and safer operational practices in a high-risk industry.	High
Quansah et al., 2023, Ghana [17]	Quantitative study, multi-wave survey design (3 waves); n = 539 contract mineworkers	Safety Leadership Scale (Zohar, 2000), Work Engagement Scale (UWES), Psychological Safety Scale, Safety Performance Scale	Safety leadership (safety coaching, caring, monitoring, communication, enforcement of safety rules)	Safety compliance, safety participation	Safety leadership significantly improved safety compliance (β=0.440, p<0.001) and safety participation (β=0.417, p<0.001). Employee engagement (vigor, dedication, absorption) mediated the relationship between safety leadership and safety performance. Psychological safety strengthened the effect of employee engagement on safety behavior.	High
Haas, 2020, United States of America [18]	A qualitative study (n=20 supervisors and 48 mining workers)	Semi-structured interviews, Focus group discussions	Supervisory support, safety communication, supervisor presence	Health and safety performance, safety compliance	Communicative and informative supervisory support, together with supervisors' direct presence, was perceived as more effective in improving safety performance than incentive-based strategies.	Moderate

Table 3 summarizes the included studies, including study characteristics, measurement tools, safety leadership domains, safety behavior outcomes, methodological quality, and key findings. Across the six studies, researchers examined safety leadership through several dimensions, including management commitment, safety communication, safety training, safety incentives, safety coaching, sustainable leadership, and supervisory support. Safety behavior outcomes were most commonly measured as safety compliance, safety participation, and safety performance. Despite differences in study design and context, the findings consistently suggest that leadership-related factors are associated with improved safety-related outcomes among workers in high-risk industries, particularly mining and oil and gas operations.

Across the seven included studies, six quantitative studies and one qualitative study examined the relationship between safety leadership and safety-related outcomes. All included studies reported positive associations between safety leadership and safety outcomes. The most commonly assessed outcomes were safety compliance (n=3), safety participation (n=4), safety performance (n=3), and unsafe behavior reduction (n=1). Studies identified safety training, safety incentives, safety communication, safety coaching, leadership commitment, sustainable leadership, and supervisory support as key safety leadership dimensions. Collectively, the evidence demonstrated a consistent association between leadership-related practices and improvements in worker safety behaviors and performance in mining and other high-risk industries.

DISCUSSION

This review's findings indicate that safety leadership is consistently associated with positive safety-related outcomes among workers in mining and other high-risk industries [7,13–18]. Across the included studies, leadership-related practices were consistently associated with improved safety outcomes despite variations in leadership constructs and outcome measures. Management commitment, safety communication with feedback, safety training, safety coaching, leadership commitment, sustainable leadership, and supervisory support were consistently linked to improved safety compliance, safety participation, safety performance, or reduced unsafe behavior [7,13–18]. Notably, management commitment, safety communication, and safety training emerged as the most frequently reported determinants of worker safety behavior, suggesting that effective safety leadership extends beyond managerial authority and serves as an important mechanism for communicating safety expectations, reinforcing organizational safety norms, and encouraging safe work practices among workers [7,14,15,17,18].

The relationship between safety leadership and safety behavior may be explained by the Theory of Planned Behavior (TPB), which posits that behavior is influenced by attitudes toward the behavior, subjective norms, and perceived behavioral control [19]. In mining operations, management commitment and safety communication may strengthen workers' perceptions that safety is an organizational priority, shaping subjective norms around safe work practices. Studies in this review support this explanation, identifying management commitment and safety communication as important determinants of safety compliance, safety participation, and safety performance [7,14,17,18]. Safety training may also improve perceived behavioral control by increasing workers' confidence and competence in recognizing hazards and implementing safe procedures. Consistent with this perspective, safety training was repeatedly associated with improved safety compliance and safety participation and demonstrated one of the strongest effects on worker safety behavior among the reviewed studies [7,14]. Consequently, workers may be more willing to comply with safety regulations and actively participate in workplace safety initiatives. Overall, the available evidence suggests that safety leadership may support positive safety behavior by influencing safety-related attitudes, organizational norms, and workers' perceived ability to perform tasks safely [7,13–18,19].

The findings may also be interpreted through Social Learning Theory (SLT), which suggests that individuals acquire behaviors through observation, modeling, and interaction with influential role models [20]. In mining environments, supervisors and managers serve as visible examples of organizational expectations regarding safety. Leadership dimensions identified across the reviewed studies, particularly supervisory support, safety communication, safety coaching, management commitment, and leadership commitment, may influence workers by demonstrating expected safety behaviors and reinforcing safety norms through continuous interaction and feedback [7,13,15,17,18]. Workers who perceive consistent leadership engagement in safety activities may be more inclined to adopt similar behaviors, which may improve adherence to safety procedures and increase participation in safety-related programs. This explanation is supported by Quansah et al., who reported positive effects of safety leadership on safety

compliance and safety participation, and by Niu and Liu, who found that leadership commitment enhanced safety participation behavior among miners [13,17].

Furthermore, Haas's qualitative study highlighted communicative supervisory support and direct supervisor presence as important contributors to improved safety performance, suggesting that visible leadership behaviors can influence workers' safety practices through observation and social interaction [18]. Collectively, these findings support the proposition that safety leadership functions not only through formal safety policies but also through behavioral modeling that encourages workers to adopt and maintain safe work practices [7,13–18].

Several studies identified psychological safety and employee engagement as important mechanisms linking safety leadership to positive safety outcomes [13,17]. These findings suggest that safety leadership influences workers not only through direct supervision but also through psychosocial processes that encourage trust, confidence, and active participation in safety activities. Perceived leadership support may encourage employees to report hazards, communicate safety concerns, and engage in proactive safety behaviors, which may contribute to a stronger organizational safety culture.

The findings also suggest potential benefits for workers' psychosocial well-being. Several studies highlighted the importance of psychological safety, employee engagement, supportive communication, and supervisory support in shaping safety-related behaviors [13,17,18]. These leadership practices may help create a work environment in which workers feel valued, supported, and comfortable expressing safety concerns without fear of negative consequences. These conditions may strengthen trust between employees and management, enhance worker engagement in safety activities, and contribute to a healthier, more positive organizational safety culture. Ultimately, improvements in psychosocial well-being may support both worker health and sustainable occupational safety performance.

Although all included studies reported positive associations between safety leadership and safety outcomes, the evidence base showed considerable heterogeneity [7,13–18]. Differences were found in geographical settings, industrial contexts, study designs, leadership constructs, and outcome measures. The included studies were conducted in China, Ghana, Malaysia, and the United States and involved workers from mining and other high-risk industries [7,13–18]. Safety leadership was assessed across dimensions including management commitment, communication, training, coaching, incentives, leadership commitment, sustainable leadership, and supervisory support [7,13–18], while outcomes ranged from safety compliance and participation to safety performance and reductions in unsafe behavior [7,13–18].

Furthermore, most of the included studies employed cross-sectional designs [7,13,15–18], which limit the ability to establish temporal relationships and causal inferences between safety leadership and safety outcomes. Several studies also relied on self-reported measures, which may be subject to reporting bias and common method bias. Collectively, these methodological differences may influence the magnitude and underlying mechanisms of the reported associations and limit direct comparison across studies. Future research should prioritize longitudinal and intervention-based studies, utilize more standardized measures of safety leadership and safety outcomes, and further explore potential mediating mechanisms such as psychological safety and employee engagement to strengthen the evidence base.

Beyond organizational performance, the findings have important occupational and public health implications. Leadership practices that enhance safety compliance, safety participation, and safety performance may contribute to reducing occupational injuries, disabilities, and fatal accidents in the mining sector [7,13–18]. Improved safety outcomes may also reduce the economic burden of workplace accidents, including healthcare expenditures, compensation costs, productivity losses, operational disruptions, and broader societal costs related to occupational injuries and disabilities. This is particularly important because occupational injuries and work-related illnesses continue to represent a significant global public health and economic challenge [21]. Therefore, strengthening safety leadership may contribute not only to improved organizational safety performance but also to broader occupational health and public health objectives [7,13–18].

From a practical perspective, OHS practitioners and mining management should prioritize leadership-based interventions within safety management systems. Particular attention should be given to strengthening management commitment, safety communication with feedback, and safety training, as these dimensions emerged most consistently across the reviewed studies [7,14,17,18]. Routine safety management should incorporate supervisory coaching and leadership support to drive worker participation and positive safety behaviors [13,15,17,18]. Implementing these leadership practices within existing OHS programs may strengthen safety culture and improve overall workplace safety performance [7,13–18].

CONCLUSION

This systematic review demonstrates that safety leadership is consistently associated with positive safety-related outcomes among workers in the mining sector and other high-risk industries. Management commitment, safety communication with feedback, and safety training emerged as the safety leadership dimensions most consistently linked to improvements in safety compliance, safety participation, safety performance, and reductions in unsafe behavior. The findings also suggest that psychological safety and employee engagement may serve as important mechanisms through which safety leadership influences workers' safety behavior. These results highlight the importance of integrating leadership-based approaches into occupational safety and health management systems to strengthen safety culture and improve workplace safety performance. Future research should employ longitudinal and intervention-based designs and adopt more standardized measures to clarify the causal pathways between safety leadership and safety-related outcomes.

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Authors' contributions
R.: Conceptualization, Investigation, Literature search, Study selection, Data extraction, Quality appraisal, Formal analysis, Writing - original draft. P.L.K.: Literature screening, Data extraction, Writing - original draft. A.P.P.: Supervision, Methodology, Writing - review and editing. B.S. and Y.H.E.S.: Expert consultation, Interpretation of findings, Writing - review and editing. All authors read and approved the final manuscript.

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Data availability
The data supporting the findings of this study are available within the article and its supplementary materials. All included studies are publicly available through the respective databases and publishers.

Ethics statement
Ethical approval was not required because this study involved analyzing previously published literature and did not include human participants or identifiable personal data.

Conflicts of interest
The author declares no conflicts of interest related to this study.

Use of artificial intelligence (AI)
During manuscript preparation, the authors used Copilot to assist with paraphrasing the text. After using this tool, the authors reviewed and edited the content as needed and took full responsibility for the publication's content.

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