Academic Journal of Management and Social Sciences
ISSN: 2958-4396 | Vol. 18, No. 1, 2026

Macro-level Governance Environment and Occupational Health: A Comparison of Pneumoconiosis Policies

Boyan Tong *

Wuhan Britain-China School, Wuhan, Hubei, 430030, China
*** Corresponding author Email:** tongboyan2027@126.com

Abstract: Under the background of the "Healthy China" initiative and the continuous improvement of the occupational health system, pneumoconiosis still poses a challenge to the health rights and interests of workers and the ability of public governance. This disease has the characteristics of long incubation period, irreversible course, and difficult traceability of responsibility. This article reviews the experience of the United States and other developed countries in the control of pneumoconiosis, and uses the panel data of 31 provincial administrative units in China from 2007 to 2023 to construct a two-way fixed effect model. Given data limitations, the reported incidence rate of tuberculosis is used as a proxy indicator to examine macro-level factors such as industrial structure, industrial pollution, public services, labor protection, and medical resources. The study also analyzes institutional inflection points in China's governance of pneumoconiosis by combining policy documents with prosecutorial case studies. The study found that the share of the secondary sector and sulfur dioxide emissions is significantly and positively correlated with reported incidence rates, while the share of healthcare expenditure, urbanization rates, and infrastructure are significantly and negatively correlated. The relationship between the number of workers covered by work-related injury insurance, the allocation of healthcare professionals, and human capital lacks stability. Case studies further indicate that the coordination among workplace protection, occupational health records, occupational disease diagnosis, work-related injury determination, and benefit payments is a key institutional condition affecting the prevention of pneumoconiosis and the protection of patients. Based on these findings, this paper proposes that the development of the pneumoconiosis management system for the 15th Five-Year Plan should strengthen dust control at the source, protection for high-risk populations, grassroots occupational health services, cross-regional information coordination, and long-term collaborative care, thereby promoting the coordinated development of occupational health risk prevention and control and the protection of workers' rights.

Keywords: Pneumoconiosis Governance; Occupational Health; Macro-governance Environment; Two-way Fixed-effects Model; Case Study.

1. Introduction

Occupational health risks are a long-standing yet often underestimated issue in global public health governance. According to joint estimates by the World Health Organization (WHO) and the International Labor Organization (ILO), approximately 1.9 million people worldwide died from work-related diseases and injuries in 2016, with noncommunicable diseases accounting for as much as 81% of these deaths. The situation is particularly acute in developing countries. In 2021, China's National Health Commission reported 915,000 cases of occupational pneumoconiosis, nearly half of which were coal workers' pneumoconiosis. Among various occupational lung diseases, pneumoconiosis is unique in that it is characterized by long-term latency, gradual progression, and irreversibility—yet it is "entirely preventable". The U.S. National Institute for Occupational Safety and Health (NIOSH) states that pneumoconiosis (primarily silicosis, coal worker's pneumoconiosis, and asbestosis) is mostly caused by the inhalation of specific dusts in the workplace. Severe cases can lead to irreversible damage to lung function, loss of labor capacity, and even premature death. The root cause of pneumoconiosis is that industrial development and large-scale urban construction have exposed people to extensive exposure to the smoke and dust environment. At the same time, due to the lack of necessary occupational safety protection and medical security, the incidence of pneumoconiosis is becoming more and more serious.

From a global perspective, pneumoconiosis is particularly common in developing countries and economies in transition. This situation not only stems from the transfer of high-dust industries and labor-intensive industries to low-cost areas, but also closely related to the lack of investment in workplace protection, unstable labor relations, limited coverage of work injury insurance and weak grass-roots treatment capacity in these areas. Take China as an example. Many high-dust industries such as coal, metallurgy, building materials and construction have existed for a long time. Pneumoconiosis has always been a key area for the prevention and control of occupational diseases in China. In recent years, China has gradually built a more comprehensive macro-policy framework. The Healthy China 2030 Planning Outline emphasizes the need to strengthen workplace safety and occupational health and curb the high incidence of pneumoconiosis and occupational poisoning. The National Plan for the Prevention and Control of Occupational Diseases (2021–2025) and the Action Plan for the Prevention and Control of Pneumoconiosis have further promoted dust control, patient assistance and service capacity building to policy priorities. Against this background, this article studies relevant issues around the goal of building a healthy China and promoting occupational health governance during the 15th Five-Year Plan Period.

Existing academic research has laid a solid knowledge foundation for understanding pneumoconiosis, while medical and epidemiological studies have primarily focused on the mechanisms of pulmonary fibrosis, pathophysiological

processes, imaging diagnosis, complications, and the quantification of the disease burden. Relevant research has elucidated the fundamental mechanisms by which mineral dust induces inflammatory responses, macrophage damage, and pulmonary fibrosis [1–2], and has further demonstrated the irreversible nature and long-term hazards of pneumoconiosis from the perspectives of clinical diagnosis, disease progression, and global burden [3–5].Research on occupational health and exposure control has focused on the occupational exposure risks associated with respirable crystalline silica, coal dust, asbestos, and dust from engineered stone processing, as well as in construction, mining, and manufacturing settings, highlighting the critical importance of engineering controls, ventilation and dust removal, personal protective equipment, and exposure monitoring [6–8].The resurgence of coal workers' pneumoconiosis in the United States and the rapid emergence of silicosis associated with engineered stone processing indicate that even in countries with relatively well-developed regulatory systems, technological shifts, changes in industrial organization, and lax regulatory enforcement can still lead to a resurgence in the risk of occupational lung diseases [9–11].

Social policy research examines pneumoconiosis within the context of labor relations, workers' compensation claims, occupational disease compensation, medical assistance, and household livelihood pressures, noting that the consequences of the disease generally extend to labor rights, family financial burdens, and social assistance systems [12]. Governance research explores the coordination among corporate responsibility, government regulation, occupational health services, and community-based screening [6–7, 15].The U.S. black lung compensation program, Australia's ban on engineered stone, the UK's occupational exposure guidelines, and Japan's occupational disease compensation practices provide various case studies for understanding the relationship among prevention, regulation, and compensation. However, current research still largely focuses on medical diagnosis and treatment, epidemiological surveillance, or individual policies, and there is a relative lack of comprehensive studies on the determinants of pneumoconiosis in China, the operation of relevant systems, and governance pathways.

This paper begins by examining the development of pneumoconiosis governance systems in the United States and other developed countries, studying the practical implementation and limitations of dust control, health surveillance, regulatory enforcement, and compensation and relief measures. This study uses China's provincial panel data to analyze the relationship between industrial structure, industrial pollution, public services, labor protection, medical resources and the reported incidence of tuberculosis. On this basis, combined with occupational health research, policy documents and judicial cases, this study further evaluates the applicability of these macro-level correlations in the control of pneumoconiosis. Subsequently, this article discusses how to improve in terms of source prevention, corporate responsibility, grass-roots services, social security and cross-departmental collaboration within the framework of pneumoconiosis governance in China.

The value of this paper lies primarily in three areas: research perspective, methodological application, and policy research. From the perspective of research, the paper integrates the accumulated experience of international governance, empirical findings from China's provincial-level data, and specific institutional cases into a single analytical framework to examine the combined impact of industrial transformation, labor protection, public services, and social security on the risk of pneumoconiosis. The provincial panel model provides quantitative evidence on the relationship between macro-level governance conditions and reported tuberculosis incidence rates. Research on the etiology of pneumoconiosis, relevant policy documents, and judicial cases are used to explain issues related to workplace dust control, labor relations, and institutional enforcement. The regression results identify the macro-level areas addressed in Part IV, while other relevant evidence further clarifies specific governance measures. At the policy level, this paper focuses on the allocation of occupational health costs during the processes of industrialization and urbanization, providing a reference for the occupational disease prevention and control plan during the "15th Five-Year Plan" period as well as for related governance efforts in other developing countries.

2. Analysis of Pneumoconiosis Control Experiences in the United States and Other Developed Countries

2.1. Historical Origins

From the late 19th century through the first half of the 20th century, the United States witnessed the successive expansion of coal mining, railway construction, and the construction and manufacturing industries. A large number of workers were exposed for extended periods to environments containing coal dust and free silica dust. Processes such as dry drilling, blasting, and cutting resulted in high levels of occupational exposure, compounded by a lack of ventilation facilities, wet work practices, and respiratory protection measures. During the Hawks Nest Tunnel project in the 1930s, workers drilled through quartz-rich sandstone under poor ventilation and insufficient protective measures. This event became a landmark event in the concentrated outbreak of silicosis [16]. At that time, the medical diagnosis and reporting system was relatively weak, and the incubation period of silicosis itself was also long. Enterprises deny occupational causes and liability, and mobile workers in particular lack stable channels for complaints, diagnosis and compensation. As doctors carry out investigations, the participation of labor organizations and public hearings continues to increase. Black lung disease has gradually evolved from a personal health problem to a problem closely related to corporate responsibility, labor rights and public governance [12]. Under the pressure of these developments, the federal government began to shift the focus of regulation from major accidents to occupational health supervision.

2.2. Governance Approaches Based on the Rule of Law and Standardization

The Federal Coal Mine Safety Act of 1952 requires certain underground coal mines to undergo annual inspections and gives the U.S. Bureau of Mines limited power to issue suspension orders and notices of violations. However, the law mainly focuses on major accidents. Coal mines with less than 15 employees are not within the scope of application, and no fines are imposed for violations of general safety standards [17]. The enactment of the Federal Coal Mine Health and Safety Act of 1969 marked a turning point. The law covers open-air coal mines and underground coal mines, stipulates

more frequent federal inspections, mandatory dust exposure limits and chest X-ray monitoring systems, and establishes the Federal Black Lung Compensation Program under Title IV [18-19]. The 1977 Federal Mine Safety and Health Act further extended this unified framework to apply to all types of mines, while transferring law enforcement responsibilities from the Department of the Interior to the Department of Labour and establishing the Mine Safety and Health Administration (MSHA) and an Federal Mine Safety and Health Review Commission.[17] This development process is the result of joint efforts in legislation, worker mobilization, medical diagnosis, law enforcement and compensation. However, the lack of representativeness of sampling, regional differences in law enforcement, and the incubation period of the disease may hinder the timely evaluation of efficacy. Applicants for compensation often encounter problems such as insufficient medical evidence and legal aid obstacles during the application process [10, 20].

2.3. Accelerating Remediation and Prevention Through Technological Measures

At the source control level, the United States has gradually implemented measures such as mine ventilation, wet drilling and cutting, spraying and dust suppression, local exhaust ventilation, equipment closure and isolation, and remote operation. The control hierarchy requirements proposed by the National Institute for Occupational Safety and Health (NIOSH) in the United States give priority to elimination, substitution and engineering control, and personal protective equipment ranks lower in the protective level [21]. In 2014, the U.S. Mine Safety and Health Administration lowered the general standard for respirable coal mine dust from 2.0 mg per cubic meter to 1.5 mg per cubic meter, and required some underground miners to use continuous personal dust monitors. These devices can provide exposure data for each shift, and regulators and companies need to investigate the abnormal results and take corrective measures according to mandatory standards [22]. The Coal Workers' Health Surveillance Program implemented by the National Institutes of Occupational Safety and Health in the United States uses pre-employment chest X-rays and regular screenings to detect early lesions and track disease trends [23].

After the dust risk of traditional coal mines has been controlled, the processing of new materials has caused new occupational exposure problems. Cutting and grinding of engineered stone will produce high concentrations of crystalline silica. From July 1, 2024, Australia has banned the production, supply, processing and installation of engineered stone countertops, panels and plates [24]. This policy adjustment expands the scope of supervision from traditional coal mines to the new material processing industry, and ensures that technical standards can be updated with changes in production processes.

2.4. Historical Lessons and Limitations

The prevalence of coal workers' pneumoconiosis in the United States had previously declined following the establishment of dust standards and health surveillance systems; however, this trend reversed in the late 1990s. Research conducted by Blackley et al. showed that by the end of the monitoring period from 1970 to 2017, the prevalence among long-term underground miners nationwide had exceeded 10%, reaching 20.6% in the Central Appalachian region[9]. The increase in the cutting of silica-containing rock associated with thin-seam mining, along with differences in mine size, mining methods, and job-specific exposure, makes it difficult for a uniform dust standard to cover all actual risk scenarios [10]. While continuous monitoring can track changes in exposure, influencing corporate behavior still relies on inspection, penalty, and corrective action systems; compensation systems primarily address the economic losses resulting from the disease but cannot restore already impaired lung function.

The U.S. black lung compensation system is based on the Federal Mine Safety and Health Act, and its effective operation relies on three implicit prerequisites: highly organized labor unions (providing collective bargaining and legal support), a closed and traceable mining labor market (with relatively stable employment histories), and a unified federal-level collection and payment system. However, in China, high-risk groups of pneumoconiosis are concentrated among migrant workers, temporary workers and cross-regional mobile workers. The labor relations of these groups are characterized by unorganized and short-term contracts. Directly copying the technical method of stringent dust exposure limits and regular chest X-ray examination in the United States, if not supplemented by the digital transmission of cross-regional occupational health records and the joint responsibility of labor dispatching agencies and employers, it is likely to lead to a system that can only identify cases but cannot be managed and cannot provide compensation channels.

3. Factors Influencing Pneumoconiosis in China and Current Challenges

There are significant differences across China's regions in terms of industrial composition, levels of urbanization, investment in public services, coverage of labor protection, and levels of industrial pollution. These disparities influence the likelihood of workers being exposed to high-dust jobs and affect the actual accessibility of disease screening, diagnosis, reporting, and assistance.This section utilizes provincial panel data to examine the co-variation between macro-level factors and the burden of lung disease, while also identifying specific inflection points in occupational health governance through an analysis of policy implementation and judicial case studies.

Given limitations in the availability of publicly accessible data, this study has not yet obtained panel data on new or prevalent cases of pneumoconiosis that are consistent in scope and provide continuous coverage across all 31 provincial-level administrative units and 17 years. In the quantitative analysis section, this paper uses the provincial reported incidence rate of tuberculosis as a proxy indicator to examine the intra-provincial associations between industrial structure, industrial pollution, public services, and labor protection and the reported outcomes of this major lung disease.It should be noted that the reported incidence of tuberculosis cannot be equated with the actual burden of pneumoconiosis, nor can it be directly used to measure workplace dust exposure levels or the effectiveness of occupational health regulation. Based on the regression results presented above, this paper uses it to identify macro-level governance factors and then combines medical research on pneumoconiosis, occupational health literature, and institutional case studies to further examine the specific significance of these macro-level conditions in the governance of pneumoconiosis.

3.1. Empirical Findings: Influencing Factors

3.1.1. Model Specification and Variable Selection

To examine the relationship between the region's industrial structure, public services, and labor protection measures and the burden of lung diseases, this study constructs a two-way fixed-effects model at the provincial-year level. Compared to a simple cross-sectional analysis, this model accounts for differences among provinces in terms of geographic conditions, resource endowments, and long-term industrial traditions that do not change over time. It also controls for common-year shocks resulting from national policy adjustments, macroeconomic fluctuations, and changes in statistical definitions. The model specifications are as follows:

$$Disease_{it}=\alpha_0+\Sigma_{k=1}^{9}\beta_k X_{kit}+\mu_i+\lambda_t+\varepsilon_{it}$$

Where i and t denote province and year, respectively; $Disease_{it}$ represents the provincial reported incidence rate of tuberculosis, measured in cases per 100,000 people;X_{kit} denotes the kth explanatory variable, including the share of the secondary sector, the number of workers covered by work-related injury insurance, the number of medical professionals, the share of healthcare expenditure in fiscal expenditure, the urbanization rate, infrastructure, human capital, sulfur dioxide emissions, and per capita disposable income; μ_i andλ_t represent the provincial and annual fixed effects, respectively;ε_{it} are the random disturbance terms, andβ_k is the parameter to be estimated. The current results use heteroskedasticity-robust standard errors. Given that error terms across different periods within the same province may be correlated, subsequent robustness tests should also include provincial clustered standard errors.

Table 1. Variable Definitions

Category	Variable	Definition
Incidence	disease	Provincial tuberculosis reported incidence rate, cases per 100,000 people
Industrial Structure	second100	Share of secondary industry value added in regional GDP, %
Labor Protection	insurance	Number of participants in workers' compensation insurance, in ten thousand
Healthcare Resources	medpp	Healthcare personnel density, number of healthcare professionals per 1,000 permanent residents
Fiscal Expenditures	medratio	Healthcare Expenditures as a Percentage of Fiscal Expenditures, %
Urbanization	town	Percentage of the permanent resident population living in urban areas, %
Infrastructure	infra	Road area per capita, square meters
Human Capital	human	Average years of schooling, years
Industrial pollution	lnso2	Natural logarithm of sulfur dioxide emissions, 10,000 metric tons (original unit)
Income level	lndisposable	Natural logarithm of per capita disposable income, yuan (original unit)

To determine whether the direction and significance of the coefficients change after including the observed variables, this study employs a stepwise method to incorporate control variables into the estimation. Column (1) includes only the share of the secondary sector; Column (2) adds the number of workers covered by work-related injury insurance and the number of medical professionals; Column (3) further controls for the share of healthcare expenditure and the urbanization rate; Column (4) adds infrastructure and human capital; and Column (5) continues to include sulfur dioxide emissions and per capita disposable income, forming the complete model. All five models control for province and year fixed effects.

3.1.2. Data Sources and Descriptive Statistics

This study uses panel data from 31 provincial administrative units in China (excluding Hong Kong, Macao and Taiwan), covering 17 consecutive years from 2007 to 2023, with a total of 527 provincial annual observations. The data mainly comes from the EPS data platform, the China Statistical Yearbook and the China Health Statistics Yearbook. These 527 observations correspond to 31 provincial administrative units and 17 years, and the summary results are presented with balanced panel data. The proportion of secondary industry, the proportion of health expenditure and urbanization rate are expressed in percentage points, and sulfur dioxide emissions and per capita disposable income are expressed in natural logarithms.

Provincial tuberculosis indicators are used to observe changes in the regional lung health burden. Patients with pneumoconiosis face a higher risk of tuberculosis complications, and the detection and treatment of tuberculosis is also affected by medical resources, population mobility and public health capacity [3]. These indicators can indirectly reflect the medical services and socio-economic environment in the area analyzed. Infectious disease prevention and control, demographic structure, and case reporting systems also influence tuberculosis-related data; therefore, the findings should be interpreted in conjunction with pneumoconiosis policies and specific case studies.

Table 2. Descriptive Statistics

Variable	Sample Size	Mean	Standard Deviation	Minimum	Maximum
disease	527	68.7	36.6	13.3	305
second100	527	43.1	8.87	14.9	59.0
insurance	527	691	682	3.68	4,270
medpp	527	6.23	2.13	2.14	15.5
medratio	527	7.49	1.76	3.77	13.9
town	527	57.2	14.1	21.5	89.6
infra	527	15.8	5.20	4.04	28.0
human	527	9.06	1.18	4.22	12.7
lnso2	527	12.2	1.56	6.97	14.4
lndisposable	527	10.2	0.470	9.21	11.4

The mean value for "Disease" was 68.7, with a standard deviation of 36.6; the minimum and maximum values were

13.3 and 305, respectively, indicating significant variations in lung health indicators across different provinces and years. The mean share of the secondary industry was 43.1%, with values ranging from 14.9% to 59.0%;The average urbanization rate was 57.2%, ranging from 21.5% to 89.6%, indicating significant differences among regions in terms of industrial structure and the stage of urbanization.There is also some variation in the share of healthcare spending, infrastructure, industrial pollution, and income levels, laying the foundation for identifying the relationship between these factors and the burden of lung disease based on changes over time within each province. The maximum value for "disease" is significantly higher than the mean, indicating the presence of outlier provinces and suggesting that differences in statistical definitions may influence the results. Further analysis will involve removing outliers or conducting province-by-province exclusion tests to determine whether the conclusions are driven by a small number of observations.

3.1.3. Regression Results of the Two-Way Fixed-Effects Model

Table 3 reports the estimated results of five sets of two-way fixed effect models. The overall F test probability values of column (1) and column (2) are 0.1013 and 0.1450 respectively, which has not yet reached the commonly used significance level. Starting from column (3), the overall model has statistical significance. With the gradual addition of variables such as public services, infrastructure, industrial pollution and income, the R^2 inside the model increased from 0.0128 to 0.188, indicating that the complete model can better explain the changes over time in the same province.The overall R^2 also includes variations explained by province and year fixed effects; therefore, when evaluating model performance, one should primarily consider the Within R^2, coefficient stability, and overall F-test results. We examined the estimation results using stepwise regression and found that R^2 consistently increased as more explanatory variables were added. This paper focuses on the results in Column (5).

Table 3. Regression Results for the Two-Way Fixed-Effects Model

Variables	(1)	(2)	(3)	(4)	(5)
Share of the Secondary Sector (second100)	0.464 (0.283)	0.458 (0.286)	0.548* (0.305)	0.627** (0.258)	0.396** (0.192)
Number of people covered by workers' compensation insurance (per 100,000) (insurance)	—	-0.00733** (0.00372)	-0.00351 (0.00356)	-0.00831** (0.00383)	-0.00259 (0.00350)
Medical Technicians (medpp)	—	-1.43 (0.876)	2.83** (1.37)	2.18* (1.32)	2.07 (1.36)
Share of Healthcare Expenditures (medratio)	—	—	-3.37** (1.33)	-3.27** (1.27)	-2.74** (1.12)
Urbanization Rate (town)	—	—	-1.65*** (0.476)	-0.950** (0.456)	-1.64*** (0.473)
Infrastructure (infra)	—	—	—	-1.71*** (0.406)	-2.02*** (0.414)
Human Capital (human)	—	—	—	0.446 (3.40)	-4.55 (3.41)
Sulfur Dioxide Emissions (lnso2)	—	—	—	—	7.37*** (2.20)
Per capita disposable income (disposable)	—	—	—	—	71.1*** (17.9)
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes
Fixed-effect model by year	Yes	Yes	Yes	Yes	Yes
Sample size	527	527	527	527	527
R^2	0.861	0.863	0.872	0.877	0.886
Adjusted R^2	0.848	0.849	0.858	0.863	0.873
Within R^2	0.0128	0.0248	0.086	0.125	0.188

Note: Standard errors in parentheses are heteroscedasticity-robust; ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. All models control for province and year fixed effects

Across the five sets of models, the estimated coefficients for the share of the secondary sector are all positive. In columns (4) and (5), this coefficient is significant at the 5% level. The full model shows that the coefficient for this variable is 0.396. If the unit of this variable is percentage points, then a 1 percentage point increase in the share of the secondary sector corresponds to an increase of 0.396 cases per 100,000 people in the reported incidence of tuberculosis. After taking the natural logarithm of sulfur dioxide emissions, the coefficient is 7.37 and is significant at the 1% level. A 1% increase in emissions corresponds to an increase of approximately 0.0737 cases per 100,000 people in the reported incidence of tuberculosis.The proportion of the secondary industry reflects the characteristics of the industrial structure of a region, and the discharge of sulfur dioxide reflects the intensity of industrial pollution and coal-fired activities. These two indicators cannot replace the measured concentration of dust in the workplace. The results mainly reflect the macro relationship between the industrial development model and the reported incidence of tuberculosis.

In columns (3) to (5), the proportion of health care expenditure is significantly negatively correlated, and the coefficient in the complete model is -2.74. For every 1 percentage point increase, the reported incidence of tuberculosis is associated with fewer reported cases/100,000 people. The urbanization rate is significantly negatively correlated in all three model groups, and the coefficient in the complete model is -1.64. For every 1 percentage point increase in the urbanization rate, the reported incidence of tuberculosis is associated with fewer cases/100,000 people.

The coefficients for infrastructure in columns (4) and (5)

were −1.71 and −2.02, respectively, both significant at the 1% level. Since the specific units of the infrastructure variable have not been specified, no quantitative interpretation is provided here. The aforementioned negative association may involve factors such as primary-level screening, transportation accessibility, public health services, and changes in living conditions; however, the model itself cannot distinguish the independent effects of each mechanism.

In the data presented in Columns (2) and (4), the number of workers enrolled in work-related injury insurance showed a significant negative association; for the full model, the coefficient is −0.00259, though it did not reach statistical significance. Measured per 10,000 people, a 10,000-person increase in the number of workers enrolled in work-related injury insurance corresponds to a decrease of 0.00259 cases per 100,000 in the reported incidence of tuberculosis. Given that the coefficient in the full model is not significant,the current results do not indicate a stable association between the scale of coverage and the reported incidence of tuberculosis. Since this variable uses the absolute number of insured individuals, it is susceptible to the influence of the region's population and employment scale; furthermore, it does not distinguish between the coverage status of dust-exposed workers, migrant workers, and dispatched workers.

The direction of the coefficient for the number of healthcare professionals per 1,000 permanent residents varied across different models. The coefficient in the full model was 2.07, but it was not statistically significant. Based on this coefficient, an increase of 1 healthcare professional per 1,000 permanent residents corresponds to an increase of 2.07 reported tuberculosis cases per 100,000 people. Due to changes in model specifications, the direction of the coefficient shifted,the current results are insufficient to conclude that an increase in the number of healthcare professionals raises the risk of tuberculosis. This variable measures the overall density of healthcare personnel and does not distinguish between those involved in tuberculosis prevention and control, occupational disease diagnosis, rehabilitation, and primary care services.

In the full model, the coefficient for average years of education is −4.55, which also fails to meet the standard for statistical significance. On average, an increase of one year in education corresponds to a decrease of 4.55 cases of reported tuberculosis incidence per 100,000 people. This association lacks statistical stability. It is impossible to determine whether workers exposed to dust have received notices of work hazards, protection training or occupational health education based on general education alone.

In the complete model, the coefficient of per capita disposable income is 71.1, which is statistically significant at the significance level of 1%. After taking the natural logarithm of this variable, for every 1% increase in income, the reported incidence of tuberculosis will increase by about 0.711 cases/100,000 people. This positive coefficient may also reflect industrial growth patterns, population mobility, case detection rates and other regional differences not included in the model. Improvements in medical services may increase the detection and reporting rates of tuberculosis cases, and economic growth may also occur at the same time as population concentration and industrial expansion. The current model cannot distinguish between these mechanisms, so the income coefficient cannot be explained as an increase in tuberculosis or pneumoconiosis cases due to income growth.

The proportion of secondary industry and sulfur dioxide emissions are positively correlated with the reported incidence of tuberculosis, while the proportion of health expenditure, urbanization rate and infrastructure construction level are negatively correlated. The research results on the number of work-related injury insurance coverage, the number of medical personnel and human capital are unstable. The above conclusions are based on the statistical correlation analysis at the provincial level. The follow-up analysis will examine the relationship between occupational disease policies and specific case studies to analyze institutional issues such as public service allocation, workplace protection, occupational disease history preservation and welfare distribution.

3.2. Practical Challenges: Specific Cases

The results of the provincial level regression reflect the interrelationship between industry, public services, labor protection and the burden of lung disease. In order to determine the occurrence of specific institutional defects, it is necessary to assess the implementation of the policy and analyze the case data. The following analysis focuses on occupational disease medical services, industrial growth models, hazard disclosure, law enforcement procedures and work-related injury compensation benefits.

3.2.1. Inadequate Public Healthcare Services and Infrastructure

In the comprehensive model, the proportion of medical expenditure, urbanization rate, per capita road area and reported incidence of tuberculosis are all significantly negatively correlated, while there is no stable correlation between the number of medical staff per 1,000 residents and lung disease management. These results suggest that public finance, urban development and overall infrastructure status may be related to lung disease management, and the density of health personnel has not showed a stable statistical association. The per capita road area reflects the condition of urban roads and the convenience of transportation, but does not directly reflect the accessibility of occupational disease medical facilities. The number of medical staff per 1,000 permanent residents does not distinguish between medical staff engaged in occupational disease diagnosis, rehabilitation and grass-roots follow-up. The gap between occupational disease policies and actual service provision further highlights the challenges faced by patients with pneumoconiosis, mainly focusing on the allocation of professionals, the coverage of diagnostic facilities, grass-roots rehabilitation capacity and cross-regional medical record coordination.

According to the National Plan for the Prevention and Control of Occupational Diseases (2021-2025), it is necessary to strengthen the occupational health information system, professional and technical personnel, and the ability of supervision and service guarantee. The plan also proposes to establish an occupational disease prevention and control network characterized by provincial and municipal diagnosis, provincial and county treatment and grass-roots rehabilitation [25]. The mid-term assessment report released in 2024 shows that most of the goals of the plan have been achieved or are close to being achieved. However, in townships where pneumoconiosis patients are concentrated, the level of workers' occupational health knowledge and the coverage of rehabilitation services still need to be improved [26]. The existing system already covers diagnosis, treatment and

rehabilitation, but there are regional differences in grass-roots service capacity and the coverage rate of high-risk people.

The centralized examination and approval of occupational disease diagnosis qualifications by provincial health departments has led to the lack of institutional guarantee for small and medium-sized enterprises in the county-level economy to obtain diagnosis services nearby, resulting in geographical accessibility problems. When workers move across provinces, the seamless transfer of occupational health examination records and treatment files is often difficult to achieve. Patients living in remote mining areas and townships need to bear high transportation and time costs. Whether financial investment can effectively narrow the regional gap ultimately depends on whether diagnosis, rehabilitation and information services can really benefit these groups.

3.2.2. Economic Development and Rising Household Incomes Pose Potential Risks of Pneumoconiosis

The comprehensive model shows that there is a significant positive correlation between the proportion of secondary industry, sulfur dioxide emissions and per capita disposable income, while the urbanization rate shows a significant negative correlation. This shows that different growth models have different effects on occupational health. Industrial upgrading, the improvement of formal employment conditions and the improvement of public services may reduce the prevalence of crude production methods and informal employment. The continued expansion of mining, metallurgy, building materials, construction and pollution-intensive manufacturing will increase the risk of workers' exposure to industrial dust and harmful gases. Sulfur dioxide emissions can be used to gauge the intensity of heavy industry and coal-burning activities, while the income coefficient incorporates the combined effects of industrial growth, population mobility, and case detection capabilities.

The public interest litigation case regarding occupational diseases in Anshun, Guizhou, disclosed by the Supreme People’s Procuratorate provides concrete evidence: the glass manufacturing company involved faced hazards from dust and noise, and there were deficiencies in the implementation of occupational health protection measures. Following the intervention of procuratorial oversight, health authorities prompted 50 enterprises to conduct testing for occupational hazard factors, subsequently arranging occupational health examinations and providing protective equipment to 1,225 workers exposed to dust and noise [28].Prior to regulatory intervention, as enterprises expanded their production and employment scales, they failed to concurrently implement testing, health surveillance, and protective measures; subsequent corrective actions added the corresponding health-related costs back into the enterprises’ production management.

Industrial development policies should be implemented in tandem with occupational health regulation. Depending on industry-specific processes, measures such as wet operations, enclosed ventilation systems, and local exhaust ventilation should be enforced. Monitoring results and health examination records for high-risk positions must also be incorporated into routine law enforcement. Occupational health investments can serve as a criterion for evaluating enterprises’ production conditions during industrial park admission, corporate credit assessments, and regulatory inspections, thereby reducing dust exposure that has accumulated over the long term during periods of economic growth but has not yet been identified.

3.2.3. Insufficient Public Awareness of the Disease.

The high-risk groups of pneumoconiosis mainly include migrant workers, labor dispatch workers, outsourced workers and temporary workers. Some workers lack stable labor contracts when entering dust-exposed positions, and the pre-employment occupational health inspection, hazard notification and protective training have not been fully implemented. Due to the long incubation period of pneumoconiosis, workers may not have obvious symptoms at the beginning of their employment. When the disease appears many years after leaving the company, it becomes more difficult to track the occupational history and determine the responsible party. Workers' knowledge of occupational health is influenced by the information provided by employers, the stability of labor relations and the conditions for risk communication, and these differences cannot be fully reflected by the provincial average level of education alone.

In the case of Anshun, Guizhou, a pipe cutter worked for eight consecutive years. When she joined the company, she was neither subjected to an occupational health examination nor was she informed of the occupational disease hazards related to her job. It was not until the company later organized a physical examination that she learned about the risks of occupational diseases and dust exposure [28]. This case highlights the connection between harm awareness and employers' legal obligations. The lack of hazard notices and medical examination records for specific jobs will delay workers from taking protective measures and make it difficult for them to prove their work experience and dust exposure after illness. Occupational health information is crucial for disease prevention, evidence preservation and protection of rights and interests.

The Law of the People's Republic of China on the Prevention and Control of Occupational Diseases requires employers to carry out occupational hazard monitoring and evaluation in accordance with the law, inform workers of relevant hazards, organize occupational health examinations, provide protective equipment that meets the requirements, and participate in work injury insurance. In the diagnosis of occupational diseases, when the employer fails to provide relevant information, the diagnostic institution can make a diagnosis according to the comprehensive judgment of the worker's occupational history, self-report, regulatory information and clinical manifestations [27]. In practice, outsourcing and labor dispatch may lead to the dispersion of responsibilities, cross-regional mobility may lead to missing records, and it will become more difficult to obtain relevant evidence after the collapse of micro and small enterprises. Different institutions are responsible for labor dispute arbitration, occupational disease diagnosis and work injury identification, and workers need to submit information repeatedly in multiple procedures.

General health awareness propaganda alone is not enough to solve these problems. Employers should ensure that hazard notification and occupational health checks are carried out during employees' entry, on-the-job and separation, and allow employees to keep and transfer relevant records. The supervision of labor dispatch, outsourcing and temporary employment must be traced back to actual employing units and dust-exposed workplaces. When employees lack the ability to provide evidence or protect their own rights and interests, public welfare lawsuits filed by trade unions, health regulators and procuratorial organs can provide support. Occupational health records are continuous and easy to verify,

which can enhance the practical implementation of the provisions of the law on diagnosis and recognition of work-related injuries.

3.2.4. Limited Effectiveness of Medical Insurance to the Migrant Worker Population

Basic medical insurance mainly covers general medical expenses, while work injury insurance provides compensation after the diagnosis of an occupational disease and the identification of a work-related injury. When measuring the number of work injury insured participants, measured in units of 10,000 people, the results of some models are significantly negative, but the statistical significance is not achieved in the complete model. These results show that there is no consistent correlation between the scale of provincial insurance and the reported incidence of tuberculosis. The absolute value of the number of insured persons cannot reflect the coverage of high-risk industries, the contribution base, the recognition of work injuries or the payment of compensation. The following case study will analyze the systemic operation problems outside the scale of insurance.

For migrant workers, dispatched workers and temporary workers, the above process is easily disturbed in many links. Some workers lack written contracts or work across regions for a long time, resulting in employers paying less or not paying work-related injury insurance premiums. By the time pneumoconiosis is diagnosed, the original employer may have been canceled, reorganized or closed. The multi-layer subcontracting and project-based employment mode in the construction and mining industries cut off the continuous employment relationship between workers and their original employers, and transformed the 20-year incubation period of pneumoconiosis into a systematic buffer period for enterprises to evade historical responsibility. In the case of Wang Yinzhu disclosed by the Supreme People's Procuratorate, a coal mining enterprise lowered the basis of work-related injury insurance contributions, resulting in insufficient work-related injury compensation for patients with pneumoconiosis. Under the supervision of the prosecution, the two parties reached a settlement in 2022, and a settlement providing 180000 yuan in supplemental compensation. Shanxi Province then clearly stipulated in 2023 that the welfare shortfall caused by the employer's failure to truthfully declare the contribution base shall be borne by the employer [29]. In addition to the insurance coverage, the contribution base and responsibility distribution rules will also affect the final benefits of workers.

The systemic flaw revealed in Wang Yinzhu's case is that the work-related injury determination procedure is disconnected from the labor arbitration procedure. After the diagnosis report of pneumoconiosis is issued, the worker must first prove the existence of employment, and then apply for work-related injury recognition, and finally the social security institution will calculate the benefits. When the employer deliberately and maliciously reduces the contribution base, the social security system cannot automatically correct the error, forcing the worker to file a separate civil infringement lawsuit. This procedural arrangement transfers the administrative responsibility of social security contributions to the proof and protection of the rights and interests of individual workers. For migrant workers, the evidence required to prove the error of the payment base - such as payroll and attendance records - is usually withheld by the employer on the grounds of internal documents. The key role of procuratorial organs in filing public welfare lawsuits is precisely to make up for the absolute disadvantage of workers in obtaining evidence through the exercise of public power to investigate. The key to solving this problem is not to improve the insurance coverage rate, but to give occupational disease diagnosis institutions the right to independently investigate and verify the contribution base.

When the responsible subject no longer exists, another series of problems will arise. The eleventh batch of typical administrative prosecution cases announced by the Supreme People's Procuratorate shows that the coal mine where Mr.Xiang works has been in arrears with work injury insurance contributions for a long time. After the enterprise stopped production according to law, it was unable to pay the relevant compensation. The procuratorial organs assisted the local government in formulating a relief plan for pneumoconiosis patients who lost work-injury insurance coverage due to pneumoconiosis, and included hospitalization expenses, township rehabilitation services, living allowances, etc. in the comprehensive relief measures [30]. When an enterprise stops production, does not participate in insurance or it is difficult to determine the responsible subject, the standard work injury insurance system alone is not enough to bear all the liability, and local government finance and special relief mechanisms need to intervene.

At present, the Law on the Prevention and Control of Occupational Diseases and the National Plan for the Prevention and Control of Occupational Diseases have clearly stipulated the responsibility of employers who have not insured employees in accordance with the law, and require the provision of medical and living assistance for patients with occupational diseases under the condition that the subject of responsibility is unclear or the insurance coverage is insufficient [25][27]. However, in practice, the coverage of basic medical insurance and work injury insurance still needs to be clearly coordinated. There is a case of repeated submission of evidence in the process of diagnosis and work injury identification. The transfer of insurance records and occupational health files of cross-provincial mobile workers is still facing challenges, and the legacy liability of occupational diseases caused by the closure of enterprises also needs to be clarified. It will be solved by a special aid and recourse mechanism. Only by combining the insurance coverage with the procedures of premium payment, recognition and reimbursement can the insurance guarantee be truly transformed into the practical interests of patients.

The risk of pneumoconiosis in China is closely related to the regional industrial structure and the degree of industrial pollution. Public health inputs, urbanization and infrastructure provide the necessary conditions for disease screening, diagnosis and treatment. However, the size, education level, coverage of work-related injury compensation, and provincial health personnel have not shown stable association. The main reason may be that these overall indicators fail to reflect the grass-roots distribution of occupational disease services, the coverage of high-risk people and the welfare distribution process.

Policy documents and judicial cases further show that the main challenge of current governance is the connection between the components of the various institutions. Incomplete records of enterprise dust control and health monitoring may lead to complications for subsequent diagnosis and liability determination. Unstable labor relations

and cross-regional labour mobility may disrupt the continuity of personnel files, insurance registration and assistance procedures.Building on the preceding analysis, this section will discuss specific measures for improving dust source control, the utilization of regulatory data, grassroots occupational health services, and the occupational disease protection system.

4. Optimizing China's Pneumoconiosis Management System in Preparation for the 15th Five-Year Plan and the "Healthy China" Initiative

Results from provincial-level analyses indicate a statistical correlation between reported tuberculosis incidence rates and industrial structure, industrial pollution, and public service conditions. Occupational disease policies and prosecution cases also reveal thatthe management of pneumoconiosis is influenced by workplace protection, occupational health records, diagnostic services, and social security procedures. Management plans designed for the "15th Five-Year Plan" period must integrate source prevention, medical services, and legal remedies, and institutional planning should also take into account the reality of significant cross-regional mobility among dust-exposed workers in China.

4.1. Strengthen Top-level Design to Safeguard the Occupational Health Rights and Interests of Groups Such as Migrant Workers

During the 15th Five-Year Plan period, the prevention and control of pneumoconiosis should be incorporated into national health plans, occupational health policies, and development arrangements for key industries. It is necessary to further clarify departmental responsibilities: the health authorities should assume responsibility for occupational health supervision, occupational disease monitoring, and the establishment of diagnostic and treatment service systems, while the human resources and social security departments should be responsible for work-related injury determination and work-related injury insurance management.Labor and personnel dispute arbitration bodies shall handle disputes arising from labor relations, job types, positions, and length of service in accordance with the law. Relevant industry authorities and mine safety inspection agencies shall carry out supervision of key industries in accordance with their respective responsibilities. Local governments may utilize existing occupational disease prevention and control coordination mechanisms to promote information sharing, thereby reducing gaps in occupational exposure data caused by cross-regional employment, business deregistration, and changes in labor relations.

When allocating occupational health funds, comprehensive planning should be based on the current distribution of key industries, the results of occupational hazard monitoring, the number of patients with pneumoconiosis, and existing service capacity, with a focus on resource-based cities, counties and districts with concentrated occupational hazards, and regions with relatively weak service capacity.Employers in industries such as coal mining, non-coal mining, building materials, and stone processing must implement engineering controls, periodic testing, and occupational health examinations in accordance with the law. They must notify workers of the examination results in writing; workers have the right to access and copy their own occupational health surveillance records,Employers must also explain the occupational hazard factors associated with each position and the corresponding protective requirements, ensuring that migrant workers can retain basic documentation proving their occupational work history and exposure to occupational hazards.

Digital technologies can be used to improve the efficiency of occupational health supervision. In key industries such as coal mining and stone processing, as well as in high-risk work processes, employers may explore online monitoring of dust concentrations; however, statutory periodic testing must still be strictly enforced. Artificial intelligence can be used to identify abnormal data, screen for high-risk work processes, and determine priorities for supervision and inspection; system conclusions must be verified by professionals and cannot be used alone as the basis for administrative penalties or occupational disease diagnoses.In processes such as crushing, cutting, grinding, and material handling, industrial robots or remotely operated equipment may be adopted to reduce workers' direct exposure when technical conditions permit. The effectiveness of such technological upgrades should be evaluated based on reductions in dust concentration and exposure time. Violations of the law should be handled in accordance with the law and included in credit records as required by laws and regulations.

4.2. Optimizing Industrial Structure to Improve the Production Environment for Pneumoconiosis Control

The positive correlation between the share of the secondary sector and sulfur dioxide (SO_2) emission indicators suggests a macro-level link between industrial development patterns and reported tuberculosis incidence rates. As an environmental pollution indicator, sulfur dioxide cannot substitute for workplace dust concentration testing. Industrial policies should continue to incorporate occupational health impacts into project approval, technological upgrades, and industrial park management to prevent production expansion from relying long-term on high-dust, high-pollution processes.

Adjustments to the industrial structure can increase the share of high-end manufacturing and modern service industries, thereby supporting the development of sectors with relatively lower occupational health risks. Traditional manufacturing and resource-based industries should promote the adoption of enclosed production, wet processes, local ventilation, and mechanization based on dust exposure levels in different production processes. The effectiveness of digital transformation must be evaluated through workplace monitoring and worker health surveillance; simply connecting equipment to networks or reporting data does not, in and of itself, prove that occupational exposure has been reduced.

Industrial relocation may result in high-dust processes being transferred to regions with insufficient regulatory capacity, as well as to small and micro-enterprises and multi-tiered subcontracting chains. Large enterprises must incorporate occupational health requirements into the management systems of their suppliers and contractors. When local governments undertake industrial projects, they must conduct assessments of occupational disease hazards.Resource-based cities should utilize transformation policies to develop successor industries and provide retraining for workers in existing high-risk positions to reduce

the likelihood of workers returning to high-dust jobs due to a lack of skills or employment opportunities. Once new dust hazards arise from production activities such as engineered stone, new building materials, and mineral processing, they should be promptly incorporated into occupational health monitoring and targeted remediation efforts [33–34].

4.3. Improving Work Injury Insurance Benefits and Strengthening Medical Services and Collaborative Care

Healthcare expenditure as a percentage of GDP, the urbanization rate, and per capita road area show a negative correlation with the reported incidence of tuberculosis, while the number of healthcare professionals per 1,000 permanent residents does not exhibit a stable relationship. These findings suggest that, in addition to increasing healthcare investment, attention must also be paid to the professional composition and regional distribution of healthcare personnel. In conjunction with occupational health policies, the development of healthcare services can further focus on occupational disease diagnosis, occupational health examinations, primary-level rehabilitation, and cross-regional referral capabilities.

Among the variables included in the comprehensive model, the number of workers enrolled in workers' compensation insurance did not show a stable correlation. This result does not invalidate the view that workers' compensation insurance provides protection for patients with occupational diseases;The total number of insured individuals at the provincial level does not accurately reflect whether high-risk workers are actually enrolled in the program, nor does it illustrate the processes of occupational disease diagnosis, work-related injury determination, and benefit disbursement. Regulatory efforts should primarily focus on employers' enrollment responsibilities, verification of contribution bases, evidence retention, and benefit access. The Department of Human Resources and Social Security and social security administrative agencies shall verify enrollment and benefit information in accordance with their respective duties. Employers that fail to enroll in the program as required by law, or that fail to report contributions in full, thereby causing a loss of benefits, shall bear the relevant responsibilities in accordance with regulations.

Occupational health services can be optimized according to the framework of prefecture-level and municipal-level diagnosis, county-level physical examination and township-level rehabilitation [36]. occupational disease diagnosis institutions at the prefecture level and the municipal level need to improve their diagnosis ability and difficult case handling ability. County-level medical and health institutions are responsible for occupational health examination and related services. Township health centers and community health service centers can carry out follow-up, symptom management and rehabilitation guidance. Areas rich in medical resources can support resource-based cities and underdeveloped areas through personnel training, telemedicine consultation and expert collaboration. Counties and districts that lack independent occupational disease prevention and control institutions can rely on existing qualified medical institutions to supplement their service capabilities [33]. It is feasible to gradually explore the cross-regional integration of occupational health files. Within the scope of legal authorization and personal information protection, workers should be provided with convenient ways to access their own files.

Occupational health education should be included in pre-job training and occupational health examination. The training content should be tailored according to the specific position, and the harm of dust exposure, the use of personal protective equipment and the importance of occupational health examination should be clearly explained. At the same time, according to the employees' educational background and language preferences, on-site demonstration, visual assistance or team explanation should be adopted. Employers must ensure sufficient training time and the supply of protective equipment to prevent piecework wages, accelerated project progress and on-site management pressure from affecting protection standards. For employees who have left dust-exposed positions, employers should inform them that pneumoconiosis may not be detected until years later and guide them on continuous health monitoring and health care.

From the perspective of medical humanities, the management of pneumoconiosis must also pay attention to the long-term impact of the disease on daily life, family relationships and work ability. Symptoms such as dyspnea, fatigue, limited movement and interruption of work may persist even after hospitalization or a course of treatment. The term care community used in this article refers to the collaborative relationship involved in the long-term joint care of pneumoconiosis, which does not mean the establishment of a new administrative agency. Occupational disease diagnosis institutions, primary medical institutions, rehabilitation centers, medical social workers, patient families and non-profit organizations can participate in joint care within their respective responsibilities to ensure the integration of diagnosis, treatment, rehabilitation and social security.

Occupational attribution and statutory diagnosis of pneumoconiosis must be based on national diagnostic standards, occupational history, occupational hazard exposure history and workplace monitoring data. Medical uncertainty in the process of diagnosis and treatment mainly focuses on the progression of the disease, the manifestation of complications, the degree of symptom relief, and the assessment of rehabilitation needs. Some patients may lack relevant data on early occupational exposure, and their subjective symptom experience may not be fully consistent with the results of regular examination. Doctors must clearly explain the existing evidence, the basis of judgment and the scope of conclusion. They should listen carefully to patients' descriptions of dyspnea, fatigue, mobility difficulties and decreased work ability, respect the patient's right to make independent decisions, and involve patients in the choice of treatment and rehabilitation programs through informed consent. This kind of communication helps to improve the doctor-patient relationship and break the pattern of doctor-led and patient-passive.

When more evidence is still needed, medical institutions and relevant staff must avoid treating the description of the patient's symptoms as an exaggeration or a means of seeking compensation, so as to reduce the risk of stigmatization of the patient. Chest imaging is used in the diagnosis and staging of pneumoconiosis, while lung-function testing helps assess functional impairment and rehabilitation needs. The patient's description of his sleep, mobility and work ability can be used to set rehabilitation goals and evaluate the effectiveness of the service. Medical examination and the patient's disease experience have different evaluation functions, and both

should be properly recorded.

The support provided by family members - including accompanying patients to see a doctor, managing drugs, providing home oxygen therapy and providing financial support - constitutes long-term care work. Medical institutions and social security departments should reduce the burden of family care by providing practical guidance and information on available social resources to carers. Medical social workers can assist patients in sorting out documents and help them understand the processes related to referral, basic medical insurance, work injury compensation and social assistance. If there is a dispute over the diagnosis of occupational diseases and employment, it should be ensured that symptom management, follow-up and rehabilitation services are continuously provided to prevent delays in treatment and increased family burdens due to procedural delays.

4.4. Refine Legal Procedures to Improve Work Injury Recognition and Labor Dispute Resolution

The protection of the rights of patients with pneumoconiosis is linked to occupational disease diagnosis, work-related injury recognition, confirmation of the employment relationship, and benefit payments. To improve the system, it is necessary to clarify the boundaries of responsibilities for each procedure and reduce the need for duplicate submission of materials.Occupational disease diagnostic institutions shall conduct diagnoses in accordance with statutory standards, while employers shall provide, as required by law, the worker's occupational history, relevant history of exposure to occupational hazards, workplace testing results, and occupational health surveillance records. In cases involving labor dispatch, engineering contracting, or labor subcontracting, responsibilities for document retention and occupational health protection shall be determined based on the statutory duties of the employer, the labor dispatch agency, the user enterprise, and the contracting entity.

If a worker objects to materials such as the results of workplace occupational hazard factor testing, the health and wellness authority in the jurisdiction where the occupational disease diagnosis institution is located shall conduct an investigation in accordance with the law. If an employer refuses to provide relevant materials and fails to do so even after being urged by the health and wellness authority, the occupational disease diagnosis institution may make a comprehensive determination based on clinical manifestations, auxiliary examination results, occupational history, the worker's self-account, testimony from workers in the same job category, and information from supervisory inspections [35].Where there is a dispute regarding the employment relationship, job category, position, or length of service, the parties may apply for arbitration with the Labor and Personnel Dispute Arbitration Committee in accordance with the law. Work-related injury determinations shall be handled by the social insurance administrative department in accordance with the law, while the calculation and payment of benefits shall be handled by the relevant departments and social insurance agencies in accordance with their respective responsibilities.

Records related to occupational health examinations, social insurance enrollment, and employment documentation arising from cross-regional employment may be gradually integrated, provided that lawful authorization is obtained and personal information is protected.When government departments use health data for regulatory purposes, they must clearly state the purpose of use, access rights and retention period to prevent health information from being used for employment discrimination. When the company is dissolved, the responsible party is difficult to determine or the relevant procedures have not been completed, the basic medical and living difficulties of the patient can be solved through basic medical insurance, medical assistance and the existing social assistance system. Once the responsibility is determined, the payment of benefits and the recovery of expenses shall be handled in accordance with the law.

The patient's testimony can supplement the impact of the disease on his life that is difficult to capture in administrative records and statistical indicators. Under the premise of obtaining the consent of patients and protecting their personal privacy, social organizations, writers and journalists can use written records, documentaries and news reports to describe patients' experiences and bring issues such as employment interruption, family care burden, harm caused by long-term waiting for diagnosis, and social discrimination into public discussion. These narratives help society better understand the experience of patients with pneumoconiosis and provide relevant insights for planning evaluation and policy research. The diagnosis of occupational diseases and the determination of work-related injuries must still comply with the statutory evidence requirements and procedures.

Government departments should solicit patient feedback in project evaluation and special research, and provide progress in policy implementation through existing government transparency channels. Trade unions, legal aid agencies and public welfare organizations can address issues of common concern by conducting investigations, submitting legislative proposals, providing legal aid and conducting public awareness activities. The resulting public participation can ensure that the management of pneumoconiosis always prioritizes diagnosis, treatment, rehabilitation, social security and legal relief, while taking into account the actual situation of migrant workers and their families.

5. Conclusion

A comprehensive analysis of international experience and Chinese data indicates that the management of pneumoconiosis faces a time lag resulting from the disease's incubation period and the liability determination mechanism. Workers are exposed to dust while on the job,the disease may not be detected until many years after they have left their jobs or the enterprise has ceased operations. With the interruption of occupational history and health monitoring records, the health costs generated by the production process are gradually transferred to the patient's home and local relief system. Neither the number of insured persons at the provincial level nor the allocation of health professionals showed a stable association with the outcome. This indirectly shows that institutional resources must truly cover dust-exposed workers and be integrated into the diagnosis, identification and reimbursement processes in order to be transformed into effective safeguards.

In the next stage of institutional development, in view of the chronic characteristics of pneumoconiosis, responsibility must be reallocated across the relevant institutions. Vocational schools should actively carry out occupational disease prevention education. The contact history and health records accumulated by the employee during the service

should be kept by the employee himself and can be used in different jobs to ensure that the disease that occurs many years later can still be traced back to the corresponding workplace. Once the patient begins to be diagnosed and treated, the relevant departments should determine the responsibility according to the complete chain of evidence. If the responsible party cannot be determined immediately, treatment and rehabilitation should not be delayed by the waiting period for procedures. The policy assessment should shift the focus from the scale of medical investment to the actual results, examining whether dust exposure is reduced and whether patients have timely access to services and benefits.

Due to data limitations, this article examines the governance environment at the macro level based on the reported incidence of tuberculosis. This approach can only reflect the concurrent changes in relevant factors; it cannot directly quantify the burden of pneumoconiosis or establish causal relationships. In the future, once continuous data on occupational dust exposure and pneumoconiosis cases become available, the aforementioned mechanisms of temporal lag and the shift in health costs can be further verified.

References

[1] Heppleston, A. G. (1988). Prevalence and pathogenesis of pneumoconiosis in coal workers. Environmental Health Perspectives, 78, 159–170. https://doi.org/10.1289/ehp.8878159.

[2] Fujimura, N. (2000). Pathology and pathophysiology of pneumoconiosis. Current Opinion in Pulmonary Medicine, 6(2), 140–144. https://doi.org/10.1097/00063198-200003000-00010.

[3] Leung, C. C., Yu, I. T. S., & Chen, W. (2012). Silicosis. The Lancet, 379(9830), 2008–2018. https://doi.org/10.1016/S0140-6736(12)60235-9.

[4] GBD 2019 Diseases and Injuries Collaborators. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019. The Lancet, 396(10258), 1204–1222. https://doi.org/10.1016/S0140-6736(20)30925-9.

[5] Qi, X. M., Luo, Y., Song, M. Y., et al. (2021). Pneumoconiosis: current status and future prospects. Chinese Medical Journal, 134(8), 898–907. https://doi.org/10.1097/CM9.0000000000001461.

[6] Mehta, A. J., Miedinger, D., Keidel, D., et al. (2012). Occupational exposure to dusts, gases, and fumes and incidence of chronic obstructive pulmonary disease. American Journal of Respiratory and Critical Care Medicine, 185(12), 1292–1300. https://doi.org/10.1164/rccm.201111-2041OC.

[7] Rose, C., Heinzerling, A., Patel, K., et al. (2019). Severe silicosis in engineered stone fabrication workers: California, Colorado, Texas, and Washington, 2017–2019. MMWR Morbidity and Mortality Weekly Report, 68(38), 813–818. https://doi.org/10.15585/mmwr.mm6838a1.

[8] Hoy, R. F., Baird, T., Hammerschlag, G., et al. (2018). Artificial stone-associated silicosis: a rapidly emerging occupational lung disease. Occupational and Environmental Medicine, 75(1), 3–5. https://doi.org/10.1136/oemed-2017-104686.

[9] Blackley, D. J., Halldin, C. N., & Laney, A. S. (2018). Continued increase in prevalence of coal workers' pneumoconiosis in the United States, 1970–2017. American Journal of Public Health, 108(9), 1220–1222. https://doi.org/10.2105/AJPH.2018.304504.

[10] Hall, N. B., Blackley, D. J., Halldin, C. N., & Laney, A. S. (2019). Current review of pneumoconiosis among U.S. coal miners. Current Environmental Health Reports, 6(3), 137–147. https://doi.org/10.1007/s40572-019-00241-6.

[11] Mazurek, J. M., Wood, J. M., Blackley, D. J., & Weissman, D. N. (2018). Coal workers' pneumoconiosis-attributable years of potential life lost in terms of life expectancy and potential life lost before age 65: United States, 1999–2016. MMWR Morbidity and Mortality Weekly Report, 67(30), 819–824. https://doi.org/10.15585/mmwr.mm6730a3.

[12] Derickson, A. (1998). Black lung: Anatomy of a public health disaster. Cornell University Press.

[13] Boden, L. I., & Ozonoff, A. (2008). Capture-recapture estimates of nonfatal workplace injuries and illnesses. Annals of Epidemiology, 18(6), 500–506. https://doi.org/10.1016/j.annepidem.2008.02.001.

[14] Leigh, J. P. (2011). Economic burden of occupational injury and illness in the United States. Milbank Quarterly, 89(4), 728–772. https://doi.org/10.1111/j.1468-0009.2011.00648.x.

[15] Blanc, P. D., Annesi-Maesano, I., Balmes, J. R., et al. (2019). The occupational burden of nonmalignant respiratory diseases: an official American Thoracic Society and European Respiratory Society statement. American Journal of Respiratory and Critical Care Medicine, 199(11), 1312–1334. https://doi.org/10.1164/rccm.201904-0726ST.

[16] National Institute for Occupational Safety and Health. (2021). The OSH Act—A response to workplace tragedies. Centers for Disease Control and Prevention.

[17] Mine Safety and Health Administration. (n.d.). History. U.S. Department of Labor.

[18] Mine Safety and Health Administration. (n.d.). History of Mine Safety and Health Legislation. U.S. Department of Labor.

[19] U.S. Department of Labor, Benefits Review Board. (n.d.). Black Lung Deskbook, Part I: General History and Purposes. U.S. Department of Labor.

[20] U.S. Government Accountability Office. (2009). Black Lung Benefits Program: Administrative and Structural Changes Could Improve Miners' Ability to Pursue Claims. U.S. Government Accountability Office.

[21] National Institute for Occupational Safety and Health. (2024). Hierarchy of Controls. Centers for Disease Control and Prevention.

[22] Mine Safety and Health Administration. (2014). Lowering miners' exposure to respirable coal mine dust, including continuous personal dust monitors. Federal Register, 79 FR 24813.

[23] National Institute for Occupational Safety and Health. (2021). Respiratory health research at NIOSH. Centers for Disease Control and Prevention.

[24] Safe Work Australia. (2024). Engineered Stone Ban. Australian Government.

[25] National Health Commission et al. (2021, December 7). National Plan for the Prevention and Control of Occupational Diseases (2021–2025).

[26] Wu, Q. (2024, April 26). "Half the Time, Half the Tasks" in the National Plan for the Prevention and Control of Occupational Diseases. Health Daily.

[27] Standing Committee of the National People's Congress. (2018, December 29). Law of the People's Republic of China on the Prevention and Control of Occupational Diseases (Amended in 2018).

[28] Supreme People's Procuratorate. (2025, February 27). Beware of Occupational Diseases! Protecting Neglected Health—"Safeguarding Workers" Series Report 4.

[29] Supreme People's Procuratorate. (2025, August 4). Rescuing Those "Trapped" in Dust.

[30] Supreme People's Procuratorate. (2023, April 28). "Procuratorial Work Serving the People"—A Series of Typical Cases on Administrative Procuratorial Work in Step with the People (11th Batch).

[31] World Health Organization, & International Labour Organization. (2021). WHO/ILO Joint Estimates of the Work-Related Burden of Disease and Injury, 2000–2016: Global Monitoring Report. World Health Organization and International Labour Organization.

[32] National Health Commission. (2021, July 13). Statistical Bulletin on the Development of China's Health Sector in 2020.

[33] State Council. (2026, July 7). Notice of the State Council on Issuing the "15th Five-Year Plan for National Health" (State Council Document [2026] No. 23).

[34] National Center for Disease Control and Prevention, et al. (2026, July 21). Notice on Issuing the "15th Five-Year Plan for Disease Prevention and Control" (Guojikong Guicai Fa [2026] No. 17).

[35] National Health Commission. (2021, January 4). Measures for the Administration of Occupational Disease Diagnosis and Appraisal (Order No. 6 of the National Health Commission).

[36] National Health Commission. (2022, August 5). Response to Proposal No. 6635 of the Fifth Session of the 13th National People's Congress.

[37] National Health Commission. (2024, April 25). Transcript of the National Health Commission Press Conference on April 25, 2024.