Article

Socioeconomic Status, Occupational Disease, and Psychological Well-Being: Evidence from People with Pneumoconiosis in China

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Abstract: Background: Pneumoconiosis is one of the most prevalent occupational diseases in China. The present study aims to examine the status, needs, and challenges of people with pneumoconiosis from a socioeconomic perspective and to reveal the mechanisms by which the disease is linked to their psychological well-being. This study also examines the association of the social security subsidy to such mechanism. Methods: A questionnaire survey of 1134 respondents from seven cities or districts in China was conducted from 2014 to 2016. Generalized Structural Equation Modeling (GSEM) was employed to complete the analysis using Stata 16. Results: Respondents with poor socioeconomic status engaged longer in dusty work and had higher stages of pneumoconiosis, complications, and aggravation. These, in turn, were linked to their socioeconomic status due to high treatment expenditure and loss of the ability to work, which were negatively associated with their psychological well-being. Social security assistance and subsidies could help improve their socioeconomic status. Conclusions: This study provides evidence for the mechanism of social factors linking to physical health and further to psychological well-being among people with pneumoconiosis. Social security assistance and subsidies should be urgently provided for them to improve their socioeconomic status and their psychological well-being.

Keywords: pneumoconiosis; clinical characteristics; socioeconomic status; psychological well-being; social security subsidy; China

1. Introduction

Occupational safety and environmental justice have been negatively affected by erratic and uncertain development in China and in an international context, leading to public health issues, social inequality, and environmental risks, especially in high-risk industries such as mining and construction (Tam et al. 2004; Donoghue 2004; Fong and Mou 2014). Pneumoconiosis, also called occupational lung disease, is a serious global occupational risk factor (Hämäläinen et al. 2017). Pneumoconiosis is still an important public health issue in the current world and has caused great disease burden (Wang et al. 2021). It leads to irreversible lung damage and loss of the ability to work, which affects people's quality of life negatively (Han et al. 2019; Liu 2021). In China, pneumoconiosis is one of the most prevalent occupational diseases (Wang et al. 2016). The most recent data, from the end of 2018, shows that there are 873,000 pneumoconiosis cases in China, which account for nearly 90% of all occupational disease cases (Chinese Center for Disease Control and Prevention 2019).

The existing research on the condition of people with pneumoconiosis in China is far from adequate to solve the related individual and social issues. A large amount of existing

research focuses extensively on the epidemiological investigation of people with pneumoconiosis (Han et al. 2019; Li et al. 2018; Xia et al. 2014). An epidemiological perspective attributes great importance to the physical wellness of people with pneumoconiosis, while their psychological well-being, an understanding of which focuses on their perceptions and experiences and those of their family members, is relatively limited. Though some studies have examined various indicators of the psychological well-being of people with pneumoconiosis, further clarification should be done to control for pneumoconiosis-related variables (Lee 2011; Tang et al. 2006), the pathways and mechanisms by which pneumoconiosis influences people's well-beings. More quantifiable evidence and analysis are required to address these issues.

In addition, people's psychological well-being is not merely an individual outcome of the disease but is also constrained by social and structural factors that influence their socioeconomic status. Previous research has examined macro- and micro-linkages when examining the individuals' psychological well-beings and found the influence of macro-level factors, particularly socioeconomic standing, on micro-level psychological well-being (Ryff et al. 1999). Although the literature is not limited to the context of pneumoconiosis, it provides valuable perspective to understand the pneumoconiosis situation in China. Instead of seeing pneumoconiosis as an individual health problem, a shift in perspective that analyzes and understands it in the context of social, economic, and environmental development and changes in China is required (Gong et al. 2012).

Moreover, current studies on people with pneumoconiosis in China tend to be conducted using small-size data from one enterprise unit or institute (Han et al. 2015; Jin et al. 2018), or using large-size data that is limited to one region (Han et al. 2019). The 2019 *Action Plan on the Prevention and Treatment of Pneumoconiosis*, jointly formulated by 10 governmental departments, indicates that a survey on a larger scale of people with pneumoconiosis is urgently required for policy making as well. A larger investigation of the lives of people with pneumoconiosis in a broader, multi-regional, or even national scale would be more representative to reveal the post-illness lives of people with pneumoconiosis.

To address the above-mentioned issues and to provide more relevant and updated information for policy making, we conducted a questionnaire survey in seven provincial regions in China from 2014 to 2016 to understand the socioeconomic, medical, and physical and psychological well-being of people with pneumoconiosis. Using data from this survey, the present study aims to examine the status, needs, and challenges of people with pneumoconiosis from a socioeconomic perspective and reveal the mechanisms by which the disease affects their psychological well-being. The main research question (RQ) is whether the socioeconomic status of people with pneumoconiosis is linked to their years of engaging in dusty work, the clinical characteristics of pneumoconiosis, post-illness socioeconomic status, and psychological well-being. More specifically (see Figure 1):

RQ 1a: Is the previous socioeconomic status of people with pneumoconiosis associated with their years of engaging in dusty work?

RQ 1b: Is the previous socioeconomic status of people with pneumoconiosis associated with the clinical characteristics of people with pneumoconiosis?

RQ 2: Are their years of engaging in dusty work associated with the clinical characteristics of people with pneumoconiosis?

RQ 3: Are clinical characteristics of pneumoconiosis associated with the treatment expenditure, employment status, and current socioeconomic status of people of with pneumoconiosis?

RQ 4: Are clinical characteristics of pneumoconiosis associated with the psychological well-being of people with pneumoconiosis?

RQ 5: Is social security associated with the post-illness socioeconomic status and psychological well-being of people with pneumoconiosis?

RQ 6: Is their previous and current socioeconomic status associated with the psychological well-being of people with pneumoconiosis?
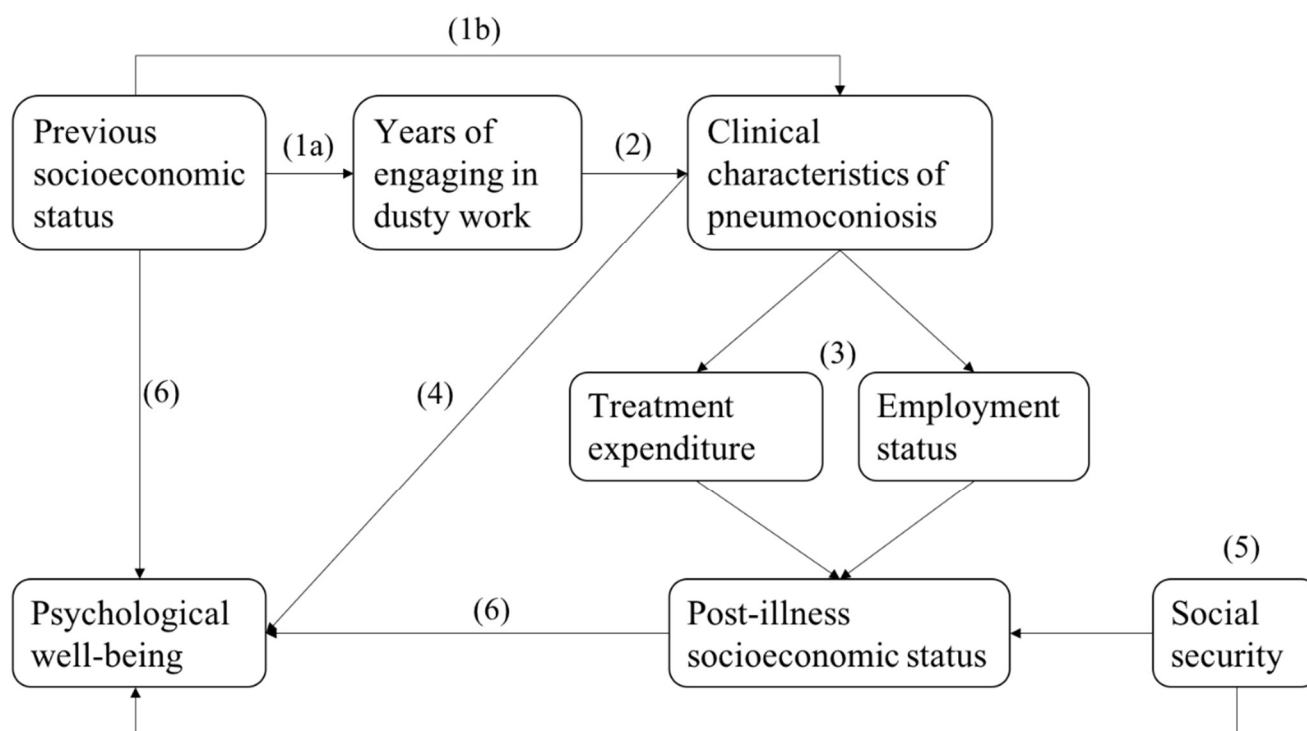
Figure 1. Research Framework of the Direct Links among the Examined Variables.

This analysis is expected to offer empirical evidence for the vicious cycle of being poorer leading to more severe clinical characteristics of pneumoconiosis, and more severe clinical characteristics of pneumoconiosis making people poorer (Da Ai Qing Chen (Love Save Pneumoconiosis) 2015, 2016). The analysis is also expected to offer evidence for the psychological consequences of the vicious cycle. Furthermore, it examines whether a social security subsidy can help break the vicious cycle of pneumoconiosis in China by improving the respondents' socioeconomic status. The findings of this study may contribute to the reform of the social security program in China, particularly the work-related injury insurance.

2. Methods

2.1. Study Design and Sampling

We conducted a questionnaire survey in seven provincial regions of China, which was held between June 2014 and January 2016. The purpose of this survey was to reflect the situation of people with pneumoconiosis comprehensively, particularly their post-illness lives, socioeconomic status, clinical characteristics, medical treatment and rehabilitation, social participation in daily life, social security needs, and their psychological well-being. In this survey, Chinese people who currently have pneumoconiosis were selected as the sampling population, and people with pneumoconiosis and their families were selected as the sampling unit. Based on the extant literature and expert consultation, we first used judgmental sampling to choose seven cities or districts that have a high concentration of pneumoconiosis cases as our sampling frame: Fangshan District of Beijing Municipality, Chaoyang City in Liaoning Province, Shiyan City in Hubei Province, Jiujiang City in Jiangxi Province, Lu'an City in Anhui Province, Wuwei City in Gansu Province, and Ankang City in Shanxi Province. The details of the survey are provided in Table S1.

In each city or district, a combination of cluster sampling, convenience sampling, and snowballing sampling was used to collect data. Specifically, for areas where the number of people with pneumoconiosis was less than 200[1], all the people with pneumoconiosis were surveyed using cluster sampling. For areas where the number was over 200, convenience sampling and snowball sampling were used to select respondents. The questionnaire used

in the survey was adapted from the Chinese version of the World Health Organization's Instrument for Measuring Quality of Life (WHOQOL-100) and St. George's Respiratory Questionnaire (SGRQ). We collected a total of 1190 questionnaires from the respondents, of which 1134 were valid[2]. Since over 95% of the questionnaire responses were valid, the survey can be considered reliable. The necessary ethics issues were considered by a research foundation, and the participants provided informed consent. The majority of the respondents in the survey had silicosis (997 respondents, 87.92% of the total sample)[3], hence this article examines the outcome for pneumoconiosis in general without distinguishing different types.

2.2. Variables and Measurements

The level of psychological well-being was measured using the following twelve items from the WHOQOL-100: (1) "How do you evaluate your mental status?" (2) "How often do you have negative feelings such as blue mood or anxiety?" (3) "How often do you have insomnia?" (4) "How much do you enjoy life?" (5) "To what extent do you feel your life to be meaningful?" (6) "How well are you able to concentrate?" (7) "Do you have enough energy for everyday life?" (8) "How often do you worry about future life?" (9) "How often do you feel scared?" (10) "How much confidence do you have in your treatment?" (11) "How much hope do you have in your future life?" and (12) "Are you satisfied with your current situation?" These items offer information about the mental status of people with pneumoconiosis, and it was ensured that they were clearly understood by the respondents. Items (1), (10), and (11) were reverse coded so that higher scores would indicate better psychological well-being. The Cronbach's alpha of the twelve items was 0.836 (N = 1134), suggesting that the items have relatively high internal consistency. The level of psychological well-being was measured by summing the scores of the twelve items, with higher total scores indicating better psychological well-being.

"Years of engaging in dusty work" was chosen to represent the respondents' engagement in dusty work in this study. Previous studies have indicated that the exposure time to dust plays an important role in the development of pneumoconiosis (Wang et al. 2016). The responses were recoded as intervals based on the five categorical options (less than 5 years; 5–10 years; 10–15 years; 15–20 years; and more than 20 years) in the questionnaire.

The stage of pneumoconiosis was often used as the main clinical characteristic of pneumoconiosis in previous studies when evaluating its prevalence and trends (Han et al. 2019; Xia et al. 2014). However, most studies treat the stage at which pneumoconiosis is diagnosed as static and do not account for its progression. In this study, three variables, namely, the stage of pneumoconiosis, complications, and the progression of pneumoconiosis, were selected as the main clinical characteristics of pneumoconiosis.

Treatment expenditure, including payments for hospital visits and stays, medicine, and rehabilitation, are direct losses for people due to pneumoconiosis, while a change in employment status due to the loss of ability to work is an indirect loss (Shen et al. 2015). In this study, we consider the treatment expenditure of pneumoconiosis per year and the current employment status as two outcomes of pneumoconiosis.

The current socioeconomic status of respondents can be measured both objectively and subjectively. In this study, the respondents' objective socioeconomic status was measured using their household monthly income. We used "household" as the unit because previous evidence shows that people tend to return to their hometown after being diagnosed with pneumoconiosis and their families bear the burden of their living and treatment expenditure (Zhang 2019). Using the same rationale, subjective socioeconomic status is measured by self-reported family economic conditions. The amount of money obtained from social security programs was used as a variable to measure the effects of social security programs.

Exogenous variables in this research included age, gender, marital status, ethnicity, education level, household registration (*hukou* in Chinese) type, occupational type before the diagnosis of pneumoconiosis, and residence area. *Hukou* is a social stratification system in China: People in China can have agricultural (also called rural) *hukou* or non-agricultural

(also called urban) *hukou*. People's access to welfare and services is tied to their *hukou* location, which means those who migrate without changing their *hukou* location do not have access to certain welfare and services (Chan 2009; Li 2006). Education, occupation, and income have been commonly used in previous research as indicators of socioeconomic status for health research (Winkleby et al. 1992). Since the respondents' income level before the diagnosis is highly related to their occupation, we use occupational type before the diagnosis of pneumoconiosis as a distant socioeconomic indicator.

The variables of treatment expenditure of pneumoconiosis per year, household monthly income, and the money obtained from social security programs were all transformed into continuous variables by using the intervals from the original categorical options in the questionnaire. The continuous values of the three variables were naturally log-transformed in the analysis. The details of the variables are provided in Table S2.

2.3. Analysis Plan

In order to answer the research questions, Generalized Structural Equation Modelling (GSEM) was employed to examine the hypothesized relationships (StataCorp LLC 2019). The associations among exogeneous and endogenous variables can be estimated concurrently in GSEM. Using GSEM, categorical variables can be transformed into dummy variables. In this study, it is understandable if we consider some variables to be categorical, such as the stage of pneumoconiosis, complications, and progression of pneumoconiosis. This is because "not sure" is also considered as a valid response for these variables. For ordered variables, an ordered logit model (i.e., an ordinal family and logit link function) was used in the GSEM path links; for continuous variables, the Gaussian family and identity link function were employed. We only included the data for respondents who have valid data for all the selected variables in the GSEM analysis ($N = 1059$).

To test the robustness of the GESM results, we analyzed an additional model, and the results of the model are shown in Table S3. This model included respondents who had missing values of the treatment expenditure variable, and thus, there were different valid numbers for respondents in different paths. We compared the models with and without missing values of the treatment expenditure variable to check if the results are robust. All the analyses were conducted using Stata 16.

3. Results

3.1. Characteristics of the Study Participants

Among the study participants ($N = 1134$), age at baseline averaged 53.36 (standard deviation (SD) = 10.82) years. Over 99% of the participants were male, which is consistent with previous findings that the majority of people with pneumoconiosis in China are males (Zhao et al. 2019).

Nearly 98% were of Han ethnicity. Over 78% of the respondents lived in rural areas and held rural *hukou*s. 95.4% of the respondents were married. Over half of the respondents had an education level equivalent to or less than primary school. Nearly 90% of the respondents worked or had worked in the mining industry, which is consistent with the high prevalence of pneumoconiosis among coal workers in China (Mo et al. 2014).

The mean psychological well-being value was 32.684 (SD = 7.112, whole sample) and 32.533 (SD = 6.959, sample without missing values). On an average, the respondents had engaged in dusty work for over 12 years. The distributions of pneumoconiosis stages, stage progression, complications, and current employment status are slightly different among the whole sample and the respondents without any missing values, yet in similar trend. However, considering that some of the respondents were unaware of their pneumoconiosis stage and some did not have their physical health checked due to financial burden, the actual situation may be worse. Compared to the respondents without any missing value, those of the whole sample had slightly lower monthly household income and obtained fewer social security subsidy but had treatment expenditure of pneumoconiosis (Table 1). The treatment expenditure constituted nearly half of the yearly household income plus

social security subsidy. Thus, over three quarters of the respondents regarded their families' economic conditions as quite poor or very poor compared to the whole Chinese population.

Table 1. Descriptive Statistics of the Analysis Variables.

Variables	Total Sample (with Missing Value)	Sample without Missing Value
N	1134	1059
Endogenous variables		
Psychological well-being	32.684 (7.112)	32.533 (6.959)
Years of engaging in dusty work (%)	12.046 (7.151)	12.212 (7.143)
Stage of pneumoconiosis (%)		
Pneumoconiosis stage I	28.75	27.48
Pneumoconiosis stage II	35.54	36.54
Pneumoconiosis stage III	17.64	18.60
Not clear about the stage	18.08	17.37
Complications (%)		
No complications	50.35	49.95
At least one complication	36.51	37.87
Not sure whether there are complications	13.14	12.18
Progression of pneumoconiosis stage (%)		
No aggravation of pneumoconiosis stage	58.02	57.88
Aggravation of pneumoconiosis stage	21.43	22.57
Not sure whether pneumoconiosis stage	20.55	19.55
Current employment status (%)		
Work inability	40.92	42.12
Have work ability but unemployed	2.56	2.17
Agricultural work	19.75	18.79
Non-agricultural work	17.37	16.81
Retired or other situations	19.40	20.11
Household income per month (RMB)	1945.642 (1119.753)	1967.505 (1127.511)
Ln value of household income per month	7.386 (0.634)	7.397 (0.636)
Self-rated family economic conditions (%)		
Very poor, often in debt	33.07	33.43
Quite poor, needs careful calculation	40.74	41.55
Average, but meets basic expenses	24.60	23.80
Quite good	1.59	1.23
Treatment expenditure of pneumoconiosis per year (RMB)	6964.027 (6353.961)	6964.027 (6353.961)
Ln value of treatment expenditure	8.441 (0.908)	8.441 (0.908)
Exogenous variables		
Gender (%)		
Female	0.97	0.94
Male	99.03	99.06
Marital status (%)		
Single, divorced or widowed	4.59	4.34
Married	95.41	95.66
Ethnicity (%)		
Minority	2.38	2.46
Han	97.62	97.54

Table 1. *Cont.*

Variables	Total Sample (with Missing Value)	Sample without Missing Value
Age	53.362 (10.823)	53.358 (10.864)
Educational attainment (%)		
Primary school and below	54.41	53.82
Middle school	39.42	39.94
High school and above	6.17	6.23
Hukou type (%)		
Rural *hukou*	78.57	77.81
Urban *hukou*	21.43	22.19
Residence area (%)		
Rural area	78.40	77.71
Urban area	21.60	22.29
Occupational type (%)		
Other relevant occupation	10.41	9.92
Mining	89.59	90.08
Social security subsidy per month (RMB)	878.571 (823.236)	903.287 (831.162)
Ln value of social security subsidy per month	6.235 (1.097)	6.266 (1.104)

Note: Sample means are not weighted. Standard deviations are listed in parentheses.

3.2. GSEM Results

The detailed links are provided in Table 2. The degree of freedom in the GSEM analysis was 168. In Path (1), compared with those who had an education level of primary school and below, people with middle school education (b = -0.816, $p < 0.05$) and high school or higher education (b = -0.722, $p > 0.05$) had fewer years of engaging in dusty work, though the latter one is not statistically significant. People who worked in the mining industry had more years of engaging in dusty work (b = 2.815, $p < 0.001$). Interestingly, those who held an urban *hukou* (b = 6.883, $p < 0.001$) were more likely to have more years of engaging in dusty work.

People who had more years of engaging in dusty work were more likely to have more serious stages of pneumoconiosis (Odds ratio (OR) = 1.084, $p < 0.001$, Path (2)), complications (OR = 1.032, $p < 0.01$, Path (3)), and aggravation of pneumoconiosis stage (OR = 1.018, $p < 0.1$, Path (4)). In Paths (2)–(4), education level was not statistically linked to any clinical characteristics in a significant way. Those who worked in the mining industry were more likely to have more serious stages of pneumoconiosis (OR = 1.572, $p < 0.05$, Path (2)) and progression of their pneumoconiosis stage (OR = 3.058, $p < 0.001$, Path (4)).

In Path (5), compared to those who have pneumoconiosis stage I, those who have stage III (b = 0.399, $p < 0.001$) have greater expenditure for the treatment of pneumoconiosis. Compared to those who did not have complications, those who had at least one complication (b = 0.243, $p < 0.001$) or those who were unsure about their complications (b = 0.183, $p < 0.05$) had greater treatment expenditure. In Path (6), compared to those who had pneumoconiosis stage I, those who had stage III (OR = 0.279, $p < 0.001$) or those who were unsure about their stage (OR = 0.627, $p < 0.05$) were less likely to be employed. Compared to those who did not have complications, those who had at least one complication (OR = 0.550, $p < 0.001$) were less likely to be employed.

Table 2. Results of the Examined Direct Links Using GSEM Analysis (*N* = 1059).

	(1) Dusty work [a]	(2) Stage of pneumoconiosis [b]	(3) Complications [b]	(4) Progression of pneumoconiosis stage [b]	(5) Treatment expenditure [a]	(6) Current employment status [b]	(7) Household income per month [a]	(8) Self-rated family economic conditions [b]	(9) Psychological well-being [a]
Age	0.029	0.989 [!]	1.008	0.987 [!]	−0.013 ***	1.002	0.008 ***	1.047 ***	−0.011
Male	2.052	0.582	0.499	0.251 *	−0.366	0.168 **	0.301 [!]	0.442	1.071
Married	2.406 **	0.623 [!]	1.077	0.868	−0.124	1.508	0.191 *	0.918	0.348
Han ethnicity	−1.485	0.292 **	0.729	0.246 ***	−0.039	0.685	−0.125	1.257	−0.176
Education level									
Middle	−0.816 *	0.839	1.044	1.186	−0.049	0.906	0.046	0.937	0.814 *
High and above	−0.722	0.742	0.893	1.205	0.074	0.547 [!]	0.230 **	2.200 **	0.808
Urban *Hukou*	6.883 ***	0.786	0.846	1.208	−0.416 *	6.675 ***	0.070	1.031	1.242
Mining occupation	2.815 ***	1.572 *	1.214	3.058 ***	−0.176 [!]	0.958	−0.104 [!]	0.661 [!]	−1.376 *
Urban area	3.556 **	0.281 **	0.842	0.635	−0.212	14.187 ***	0.187	1.009	−0.401
Stage of pneumoconiosis									
Stage II					0.035	0.846	−0.002	0.711 *	0.514
Stage III					0.399 ***	0.279 ***	0.010	0.627 *	−0.992
Not sure					0.113	0.627 *	0.044	0.557 **	1.399 *
Complications									
At least one					0.243 ***	0.550 ***	−0.051	0.994	−1.270 **
Not sure					0.183 *	0.860	−0.067	0.820	−0.750
Progression of pneumoconiosis stage									
Aggravation					0.109	1.098	0.052	1.379 [!]	−1.466 **
Not sure					−0.037	1.253	−0.081 [!]	1.019	−2.351 ***
Dusty work		1.084 ***	1.032 **	1.018 [!]	0.033 ***	1.047 ***	0.000 [c]	0.942 ***	−0.017
Treatment expenditure							−0.063 **	0.636 ***	−0.444 [!]
Current employment status									
Have work ability but unemployed							−0.203 [!]	1.692	−2.599 *
Agricultural							0.131 **	1.596 **	1.154 *
Non-agricultural							0.354 ***	2.758 ***	2.333 ***
Retired or other							0.343 ***	3.448 ***	0.918

Table 2. *Cont.*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Money from social security programs							0.083 ***	1.350 ***	0.195
Household monthly income									0.398
Self-rated family economic conditions									
Quite poor, needs careful calculation									2.205 ***
Average, but meets basic expenses									5.436 ***
Quite good									8.333 ***
_cons	3.268				9.328 ***		6.476 ***		30.434 ***

Note: [a] For Paths (1), (5), (7), and (9), the effect measure is b. [b] For Paths (2), (3), (4), (6) and (8), the effect measure is OR. [c] 0.0003876. [!] $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. GSEM results reported unstandardized coefficients.

In Path (7), those who had more treatment expenditure (b = −0.063, *p* < 0.001) had lower household monthly incomes. Compared with those who had lost the ability to work, those who were engaged in agricultural work (b = 0.131, *p* < 0.01), non-agricultural work (b = 0.354, *p* < 0.001), and were retired or in other situations (b = 0.343, *p* < 0.001) had higher household monthly incomes. Those who could work but were unemployed had lower household incomes (b = −0.203, *p* < 0.1), although the association was only marginally significant. Those who obtained more money from social security programs (b = 0.083, *p* < 0.001) had higher household monthly incomes.

In Path (8), those who had greater treatment expenditure (OR = 0.636, *p* < 0.001) were less likely to have better self-reported family economic conditions. Compared to those who had lost the ability to work, respondents who were engaged in agricultural work (OR = 1.596, *p* < 0.01), non-agricultural work (OR = 2.758, *p* < 0.001), and were retired or in other situations (OR = 3.448, *p* < 0.001) were more likely to have better self-reported family economic conditions. Those who obtained more money from social security programs (OR = 1.350, *p* < 0.001) were more likely to have better self-reported family economic conditions.

In Path (9), the objective household monthly income was not significantly linked to psychological well-being (b = 0.398, *p* > 0.1). Nevertheless, self-reported family economic conditions were significantly associated with psychological well-being. Compared to those who self-reported family economic conditions as "very poor," those who selected "quite poor" (b = 2.205, *p* < 0.001); "average" (b = 5.436, *p* < 0.001); and "quite good" (b = 8.333, *p* < 0.001) had higher values of psychological well-being. The money obtained from social security programs was not significantly associated with psychological well-being (b = 0.195, *p* > 0.1). Compared to those who did not have complications, those who had at least one complication (b = −1.270, *p* < 0.01) had lower values of psychological well-being. Compared to those without aggravation of pneumoconiosis stage, those with aggravation (b = −1.466, *p* < 0.01) or unsure about whether they had aggravation (b = −2.351, *p* < 0.001) had lower values of psychological well-being.

4. Discussion

4.1. Socioeconomic Status and Clinical Characteristics of Pneumoconiosis

The findings indicate that the low socioeconomic status of people before being diagnosed with pneumoconiosis prolongs the number of years of engaging in dusty work, which can worsen the clinical characteristics of pneumoconiosis further. This is consistent with previous research that finds different groups of people have different exposure levels to environmental and occupational risks, and that vulnerable groups face disproportionate exposure to such risks and, consequently, have higher risk for environmental and occupational disease (Gochfeld and Burger 2011). Occupation status can not only be considered as an indicator of socioeconomic status, but can also be considered to be a direct indicator of environmental exposure (MacDonald et al. 2009; Burgard et al. 2003). Although most of the people with pneumoconiosis had rural *hukou*, the findings show that those who had urban *hukou* had longer years of engaging in dusty work than those who had rural *hukou*. A possible explanation is that people with urban *hukou* have access to certain kinds of welfare and services (Chan 2009; Li 2006), due to which they did not have to work on the front lines of mining, such as mining operation and ground blasting, for limited higher salary at the cost of their health. For example, they could work as security guards in the mines; in this case, they are still exposed to dusty environment, but much less than those who directly excavate mines. Thus, they could have longer years in dusty work. It is worth mentioning that such explanation needs more investigation in future studies.

The findings also clarify that the clinical characteristics of pneumoconiosis are linked to people's current socioeconomic status through their treatment expenditure and employment status. Existing studies have summarized that coal workers' pneumoconiosis leads to both direct economic costs, including medical fees, allowances and compensation, and indirect economic costs, including productivity losses, at the national level (Han et al. 2018;

Liang et al. 2003). Similarly, pneumoconiosis is also negatively associated with people's socioeconomic status at the individual level directly due to treatment expenditure and indirectly due to the loss of the ability to work. Although people who have work are more likely to have higher socioeconomic status, pneumoconiosis decreases the possibility that they could find appropriate jobs, and over 40% of the respondents had lost the ability to work. Therefore, their quality of life continues to be affected reversely.

4.2. Clinical Characteristics of Pneumoconiosis and Psychological Well-Being

The findings show that people with higher stages of pneumoconiosis, complications, and aggravation have lower values of psychological well-being. The negative relation of complications and aggravation to psychological well-being was found to be statistically significant. Previous study also found that aged Chinese patients with silicosis, one type of pneumoconiosis, had high prevalence of depressive symptoms, and respiratory symptoms, physical function, and pulmonary functions were associated with depressive symptoms (Wang et al. 2008). This correlation is understandable given that poor physical health is associated with poor mental health, and poor mental health is harmful for the treatment of physical conditions (Canadian Mental Health Association n.d.). Extant epidemiological research focuses more on the physical treatment and rehabilitation of people with pneumoconiosis (Han et al. 2019; Li et al. 2018; Xia et al. 2014), while the psychological aspect is relatively neglected. More studies should be conducted focusing on the psychological aspect to further address this gap.

4.3. Socioeconomic Status and Psychological Well-Being

Our study has found that people's socioeconomic status both before and after being diagnosed with pneumoconiosis is associated with their psychological well-being. Lower education level and working in the mining industry (indicating previous socioeconomic status) are likely to lower their psychological well-being. The current socioeconomic status of people with pneumoconiosis is negatively associated with their psychological well-being primarily in a subjective way. Subjective socioeconomic status not only considers what people have, but also what people believe they should have, and includes self-rated judgement, comparison, and evaluation (Adler et al. 2000).

People with pneumoconiosis benefit from participation in social security programs due to economic gains. Given that the social security subsidy directly improves the respondents' socioeconomic circumstances, extending the coverage of the social security subsidy is necessary, since many people with pneumoconiosis do not have enough access to these social security programs (Kerswell and Deng 2020). Although social security programs are effective in improving the post-illness socioeconomic status of people with pneumoconiosis and their families, their effectiveness in improving psychological well-being needs further investigation.

5. Conclusions

This study provides empirical evidence for how the socioeconomic status of people with pneumoconiosis is linked to their clinical characteristics, which is further associated with their post-illness socioeconomic status and their psychological well-being. In summary, this study offers proof for the vicious cycle of being poorer leading to more severe clinical characteristics of pneumoconiosis, and more severe clinical characteristics of pneumoconiosis making people poorer (Lee 2011; Li 2006) and its negative association with the patients' psychological well-being. Social security subsidy is beneficial for improving the economic situation of people with pneumoconiosis. Policies and practices are needed to break the vicious cycle by increasing socioeconomic support for people with pneumoconiosis and their families.

The present study has some limitations. Data availability is one issue. The years of being engaged in dusty work, income, and expenditure were all categorically measured rather than continuously. Only two measurements of education level and occupational

type can be used to indicate the previous socioeconomic status of people before engaging in dusty work, and in addition to them, *hukou* is included. Nevertheless, since education level tends not to change with the diagnosis of pneumoconiosis, and the occupational type pertains to a time before the diagnosis of pneumoconiosis, using them to capture patients' previous socioeconomic status is reasonable. Moreover, this study did not include people who have not been diagnosed with pneumoconiosis, hence a comparison between patients and non-patients could not be undertaken.

Notes

[1] Because of the uneven economic development among Chinese provinces, we first selected a few typical migrant-sending provinces based on the development status and the labor flow among regions. Then, we selected six of these provinces where people with pneumoconiosis are relatively concentrated based on the situation we learned of in the preliminary survey. Considering the statistical significance, we believe if over 200 samples can be collected in each province, they can reflect the status of people with pneumoconiosis in the province to a certain extent. In total, we would collect 1200 questionnaires in the selected six provinces, which met the sampling requirement of 95% confidence interval and 3% margin of error. However, in the practical survey, we did not collect 1200 questionnaires in the selected six provinces, and then we added Shaanxi to the surveyed provinces.

[2] Three main criteria of invalid questionnaires include: (1) 10% or more of the questions were unanswered or multiple answers were chosen; (2) 3% or more of the questions had conflicting answers; (3) if more than 50% of the questions had the identical answers in two questionnaires, these two questionnaires were considered invalid. Any questionnaire meets one of the three criteria is considered invalid.

[3] The distribution of other types of pneumoconiosis in the survey are coal workers' pneumoconiosis (6.61%), graphite (0.35%) carbon black (0.26%), asbestos (0.18%), talc (0.35%), cement (1.06%), mica (1.59%), welding workers' (0.62%), caster (0.35%) and other pneumoconiosis (0.71%).

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