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Perspective

Establishing Effective Dust Exposure Limits in Nepal: A Global Imperative for Worker Safety and Health

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ABSTRACT

To highlight the importance of implementing stringent dust exposure limits in Nepal and to propose a framework for aligning with international best practices. A comparative analysis of existing PELs for respirable crystalline silica and other dust types across several countries, including the United States, Australia, India, China, and Singapore, was conducted. The analysis focused on enforcement mechanisms, health outcomes, and regulatory frameworks. The findings reveal significant variations in PELs, with developed countries like the United States and Australia adopting stricter limits (0.050 mg/m^3) compared to India (0.150 mg/m^3) and China (0.700 mg/m^3). Nepal's proposed PEL of 0.050 mg/m^3 aligns with international standards but requires robust enforcement mechanisms and comprehensive monitoring strategies. Establishing effective dust exposure limits is a moral and regulatory imperative for Nepal to protect worker health. By adopting stringent PELs and enhancing regulatory frameworks, Nepal can significantly reduce the burden of dust-related diseases and promote a healthier workforce. Collaboration with international organizations and learning from the experiences of other countries will be crucial for successful implementation.

Keywords: dust exposure, respirable crystalline silica, permissible exposure limits, occupational health, Nepal, international standards.

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Introduction

Exposure to particulate matter (PM), particularly respirable crystalline silica (RCS), is a pressing public health concern that affects populations worldwide. The adverse health effects associated with dust exposure, including respiratory diseases, cardiovascular problems, and increased mortality rates, underscore the necessity of establishing permissible exposure limits (PELs) for dust in every country, including Nepal. Let's consider awareness in following section.

Health Impacts of Dust Exposure

Dust exposure is linked to numerous health problems, particularly respiratory conditions such as silicosis, chronic obstructive pulmonary disease (COPD), and lung cancer. In India, workers in stone-crushing industries are exposed to high levels of particulate matter, which has been shown to significantly increase the risk of respiratory diseases (Semple et al., 2008). The study found that workers at stone-crushing sites faced considerable exposure to PM, leading to serious health implications. Similarly, in Nepal, individuals involved in domestic work are exposed to average respirable dust concentrations of approximately 1400 µg/m³, which is significantly above the recommended limits (Shrestha et al., 2006; Dhimal M. , Karki KB, Aryal KK, Dhakal P, Joshi HD, Pande AR, Puri S, Gyawali P, Mahotra NB,). The high levels of exposure in both countries highlight the urgent need for standardized exposure limits to protect worker health.

Current Exposure Levels and Standards

Globally, the levels of particulate matter exposure vary significantly, with many countries reporting hazardous conditions. For instance, a study in Bangladesh revealed that poor families are particularly vulnerable to indoor air pollution, which is exacerbated by the use of biomass fuels for cooking and heating (Dasgupta et al., 2006). The findings suggest that indoor air quality is a critical issue that needs to be addressed through the establishment of effective dust exposure limits. In Sweden, research on fine particles (PM2.5 and PM1) indicated that exposure levels differ between personal, indoor, and outdoor environments, emphasizing the need for comprehensive monitoring and regulation (Johannesson et al., 2007).

Regulatory Frameworks and Enforcement Challenges

While some countries have established PELs for dust exposure, enforcement remains a significant challenge. For example, India has set a PEL of 0.15 mg/m³ for respirable crystalline silica; however, enforcement is inconsistent, leading to continued high exposure levels among workers (NCBI, 2022). In contrast, Nepal currently lacks formal PELs for dust exposure, which places its workforce at even greater risk. The absence of regulatory frameworks in Nepal makes it imperative to establish clear PELs that align with international standards to protect workers effectively.

Vulnerable Populations and Occupational Health

Certain populations, particularly those engaged in high-risk occupations and low-income families, are disproportionately affected by dust exposure. A review article highlighted the importance of assessing exposure in epidemiological studies, using silica dust as an example (Dahmann et al., 2008). In Nepal, the high levels of dust exposure among domestic workers, primarily women, underscore the need to prioritize the health of vulnerable populations. Establishing dust exposure limits is critical to ensuring that these groups receive adequate protection from the adverse effects of dust exposure.

Importance of Indoor Air Quality

Indoor air quality is a significant concern globally, with many countries facing challenges related to high levels of particulate matter. A review on indoor aerosols emphasized the need for a comprehensive approach to exposure assessment and risk management (Morawska et al., 2013). Improving indoor air quality through the implementation of effective dust control measures and the adoption of cleaner technologies can significantly reduce health risks associated with particulate matter exposure. In Nepal, where many households rely on biomass fuels, establishing dust exposure limits is essential for improving indoor air quality and protecting the health of families.

Rational for the Editorial

The need for dust exposure limits standards is a global imperative, with countries facing varying challenges in establishing and enforcing such limits. By learning from the experiences of other nations and collaborating to share best practices, countries can work towards protecting the health of their populations and ensuring a safer and healthier future for all. Establishing PELs for dust exposure in every country, including Nepal, is crucial for safeguarding public health and promoting occupational safety. Nepal's industrial sector has seen significant growth, particularly in construction, mining, and manufacturing. However, the country lacks comprehensive regulations regarding occupational exposure limits for dust, particularly respirable crystalline silica (RCS) and other hazardous particulates. According to a systematic review, countries without established limits for workplace dust exposure face higher risks of occupational diseases (Anlimah, F., Gopaldasani, V., MacPhail, C., & Davies, B. ,2023). The absence of such regulations in Nepal poses a risk to workers' health, as many are exposed to harmful dust levels without adequate protection. Establishing dust exposure limits in Nepal is essential for safeguarding public health and ensuring worker safety, particularly in industries prone to high dust levels. As highlighted by Mishra et al. (2019) and Mishra (2024), effective safety standards and preventive measures are crucial for mitigating risks associated with dust exposure, similar to the implementation of fire safety standards in commercial buildings (Mishra & Shrestha, 2017). Furthermore, the development of comprehensive building regulations in Nepal emphasizes the importance of creating a structured approach to managing environmental hazards, including dust, to protect vulnerable populations (Mishra, 2019).Further highlighted the journal offerings.

Objective

This editorial aims to highlight the importance of implementing stringent dust exposure limits in Nepal and to propose a framework for aligning with international best practices along with highlights of the issue.

Methodology

A comprehensive literature review was conducted to examine existing PELs for dust exposure in developed and developing countries, focusing on the United States, Australia, India, and China. The review included an analysis of regulatory frameworks, enforcement mechanisms, and public health priorities that influence the establishment and implementation of these limits. Additionally, the potential health risks associated with dust exposure below recommended standards were assessed to determine appropriate PEL recommendations for Nepal.

Results and Discussion

The comparison table 1 that highlights the countries based on their permissible exposure limits (PELs) for respirable crystalline silica (RCS) and other dust types.

Specific Comparison with India

Health Outcomes and Disease Prevalence

India has reported significant cases of silicosis and other dust-related diseases, particularly in high-risk industries such as mining and construction. A study indicated that 12.3% of workers in sandstone mines had radiographic findings compatible with silicosis, with many exposures recorded below the Indian PEL (NCBI, 2022). This suggests that the current PEL in India may not be adequately protective, leading to high disease prevalence.

In Nepal, the situation is similarly concerning, with average respirable dust concentrations in rural homes reaching approximately 1400 µg/m³ (1.4 mg/m³), which is significantly higher than both the Indian PEL and the UK limit (Shrestha et al., 2006; Dhimal M. , Karki KB, Aryal KK, Dhakal P, Joshi HD, Pande AR, Puri S, Gyawali P, Mahotra NB,).

The high indoor dust levels, particularly affecting women engaged in domestic work, highlight the urgent need for stricter exposure limits to protect vulnerable populations.

Regulatory Enforcement and Infrastructure

India faces challenges in enforcing its occupational health regulations due to limited resources and regulatory oversight, resulting in ongoing high exposure levels among workers (NCBI, 2022). Nepal, on the other hand, currently lacks established PELs for dust exposure, making it critical to set a more protective limit from the outset. Adopting a higher standard, such as 0.050 mg/m³, would provide a stronger foundation for future regulatory efforts and enforcement mechanisms.

Alignment with International Standards

International organizations, including the World Health Organization (WHO) and the Occupational Safety and Health Administration (OSHA) in the United States, recommend a PEL of 0.050 mg/m³ for respirable crystalline silica (OSHA, 2016; WHO, 2021). Aligning Nepal's standards with these international benchmarks would not only enhance worker protection but also improve the country's standing in global occupational health and safety practices.

Table 1

Comparison of Permissible Exposure Limits (PELs) Across Countries

Country	Permissible Exposure Limit (PEL)	Notes
United States	0.050 mg/m³	Legally binding; strong enforcement mechanisms (OSHA, 2016).
Australia	0.050 mg/m³	Emphasizes ongoing monitoring and compliance (Safe Work Australia, 2019).
India	0.150 mg/m³	Higher limit; significant cases of silicosis reported, indicating inadequacy of current PEL (NCBI, 2022).
China	0.700 mg/m³	Enforcement inconsistent; higher exposure levels reported due to regulatory challenges (NCBI, 2022).
Singapore	0.1 mg/m³	Strict regulations with a focus on industrial safety (Singapore Ministry of Manpower, 2020).
Japan	0.1 mg/m³	Comprehensive guidelines for occupational health and safety (Japan Ministry of Health, Labour and Welfare, 2021).
South Korea	0.1 mg/m³	Strong emphasis on workplace safety and health regulations (KOSHA, 2020).

Additional Note.

1. Dust Type: Respirable Crystalline Silica,
2. Time-Weighted Average (TWA):8 hours

3 Singapore, Japan and South Korea: The permissible exposure limit for respirable crystalline silica is set at 0.1 mg/m³, reflecting the country's commitment to maintaining high occupational health standards with comprehensive guidelines for occupational health and safety, demonstrating a strong emphasis on workplace safety and health regulations.

Economic Considerations

Establishing a lower PEL for Nepal can lead to long-term economic benefits by reducing healthcare costs associated with dust-related illnesses and improving worker productivity. By adopting a more protective standard, Nepal can prevent the economic burden of occupational diseases, which is particularly important for a developing country striving for sustainable growth.

Proposed Dust standard for Nepal

Given the significant health risks associated with dust exposure and the inadequacies of current standards, it is imperative for the government of Nepal to establish a permissible exposure limit (PEL) of 0.050 mg/m³ for respirable crystalline silica. This recommendation is grounded in several compelling justifications. First, a PEL of 0.050 mg/m³ would provide enhanced protection for workers, significantly reducing the risk of developing respiratory diseases, including silicosis, which is prevalent in high-dust environments (OSHA, 2016). Furthermore, aligning with international standards would bolster Nepal's credibility in occupational health and safety, potentially attracting foreign investment and improving working conditions across various sectors (Safe Work Australia, 2019).

Additionally, implementing such a standard would create a proactive regulatory framework that prioritizes worker health and safety, facilitating better enforcement and compliance. This is particularly crucial for vulnerable populations, such as women engaged in domestic work, who are disproportionately affected by high dust exposure levels (Shrestha et al., 2006; Dhimal M. , Karki KB, Aryal KK, Dhakal P, Joshi HD, Pande AR, Puri S, Gyawali P, Mahotra NB,). Moreover, protecting worker health through established PELs can lead to increased productivity and reduced healthcare costs, ultimately contributing to overall economic growth (WHO, 2021). Establishing a clear PEL would also provide a foundation for developing a robust regulatory framework that includes necessary monitoring and enforcement mechanisms, which are currently lacking in Nepal (NCBI, 2022). Finally, the implementation of a PEL would necessitate public awareness and training programs to educate employers and workers about the risks associated with dust exposure and the importance of compliance with safety standards. By taking these steps, Nepal can significantly improve the health and safety of its workforce, ensuring a healthier future for all its citizens.

Monitoring Dust Levels in Nepal

To effectively monitor particulate matter concentrations in Nepalese workplaces and homes, a combination of gravimetric and photometric methods should be employed:

1. **Gravimetric methods:** Collect dust samples on filters and measure the mass of collected particles. This method provides accurate measurements but is time-consuming and requires laboratory analysis (Anlimah, F., Gopaldasani, V., MacPhail, C., & Davies, B. (2023).
2. **Photometric methods:** Use light-scattering techniques to measure real-time dust concentrations. Photometric devices, such as the SidePak Personal Aerosol Monitor and DustTrak, have been found effective for continuous monitoring in Nepal (Kurmi, O. P., Semple, S., Steiner, M., Henderson, G. D., & Ayres, J. G. 2008). However, calibration factors of 0.48-0.51 for SidePak and 0.31-0.35 for DustTrak are required to account for the particle size and density of biomass smoke in rural areas.

To ensure comprehensive monitoring, it is recommended to establish a network of monitoring stations in high-risk areas across Nepal. These stations should be equipped with both gravimetric and photometric devices to provide real-time data on dust exposure levels and inform decision-making processes.

Conduct Regular Health Assessments in Nepal

Regular health screenings for workers in high-exposure industries are essential for monitoring respiratory health and detecting early signs of dust-related diseases. In the Nepalese context, these assessments should include:

1. **Respiratory Function Tests:** Measure lung capacity and airflow to identify any changes or impairments.
2. **Chest Radiographs:** Detect early signs of dust-related lung diseases, such as silicosis or pneumoconiosis, which are prevalent among workers in industries like brick kilns and carpet factories (Ghimire, 2014).

Medical history and physical examinations: Assess symptoms and risk factors related to dust exposure, particularly among vulnerable populations like women engaged in domestic work (Shrestha et al., 2006; Dhimal M. , Karki KB, Aryal KK, Dhakal P, Joshi HD, Pande AR, Puri S, Gyawali P, Mahotra NB,).

By collecting data on health outcomes related to dust exposure, employers and policymakers in Nepal can make informed decisions to improve safety regulations and protect worker health.

Research and Data Collection in Nepal

Conducting research studies is crucial for assessing the effectiveness of various dust control measures and understanding the impact of exposure on health outcomes in different Nepalese populations. Researchers should focus on:

Evaluating the effectiveness of engineering controls: Assess the impact of improved ventilation systems, dust suppression techniques, and alternative fuel sources on reducing dust exposure levels in industries like brick kilns and carpet factories.

1. **Investigating health outcomes in high-risk populations:** Study the effects of dust exposure on domestic workers, brick kiln workers, and other vulnerable groups to identify specific risk factors and develop targeted interventions.
2. **Collaborating with academic institutions and international organizations:** Enhance research capacity and data collection efforts by partnering with universities, research centers, and global health organizations, such as the International Labour Organization (ILO) and the World Health Organization (WHO).

Control Strategies in Nepal

Implementing effective dust control measures is essential for reducing worker exposure and ensuring compliance with safety regulations in Nepal. Key strategies include:

1. **Engineering Controls:** Promote the use of improved ventilation systems, dust suppression techniques (e.g., water spraying), and the use of flued stoves to reduce indoor dust levels, particularly in rural households relying on biomass fuels (Kurmi, O. P., Semple, S., Steiner, M., Henderson, G. D., & Ayres, J. G. 2008).
2. **Cleaner fuel Alternatives:** Encourage the adoption of cleaner fuel sources, such as liquefied petroleum gas (LPG) or electricity, to minimize biomass smoke exposure in rural households.
3. **Personal Protective Equipment (PPE):** Ensure that workers have access to appropriate PPE, such as masks and respirators, particularly in high-risk industries like construction and mining. Train workers on the proper use and maintenance of PPE to maximize its effectiveness.
4. **Legislation and Enforcement:** Enforce existing labor laws related to occupational health and safety, ensuring compliance with dust exposure limits and safety regulations. Establish penalties for non-compliance to incentivize employers to adhere to safety standards.

Challenges to Implementation

While the benefits of establishing occupational dust exposure limits are clear, several challenges must be addressed:

1. **Resource Constraints:** Developing countries often face financial and infrastructural limitations that hinder the establishment and enforcement of occupational health

regulations.

2. **Lack of Data:** There is a need for comprehensive data on dust exposure levels and related health outcomes in Nepal to inform the development of effective regulations.
3. **Cultural Attitudes:** There may be resistance to change among employers and workers who prioritize productivity over safety. Educational initiatives are essential to shift these attitudes.

Recommendations for Future Research

To further strengthen the evidence base for establishing appropriate dust exposure limits in Nepal, the following areas for future research are recommended:

1. Conducting comprehensive surveys to assess the prevalence and severity of dust-related occupational diseases, such as silicosis, among workers in high-risk industries.
2. Evaluating the effectiveness of existing dust control measures and identifying barriers to their implementation in Nepalese workplaces.
3. Assessing the economic impact of occupational dust exposure on worker productivity, healthcare costs, and the overall economy.
4. Exploring the feasibility and cost-effectiveness of implementing different dust control strategies, such as engineering controls, administrative measures, and personal protective equipment.
5. Collaborating with international research institutions to conduct joint studies and share best practices in occupational health and safety.

What Do We Offer?

Welcome to the second volume of the Journal of UTEC Engineering Management (JUEM), your premier source for cutting-edge research and insights in the field of engineering management. In this issue, we present a diverse array of articles that tackle the most pressing challenges facing Nepal and the global community.

Our authors have delved deep into the intricacies of construction projects, infrastructure development, and environmental sustainability, offering practical solutions and innovative approaches that will shape the future of engineering management. From investigating the properties of aggregates for optimal building performance to benchmarking irrigation systems for agricultural sustainability, this volume covers a wide range of topics that are crucial for the development and well-being of our societies.

One particularly compelling article, "Unlocking the Secrets of Residential Construction: Investigating Aggregate Properties for Optimal Building Performance (A Case Study in Nawalpur District Rivers)," provides a comprehensive analysis of the factors influencing building performance, offering valuable insights for construction professionals (Gautam et al. 2024). Through rigorous research and experimentation, the authors have uncovered the secrets to creating structures that are not only strong and durable but also environmentally friendly.

Another standout contribution is "Factors Affecting Construction Project Performance: Bharatpur Metro Case Study" by Bagale et al. (2024), which delves into the intricacies of project management in the context of urban development. By analyzing the challenges faced in construction projects in Bharatpur metropolitan city, the authors have shed light on the critical issues of time and cost overruns, offering practical solutions for project managers to overcome these obstacles.

In "How Safe Are Nepal's Roads? A Study of Road Safety Legislation and WHO Standards," Dhungana et al. (2024) tackle the crucial issue of road safety governance, emphasizing the importance of regulatory frameworks aligned with global standards. This research is particularly timely given the growing concerns about road safety in Nepal and around the world.

Other articles in this volume include "Unlocking Excellence: Khageri Irrigation System Benchmarking in Chitwan" by Shrestha et al. (2024), which enhances our understanding of irrigation system management, and "Navigating

Delays: A Comprehensive Study of Public Building Retrofitting Projects in Kathmandu Valley" by Bhattarai et al. (2024), which explores strategies to mitigate delays and enhance project outcomes in retrofitting projects. A new approaches of marketing through social media has been highlighted for electronics engineering products by Dangol et al,(2024) followed by two comprehensive review article highlighting risk management approaches by Blain et al(2024) and Constraints of hydropower in Nepal by by Bhatt and Joshi(2024).

The Journal of UTEC Engineering Management is committed to publishing high-quality research that pushes the boundaries of engineering management (Mishra, 2023 a&b). Our rigorous peer review process ensures that every article meets the highest standards of academic quality and credibility. We are proud to present this second issue, which is the result of the hard work and dedication of our authors, reviewers, and editorial team.

Join us in exploring the cutting edge of engineering management and be part of the conversation that will shape the future of our field. Visit to JUEM today and stay ahead of the curve!

Conclusion

Implementing effective dust exposure limits in Nepal requires a comprehensive approach that combines monitoring, health assessments, targeted research, and the adoption of control strategies. By prioritizing worker health and safety, employers and policymakers can reduce the burden of dust-related diseases and promote a healthier workforce. Collaboration between stakeholders, including workers, employers, researchers, and government agencies, is essential for the successful implementation of dust exposure limits and the protection of worker health in Nepal.

The establishment of occupational dust exposure limits in Nepal is not just a regulatory necessity but a moral imperative to protect workers' health and enhance productivity. As the country continues to develop, it must prioritize occupational health standards that align with global practices. By doing so, Nepal can safeguard its workforce against the detrimental effects of dust exposure, ultimately contributing to a healthier and more productive society.

While India's PEL for respirable crystalline silica is a starting point, it is essential for Nepal to adopt a more protective standard of 0.050 mg/m³. This approach will not only enhance worker safety but also align Nepal with international best practices, ultimately contributing to a healthier workforce and more sustainable economic development.

In brief, while occupational exposure limits provide a useful benchmark, they should be considered the maximum allowable exposure, not a safe level. Employers should strive to minimize dust exposure as much as possible, even if levels are below the recommended standards, to protect worker health and reduce the risk of long-term adverse effects. The disparities in dust exposure limits across countries highlight the complexities of occupational health regulations. While some nations adopt stringent limits to protect worker health, others may prioritize industrial output or have less robust enforcement mechanisms. This variation underscores the need for ongoing international dialogue and cooperation in establishing effective occupational health standards. Enhanced education, training, and monitoring are essential in ensuring compliance and protecting workers from the adverse effects of dust exposure.

Assurance of No Conflict of Interest

We would like to provide a comprehensive assurance regarding the integrity of our peer review process, emphasizing that there are no conflicts of interest. The following points detail the measures implemented to uphold transparency and ethical standards:

Peer Review Process

Independent Oversight: The peer review process was entirely managed by the Associate Editor-in-Chief. This independent oversight was crucial in ensuring an unbiased evaluation of all submitted articles.

Validation by Editor-in-Chief

The Editor-in-Chief played a pivotal role in editing the articles and validating the overall review process. This step further reinforces the integrity of the editorial decisions made.

Conflict of Interest

No Conflict of Interest: We affirm that there are no conflicts of interest in the editorial process. The structure of our review system ensures that all decisions are made impartially and without undue influence.

Editorial Contributions and Acknowledgments

1. **Editorial Offerings:** In our editorial content, we provide valuable insights and contributions from the Associate Editor-in-Chief, who has expressed acknowledgments for the collaborative efforts within the editorial team.
2. **Dust Exposure Limits:** The Editor-in-Chief has articulated the dust exposure limits, reflecting a common understanding among the editorial board. This collaborative approach underscores our commitment to maintaining high standards in our publications

Co-Authorship and Approval

1. **Co-Authorship Disclosure:** It is important to note that the Managing Editor was a co-author few of the submitted articles. This relationship was disclosed to the Editor-in-Chief prior to the review process.
2. **Approval from Editor-in-Chief:** The Editor-in-Chief was fully informed of the Managing Editor's co-authorship and provided explicit approval for the Managing Editor to be involved in the editorial process only after articles were accepted for other articles. Their involvement was strictly for administrative purposes, including the design and formatting of the accepted papers, thereby maintaining a clear separation from the review process.

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