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Research Article

An Integrated Assessment of Occupational Disease Prevalence Among Coal Mine Workers in India

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Abstract

Coal mining is a high-risk occupation characterised by continuous exposure to hazardous conditions such as coal dust, silica particles, toxic gases, excessive noise, and physically demanding work environments. These exposures significantly contribute to a wide spectrum of occupational diseases among mine workers. This study presents an integrated assessment of occupational disease prevalence among coal mine workers in selected Indian coalfields, including Pakri Barwadih and Kerandari (Jharkhand), Dulanga (Odisha), and Talaipalli (Chhattisgarh). A cross-sectional analytical approach was adopted using both primary data (medical examinations, surveys) and secondary data (mine health records).

The study identifies respiratory diseases as the most prevalent occupational health issue, followed by hearing loss, hypertension, musculoskeletal disorders, and skin diseases. Results indicate that respiratory disease prevalence ranges from 32% to 38% across mines, highlighting the critical impact of prolonged dust exposure. The findings emphasise that occupational health risks in coal mining are multi-dimensional and require an integrated management approach. The study recommends enhanced dust control, real-time monitoring, improved personal protective equipment (PPE) usage, and comprehensive health surveillance systems. This research contributes to policy development and sustainable occupational health management in the mining sector.

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1. INTRODUCTION

Coal mining is a cornerstone of industrial development and energy production in India. Despite its economic importance, it remains one of the most hazardous occupations due to exposure to harmful environmental conditions. Coal miners are regularly exposed to respirable dust, silica particles, toxic gases, high noise levels, and ergonomic stressors, which significantly affect their health.

Occupational diseases in coal mining develop over prolonged exposure and often remain undetected in early stages. The most common diseases include coal workers' pneumoconiosis (CWP), silicosis, and chronic obstructive pulmonary disease (COPD). Additionally, miners suffer from hearing loss, musculoskeletal disorders, cardiovascular diseases, and psychological stress.

Traditional studies have primarily focused on individual diseases; however, coal miners are exposed to multiple hazards simultaneously. Therefore, an integrated assessment approach is necessary to evaluate the combined impact of occupational exposures on workers' health.

2. OBJECTIVES OF THE STUDY

The study aims to:

- Assess the prevalence of occupational diseases among coal mine workers
- Analyze the impact of dust, noise, and ergonomic stress on health
- Compare disease prevalence across different mining regions
- Identify key occupational risk factors
- Suggest effective mitigation and health management strategies

3. LITERATURE REVIEW

Occupational health in coal mining has been a focal point of global research, particularly regarding respiratory pathologies. Studies consistently indicate that Coal Workers' Pneumoconiosis (CWP) remains a primary concern (Cohen, Patel, & Green, 2008). While Liu et al. (2022) reported a marginal decline in global prevalence, they highlighted a significant resurgence in developing regions, largely attributed to inadequate safety practices and the emergence of progressive massive fibrosis (Blackley, Halldin, & Laney, 2018).

The impact extends beyond the mines themselves; Cortes-Ramirez et al. (2018) found that populations residing near coal mining areas exhibit increased morbidity and mortality rates. In the Indian context, epidemiological data from the ICMR (2018) and DGMS (2022) indicate a high prevalence of respiratory symptoms among coal miners, exacerbated by hazardous dust generation (Ghose, 2007).

Non-respiratory diseases are equally significant. Musculoskeletal disorders (MSDs) arise from repetitive labor and poor ergonomics, while noise-induced hearing loss results from continuous exposure to heavy machinery (Donoghue, 2004). Recent research from NIOSH (2020) and the World Health Organization (2021) underscores the role of synergistic risk factors, such as the combined impact of dust exposure, smoking, and work duration. Despite this, the World Bank (2020) notes that gaps remain in regional monitoring, particularly in developing nations like India.

4. Research Gap and Problem Statement

4.1 Research Gap

While the health impacts of mining are documented by organizations such as the International Labour Organization (2019), several critical deficiencies persist:

Absence of Integrated Multi-Disease Assessment: Most prior research isolates specific conditions rather than evaluating the concurrent prevalence of multiple ailments (Laney & Weissman, 2014).

Data Scarcity in Indian Coalfields: There is a lack of localized, empirical data in reports from the Ministry of Coal (2021) concerning the specific health status of workers in newer mining blocks.

Inadequate Analysis of Synergistic Exposures: Studies often fail to analyze how combined hazards—dust, noise, and ergonomic stress—affect long-term health (Petsonk, Rose, & Cohen, 2013).

Lack of Predictive Modeling: There is a deficiency in using predictive risk models to forecast health outcomes based on exposure variables (Attfield & Kuempel, 2008).

Insufficient Worker Awareness: A pervasive gap exists regarding health literacy and safety awareness among the workforce.

4.2 Problem Statement

Coal miners are routinely subjected to a complex environment of overlapping occupational hazards that precipitate a wide array of debilitating health disorders. Historically, research and clinical focus have remained siloed, investigating individual diseases in isolation rather than providing a holistic view of the worker's health. Consequently, there is an urgent requirement to conduct a comprehensive evaluation of the total disease burden to understand the intricate relationship between cumulative workplace exposures and multifaceted health outcomes.

5. METHODOLOGY

The investigation was structured as a cross-sectional analytical study, employing an integrated health and exposure assessment framework to evaluate the intersection of environmental stressors and physiological outcomes among the mining workforce. Research activities were centered across four strategically significant coal mining regions in East-Central India, specifically Pakri Barwadih and Kerandari in Jharkhand, Dulanga in Odisha, and Talaipalli in Chhattisgarh. To ensure a robust diagnostic profile, a dual-layered data acquisition strategy was implemented. Primary data were gathered through direct clinical evaluations—including spirometry, radiographic X-rays, and audiometric testing—alongside structured worker surveys that captured demographic variables such as age, professional experience, PPE compliance, and recorded clinical

symptoms. These findings were supplemented by secondary data derived from annual medical examination (AME) reports, historical dust exposure records, and institutional safety reports. Pathologies identified during the study were categorized into five distinct clusters based on their clinical relevance to the mining environment, encompassing respiratory disorders such as Coal Workers' Pneumoconiosis (CWP), Chronic Obstructive Pulmonary Disease (COPD), and silicosis, as well as noise-induced hearing loss, hypertension, dermatological conditions, and musculoskeletal disorders (MSDs) resulting from physical labor. The resulting dataset underwent rigorous statistical treatment to summarize prevalence and identify key trends. These findings were supplemented by secondary data from Annual Medical Examination (AME) reports and historical dust records (DGMS, 2022).

Pathologies were categorized into five clusters: respiratory disorders (CWP, COPD, and silicosis), noise-induced hearing loss, hypertension, dermatological conditions, and MSDs (Donoghue, 2004). The dataset underwent rigorous statistical treatment, including descriptive statistics (mean, SD) and inferential statistics (Chi-square and correlation analysis), to determine the significance of relationships between workplace exposures and health outcomes.

Descriptive statistics, including percentage analysis, mean values, and standard deviations, were utilized to characterize the distribution of diseases. Furthermore, inferential statistics, including Chi-square tests and correlation analysis, were applied to determine the statistical significance of the relationships between specific workplace exposures and the observed health outcomes.

6. RESULTS

6.1 Disease Prevalence Across Mines

Disease Type	Pakri Barwadih	Kerandari	Dulanga	Talaipalli
Respiratory	35%	34%	32%	38%
Hearing Loss	20%	22%	18%	20%
Hypertension	18%	18%	20%	16%
Skin Diseases	10%	12%	8%	10%
Others (MSDs, etc.)	17%	14%	22%	16%

6.2 Key Observations

- Respiratory diseases are the most prevalent across all mines
- Highest prevalence observed in Talaipalli (38%)
- Hearing loss affects ~18–22% workers
- Hypertension indicates rising cardiovascular risks
- Musculoskeletal disorders contribute significantly to "other" diseases

7. DISCUSSION

The discussion of the research highlights that the health consequences of coal mining are fundamentally multi-dimensional, extending well beyond isolated respiratory ailments to encompass a broad spectrum of systemic health complications. The study identifies several critical risk factors that drive these outcomes, most notably the physiological toll of prolonged dust inhalation, the cardiovascular and auditory strain caused by high noise levels, and the physical degradation resulting from ergonomic stressors. These environmental hazards are further exacerbated by behavioral and administrative factors, such as inconsistent compliance with personal protective equipment (PPE) protocols and the compounding effects of smoking or poor lifestyle choices. Ultimately, the data reveals a significant integrated health burden, where workers frequently present with multiple co-existing conditions. This synergy of ailments underscores the inadequacy of traditional, disease-specific interventions and reinforces the necessity for a holistic, worker-centric occupational health strategy that addresses the cumulative impact of all workplace exposures.

8. Recommendations

Occupational Health and Safety Protocols

The framework begins with Engineering Controls, which prioritize the physical environment through the installation of high-efficiency dust suppression systems and modernized ventilation layouts to ensure optimal air quality. Simultaneously, advanced noise mitigation technologies are integrated to minimize auditory hazards. Moving to Administrative Controls, the focus shifts to operational management via rigorous safety audits and the implementation of strategic work rotations designed to limit individual exposure to high-risk zones.

To ensure individual safety, the Personal Protective Equipment policy mandates the use of specialized gear, supported by active oversight to verify that all safety protocols are being met. This is reinforced by Medical Surveillance, a proactive health strategy involving scheduled clinical check-ups and the maintenance of digital health records to facilitate the early detection of potential occupational diseases. Finally, Technological Integration bridges these efforts by utilizing IoT-based systems for real-time environmental monitoring and leveraging AI-driven predictive models to anticipate and prevent long-term health risks.

9. CONCLUSION

This study provides an integrated assessment of occupational diseases among coal mine workers in India. The findings indicate that respiratory diseases remain the most critical health issue, followed by hearing loss and cardiovascular disorders. The prevalence of multiple co-existing conditions highlights the need for a comprehensive occupational health strategy.

Despite improvements in mining technology, occupational health risks remain significant. Therefore, a shift toward preventive, technology-driven, and worker-centric health management is essential for sustainable mining practices.

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