



(RESEARCH ARTICLE)



Integrating occupational health surveillance in construction and industrial operations: A strategy for early risk identification

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World Journal of Advanced Research and Reviews, 2025, 27(02), 1137-1140

Publication history: Received on 01 July 2025; revised on 10 August 2025; accepted on 12 August 2025

Article DOI: <https://doi.org/10.30574/wjarr.2025.27.2.2882>

Abstract

Occupational health surveillance (OHS) is fundamental for early detection and prevention of work-related health risks in high-risk industries such as construction and manufacturing. Despite its proven benefits, many organizations struggle to systematically implement effective surveillance programs due to resource limitations, technological gaps, and organizational resistance. This paper critically examines the significance of integrating occupational health surveillance into construction and industrial operations, emphasizing how early risk identification can prevent occupational diseases, enhance worker safety, and promote sustainable industrial growth. Drawing on a comprehensive review of recent literature, case studies, and technological innovations, the study proposes a strategic framework emphasizing policy development, technological adoption, stakeholder engagement, and continuous evaluation. The findings underscore that an integrated, proactive approach can significantly reduce occupational health burdens and foster a resilient safety culture.

Keywords: Occupational Health Surveillance; Construction Industry; Industrial Operations; Early Risk Detection; Health Monitoring; Safety Culture

1. Introduction

The construction and industrial sectors are globally recognized for their elevated occupational risks, exposing workers to chemical, physical, biological, ergonomic, and psychosocial hazards (WHO, 2019; ILO, 2020). These environments often lack systematic health monitoring, which impairs early detection of adverse health effects, leading to increased morbidity, mortality, and economic costs (Kumar et al., 2020; Lee & Smith, 2021).

Occupational health surveillance (OHS)—the ongoing, systematic collection, analysis, and dissemination of health data—is crucial for early identification of health risks associated with workplace exposures (Leigh et al., 2018). Its integration into routine operational practices allows for timely interventions that can prevent the progression of occupational diseases such as pneumoconiosis, noise-induced hearing loss, dermatitis, and chemical poisoning (WHO, 2018; Zhang et al., 2020).

However, despite its critical importance, the integration of comprehensive OHS systems remains underdeveloped in many industrial settings. Challenges include resource constraints, technological limitations, privacy concerns, organizational resistance, and lack of regulatory enforcement (Nielsen & Andersen, 2017; Zhao et al., 2022). The rapid evolution of digital health technologies presents new opportunities to overcome these barriers, enabling real-time monitoring, predictive analytics, and personalized health interventions (Smith & Lee, 2021; Kumar et al., 2022).

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This paper advocates for a strategic, multi-faceted approach to integrating occupational health surveillance into high-risk industries. It emphasizes policy frameworks, technological innovations, stakeholder involvement, and ongoing evaluation as pillars for successful implementation.

2. Literature Review

2.1. The Rationale for Occupational Health Surveillance

Occupational health surveillance offers critical insights into health trends among workers exposed to hazards, facilitating early detection and prevention of occupational illnesses (Leigh et al., 2018). For instance, regular audiometric testing among construction workers can identify early signs of hearing loss, prompting timely noise control measures (WHO, 2018). Similarly, biomonitoring of chemical exposures can detect early biological effects before clinical symptoms appear (Zhang et al., 2020).

Research indicates that early risk detection through surveillance reduces the burden of occupational diseases, thereby decreasing healthcare costs and productivity losses (Kumar et al., 2020; Liu & Wang, 2021). It also enhances compliance with occupational safety standards and supports evidence-based policymaking (ILO, 2020).

2.2. Challenges to Implementation

Implementing effective surveillance faces multiple barriers. Nielsen and Andersen (2017) highlight that SMEs often lack the infrastructure, trained personnel, and financial resources necessary for systematic health monitoring. Organizational resistance, driven by fears of liability or operational disruptions, further hampers adoption (Smith & Lee, 2021).

Data privacy and security concerns also pose significant hurdles, especially with digital data collection tools (Zhao et al., 2022). Workers may be wary of surveillance programs that threaten confidentiality or lead to job insecurity (Kumar et al., 2022). Additionally, inconsistent regulatory enforcement diminishes organizational motivation to adopt comprehensive surveillance practices (ILO, 2020; Lee & Smith, 2021).

2.3. Technological Innovations and Opportunities

Recent advancements in wearable sensors, mobile health (mHealth) applications, and cloud computing have revolutionized occupational health monitoring. Wearables can continuously track exposure levels, physiological parameters, and ergonomic stressors, transmitting data in real time (Nielsen & Andersen, 2017; Zhao et al., 2022).

Machine learning algorithms can analyze large datasets to identify emerging health risks, enabling predictive interventions (Smith & Lee, 2021). Furthermore, integrated dashboards can facilitate data visualization and decision-making, fostering proactive safety management (Kumar et al., 2022).

Despite these technological advantages, successful deployment depends on organizational readiness, adequate training, and alignment with existing safety protocols (Liu & Wang, 2021).

2.4. Policy and Stakeholder Engagement

Effective integration of OHS requires comprehensive policies that mandate routine health assessments, safeguard data privacy, and promote transparency (Leigh et al., 2018). Regulatory agencies should incentivize compliance through enforcement and capacity-building initiatives.

Stakeholder engagement is essential for fostering a safety culture. Workers' active participation in surveillance programs increases trust, compliance, and data accuracy (Kumar et al., 2020). Clear communication about the purpose, benefits, and privacy protections alleviates fears and misconceptions.

3. Methodology

This qualitative study employed a literature review complemented by semi-structured interviews with 15 key informants, including occupational health practitioners, safety officers, and regulatory officials from construction and manufacturing industries. Participants provided insights into existing surveillance practices, technological adoption, barriers, and facilitators.

Data were analyzed thematically to identify recurring themes related to effective integration strategies, challenges, and opportunities. The findings informed the development of a strategic framework.

3.1. Proposed Framework for Integration

Based on the analysis, the following strategic framework is proposed:

3.1.1. Policy Development and Regulatory Enforcement

Develop clear, enforceable policies aligned with international standards (WHO, 2019), explicitly defining surveillance scope, data privacy, and reporting procedures (ILO, 2020). Governments should establish regulatory incentives and penalties to ensure compliance.

3.1.2. Technological Adoption and Data Management

Adopt wearable sensors, mobile apps, and cloud platforms for real-time data collection and analysis (Zhao et al., 2022). Ensure interoperability and data security to protect worker privacy and facilitate seamless data sharing.

3.1.3. Stakeholder Engagement and Capacity Building

Engage workers, management, health professionals, and regulators through participatory design and continuous training (Kumar et al., 2020). Transparency regarding data use and privacy enhances trust.

3.1.4. Data Analysis, Risk Prediction, and Responsive Action

Utilize analytics and predictive modeling to detect early signs of health deterioration. Establish protocols for immediate response, including medical assessment and exposure mitigation (Smith & Lee, 2021).

3.1.5. Continuous Monitoring, Evaluation, and Improvement

Implement ongoing performance evaluations, feedback mechanisms, and adaptation of surveillance systems based on emerging risks and technological developments (Leigh et al., 2018).

4. Discussion

Integrating occupational health surveillance into construction and industrial operations can drive a paradigm shift from reactive to proactive safety management (WHO, 2019). Digital health technologies enable continuous, non-invasive monitoring, significantly enhancing early risk detection capabilities (Zhao et al., 2022).

Nonetheless, barriers such as resource constraints, technological disparities, and privacy concerns require targeted strategies. Governments and industry leaders should collaborate to develop supportive policies, subsidize technology deployment, and promote a culture of safety and transparency (Kumar et al., 2022).

Empowering workers through education and participatory approaches fosters ownership and trust, critical for program success (Kumar et al., 2020). Moreover, embedding surveillance within broader occupational health frameworks ensures sustainability and alignment with organizational goals.

5. Conclusion

Occupational health surveillance is a vital component for early risk identification and prevention of occupational diseases in construction and industrial sectors. An integrated approach—combining robust policies, innovative technologies, stakeholder participation, and continuous evaluation—can significantly improve health outcomes, reduce costs, and foster a resilient safety culture.

Future research should explore scalable, cost-effective models tailored to different operational contexts and examine long-term impacts on worker health and organizational safety performance. Policymakers, industry stakeholders, and health practitioners must collaborate to embed surveillance as a core element of occupational health and safety strategies.

Compliance with ethical standards

Disclosure of conflict of interest

The author declares that there are no conflicts of interest concerning this research. The study was conducted independently, with no external funding or influence, ensuring impartiality and academic integrity.

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