

# The Current Situation and Policy Recommendations on The Influence of Air Pollution on the Health and Labor Supply of the Rural Mid-Aged and Elderly

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**Abstract:** Since the reform and opening up, China's industrialization and urbanization processes have accelerated. Blindly pursuing high-speed economic growth has led to a sharp deterioration of air quality, and rural areas have become "shelters" for high polluting and high energy consuming enterprises. Due to the incomplete rural medical insurance and medical assistance system, the ability of rural residents to resist disease risks is weak. Under the same air pollution conditions, rural residents exhibit stronger vulnerability and sensitivity. The aging of rural labor force is constantly intensifying, and middle-aged and elderly people have become the main force in the rural labor market. This article analyzes the inherent logical relationship and current situation between air pollution, health loss, and labor supply, and proposes corresponding policy recommendations for rural air pollution prevention and control, improving public health levels in rural areas, and accumulating rural human capital.

**Keywords:** Air pollution, Resident health, Labor supply, Rural mid-aged and elderly.

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## 1. Introduction

With the reform and opening up, China's industrialization and urbanization processes have accelerated, and blindly pursuing high-speed economic growth has led to serious damage to the ecological environment, with the sharp deterioration of air quality being the most prominent. According to the "Environmental Air Quality Standards" (GB 3095-2012), in December 2020, the average number of days with good air quality in 168 prefecture level and above cities in China was 64.8%. There were 51 cities with less than 50% of good air quality days, accounting for 30%. The number of days with PM<sub>2.5</sub> as the primary pollutant exceeding the standard is the highest [1]. In 2019, 239 cities in China had an Air Quality Index (AQI) that exceeded the standard, meaning 70.7% of cities did not meet the air quality standards [2]. Air pollution poses a serious threat to residents' health. According to the Global Burden of Disease Assessment released by the World Health Organization (WHO), in 2016, 1.15 million people in China died from chronic diseases related to air pollution, including 56600 deaths from lower respiratory tract infections, 147200 deaths from tracheal, bronchial, and lung cancer, 357700 deaths from ischemic heart disease, 327000 deaths from stroke, and 261800 deaths from chronic obstructive pulmonary disease. More seriously, air pollution poses a greater threat to infants and young children, with 6646 deaths related to air pollution in 2016 [3]. Numerous studies in the fields of virology and epidemiology have shown that air pollutants, especially PM<sub>2.5</sub>, are highly likely to induce chronic respiratory and cardiovascular diseases, thereby increasing the risk of mortality [4-6]. Research in the field of social sciences has also shown that long-term exposure to polluted air can affect people's life expectancy [7] and even lead to premature death [8].

Clinical medicine has shown that cardiovascular and chronic respiratory diseases caused by air pollution can be accompanied by symptoms such as headache, limb weakness, cough, chest tightness, shortness of breath, or difficulty

breathing [9]. Although long-term bed rest is not necessary, the resulting health loss can weaken the productivity of workers and prompt them to reduce their labor supply time. For manual laborers, healthy human capital is a key factor for manual laborers to earn wages in the labor market [10-11]. Impaired health will directly reduce work efficiency and shorten working hours. Within a certain time frame, rational economic agents achieve utility maximization by continuously adjusting the time allocation for leisure, market labor participation, and household labor. However, diseases can shorten the supply time of labor that maximizes utility, and even force workers to completely withdraw from the labor market, resulting in regional human capital loss. Therefore, formulating rigorous environmental regulations and policies, adopting strict pollution control measures, and formulating effective medical security policies are important means to protect the ecological environment, improve public health, and ensure sufficient supply of human capital. They are the focus of attention for every country and every era, and also the historical proposition faced by China under the concept of people-oriented development.

Nowadays, the "Lewis turning point" under the dual economic structure of urban and rural areas has emerged, and the siphon effect of urban agglomerations and urban agglomerations on rural human resources has been further strengthened. It is an undeniable fact that young rural labor force has flooded into cities, and middle-aged and elderly people have become the main force in the rural labor market. The aging of rural labor force is serious. The health status of middle-aged and elderly people is closely related to the effective supply of labor [13-14]. As they grow older, their health level decreases. Rural middle-aged and elderly people have limited physical strength and limited labor supply. In the premise that the popularization of agricultural mechanization has not yet achieved the expected effect, it may lead to the phenomenon of forests without protection, land without cultivation, and livestock without feeding. In the long run, phenomena such as land abandonment and extensive

cultivation will become increasingly severe. On the other hand, in order to promote industrial optimization and upgrading, save land and labor costs, urban industrial enterprises are gradually relocating to rural areas, and the proportion of rural industrial industries is increasing year by year, resulting in an increase in industrial waste gas emissions [15]. Many heavily polluting enterprises have relocated to rural areas to avoid environmental regulations, making rural areas a "pollution paradise" for polluting enterprises to evade punishment. In addition, rural waste incineration, coal burning for heating in winter, straw burning and other production and living behaviors further exacerbate the level of rural air pollution [3, 16-17]. Rural middle-aged and elderly people living in air polluted environments may have their physical functions damaged, leading to a decline in their health level and a shortened labor supply time. Existing research has shown that air pollution has a significant negative impact on the labor supply of people in economically developed areas [18-20]. Due to the difficulty of collecting relevant data in rural areas and the fact that environmental pollution in rural areas is often overlooked, there is still no clear conclusion on the relationship between air pollution in rural areas and residents' labor supply. However, the negative impact of air pollution on the health and labor supply of rural residents cannot be ignored.

To solve this problem, on the one hand, we need to find ways to keep more young people in rural areas, which is a medium - to long-term strategy that requires long-term efforts; On the other hand, we need to find ways to provide high-quality medical services for middle-aged and elderly people in rural areas, improve their health level, and promote effective labor supply, which is a "quick and effective" measure. However, the rural medical insurance and medical assistance system still needs further improvement. Rural residents lack effective means to reduce health losses when facing major or medium - to long-term diseases, and their ability to resist the risks brought by diseases is weak. Compared to urban residents, the high medical expenses may have a devastating impact on the economy of rural families, and the risk of poverty caused by illness and returning to poverty is much higher for rural residents than for urban residents. If the "poverty trap" caused by the impact of diseases is not timely contained, it will be difficult to consolidate the fruits of poverty alleviation and improve the quality of life and happiness index of rural residents.

Under the same air pollution conditions, rural residents exhibit stronger vulnerability and sensitivity. From the perspective of work environment, most urban residents are engaged in the tertiary industry, with short outdoor exposure time and mainly engaged in non physical labor. The working environment is relatively superior and comfortable, and the relationship between physical health and labor supply is relatively small [22]. Most rural residents engage in agricultural production activities, which are high-intensity physical labor, with harsh working environments and high requirements for physical fitness. Health has become an important factor affecting farmers' production behavior and income. At present, the basic economic system in rural areas of China is the household contract responsibility system. Agricultural production is mainly based on households, with strong autonomy in agricultural labor arrangements and greater flexibility in labor supply. The input of labor time is more sensitive to the health status of producers. Under the premise of not being able to increase the number of rural labor

force in the short term, improving the health status of rural residents can not only reduce the risk of poverty caused by illness and returning to poverty due to illness, but also improve rural human capital, increase labor productivity, and accumulate the production factors needed for rural economic growth [23]. Compared to young adults, middle-aged and elderly people have weaker immune systems and are more susceptible to the effects of air pollution on their health, leading to reduced physical function, shorter working hours, lower work efficiency, and ultimately a decrease in income [12]. In addition, as most rural residents have a long term residence in rural areas and have a relatively single type of work, studying rural mid-aged and elderly can help minimize estimation bias caused by population mobility and different work environments.

## **2. Current Situation of Air Contamination, Rural Residents' Health and Labor Supply**

This article uses the Air Quality Index (AQI) index and PM<sub>2.5</sub> concentration index data to analyze the alterations in China's air quality from 2014 to 2020, depict the current situation of air pollution, search for regional and seasonal characteristics of air pollution, reflect the effectiveness of China's air pollution prevention and control in recent years, and analyze the influencing factors of air pollution from five aspects: economic development level, energy consumption, technological level, population density, meteorological factors, etc. In reality, the aging of rural labor force is a serious problem that urgently needs to be solved. There is a necessary connection between health status and labor supply. The health status of middle-aged and elderly people is more susceptible to external environmental influences, and air pollution can directly harm the respiratory system, internal circulation, and body organs of middle-aged and elderly workers. It is necessary to analyze the health status of rural middle-aged and elderly people and the current situation of rural labor supply from a micro level, compare it with the location characteristics of air pollution, and explore the inherent relationship between air pollution, rural middle-aged and elderly people's health, and labor supply.

### **2.1. Current Situation of Air Pollution**

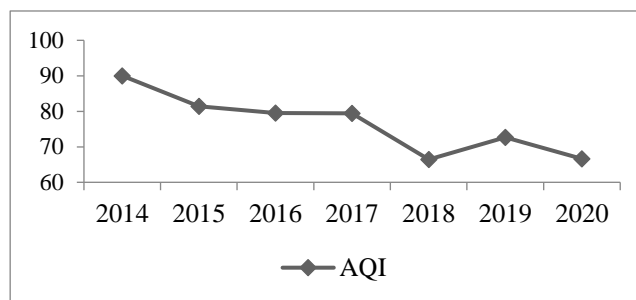
In the early stages of industrialization and urbanization, non green development models with high energy consumption and pollution have emerged in various countries around the world, resulting in varying degrees of environmental pollution. Especially in the industrial production process, various harmful substances, dust, and particulate matter at the right-hand end of the chemical equation are directly discharged into the atmosphere, greatly reducing air quality and causing serious air pollution. Especially the haze, with PM<sub>2.5</sub> as the main pollutant, has triggered a series of environmental pollution events, such as the Maas Valley smog event in Belgium, the Donora town smog event in the United States, the London smog event, and the Los Angeles photochemical smog event in the United States.

China has also experienced a period of high ecological costs in exchange for rapid development. With the acceleration of economic development, air pollution has become a historic issue that cannot be ignored. In recent years, the national and local governments have attached great

importance to the construction of ecological civilization, and have put forward a series of major measures such as high-quality economic development and supply side structural reform in the general direction. They have increased efforts to protect the ecological environment, launched a blue sky defense war, and made air pollution prevention and control a top priority in the daily work of ecological environment protection departments in various regions. Compared with the early 20th century, China's air quality has significantly improved in the past three years, but the achievements in air pollution prevention and control still need to be consolidated.

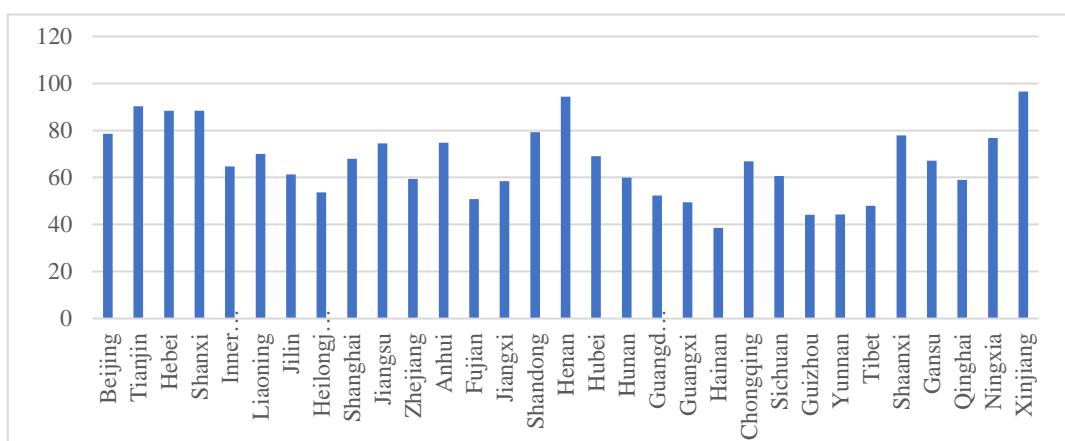
From the annual national level AQI values, from 2014 to 2020, the overall AQI showed a downward trend and did not exceed 100, indicating that the air quality level remained in a good state. The AQI value decreased from 87.21 in 2014 to 66.62 in 2020, especially between 2017 and 2018, where there was a significant drop of 19.61% in AQI value. There was a slight rebound in 2019, with an increase of 8.54%, but it fell to its lowest point in 2020, with a decrease of 9.04%. Overall, with the implementation of a series of policy measures such as the Blue Sky Defense War, China's air quality has gradually improved and air pollution levels have further decreased. However, in the process of urbanization and industrialization,

the development of large projects and infrastructure will lead to a serious rebound in air pollution. Although this is only a turning point in the trend, it indicates a decrease in air quality at that time, which may bring a series of adverse effects. Therefore, the prevention and control of air pollution and the construction of ecological civilization cannot be ignored or relaxed, and must always be on the road.



**Figure 1.** Changes in Air Quality in China from 2014 to 2020

By administrative division, in 2020, the AQI values of all 31 provinces and regions in China did not exceed 100, and the air quality remained stable throughout the year. Refer to Figure 2 for details.



**Figure 2.** Air Quality Index (AQI) of 31 provinces in China in 2020

In terms of pollution severity, the top 10 regions with the most severe air pollution are Xinjiang, Henan, Tianjin, Hebei, Shanxi, Shandong, Beijing, Shaanxi, Ningxia, and Anhui, with AQI values ranging from 73 to 96. It is worth noting that the main reason for the poor air quality and severe air pollution in Xinjiang is not due to the emission of polluting gases caused by industrial production. A large part of the factor is due to its harsh natural environmental conditions, which are often affected by sandstorms and yellow mist, resulting in a high concentration of inhalable particles in the air. Henan, Tianjin, Hebei, Shanxi, Shandong, Shaanxi, Ningxia, and Anhui follow closely behind. On the one hand, this is due to the rapid industrial development and high proportion of GDP in these nine provinces, as well as the need for coal heating in winter. On the other hand, they are also affected by weather factors such as sandstorms and droughts, resulting in poor air quality compared to other provinces in China. As the capital, Beijing's industrial structure is mainly dominated by the tertiary industry. In recent years, Beijing has been vigorously promoting air pollution control, striving to see blue skies and white clouds. Therefore, the air quality in Beijing has significantly improved. Qinghai, Jiangxi, Heilongjiang, Guangdong, Fujian, Guangxi, Xizang, Yunnan, Guizhou and Hainan are 10 provinces with good air quality in

China, and their AQI values do not exceed 60, especially in Fujian, Guangxi, Xizang, Yunnan, Guizhou and Hainan. The annual air quality is excellent (AQI is less than 50). The air quality of Xizang and Guangxi is excellent. On the one hand, the population density of these two provinces is relatively small, and they are population exporting provinces. The negative impact of human economic and social activities in this region on the natural environment is small. The other provinces with excellent air quality are concentrated in the southern region of China. Fujian, Guizhou, and Hainan are national ecological civilization pilot zones and the first batch of areas to carry out green and high-quality development reform pilot projects. They focus on the quality of economic development and the transformation and upgrading of traditional industries, with relatively low energy consumption.

## 2.2. Factors Affecting Air Pollution

Air quality is jointly influenced by the natural environment and human economic and social development. Previous studies have shown that meteorological factors and geographical environment can affect air pollution, mainly from a physical perspective that affects the state and concentration of pollutants in the air, such as wind speed, rainfall, and air pressure. Existing research has proven that

human social activities and economic development are the main sources of air pollution. This chapter mainly analyzes from the aspects of economic development level, pollutant emission level, industrial development level, urbanization level, etc. To further extend the time span of the data, the excellent days ratio is used here to reflect the degree of air pollution and air quality status.

### **2.2.1. Economic development level**

The characteristics of air pollution areas are obvious and are inevitably related to the level of local economic and social development. Therefore, this chapter adopts the per capita GDP indicator to represent the level of economic development in a certain region. The growth of per capita GDP and the change in air quality (decrease in AQI) show opposite trends, indicating that after 2014, economic growth at the expense of sacrificing the ecological environment has gradually disappeared. Measures such as industrial structure transformation and upgrading, technological progress, and industrial enterprise technological reform brought about by high-quality economic development are continuously exerting positive effects, reducing air pollution and optimizing air quality. However, it should be noted that the AQI value rebounded in 2020, indicating that the negative impact of economic growth on air quality is still present. If air pollution is not controlled, air quality will further decline.

### **2.2.2. Energy consumption level**

Human production is the main source of air pollution, and activities and behaviors such as motor vehicle exhaust emissions, factory exhaust emissions, and garbage incineration belong to the right-hand side of the chemical equation, with many activities and complex behaviors. Due to the diverse and complex sources of air pollutants, it is impractical to sum them up one by one for calculating the emissions of pollutants. According to the law of conservation of energy, the level of energy used in human economic and social activities is stable, and energy exists in different forms in nature. According to the energy balance sheet, energy production level is used as an indicator to represent energy consumption level and explore the relevance between air pollution and energy. By comparing the trends in AQI and energy consumption levels, it was found that energy consumption levels have been increasing year by year, which is consistent with the background of China's entry into the industrialization era and is also an inevitable phenomenon. The AQI value continues to decrease with the increase of energy consumption level, which is gratifying. This indicates that industries with high pollution, high emissions, and high energy consumption are further transforming and upgrading, energy utilization efficiency is further improving, traditional and backward production capacity is further being eliminated, digital economy and green economy are developing, and the utilization rate of high-tech industries and new energy is increasing, accounting for an increasing proportion of energy consumption.

There is a significant difference in energy consumption between urban and rural residents. From 2000 to 2018, the coal consumption of urban residents showed a fluctuating downward trend. On the contrary, the coal consumption of rural residents fluctuated upward, rising from 40.7768 million tons of standard coal to 50.4133 million tons of standard coal. In addition, the coal consumption of rural residents is much higher than that of urban residents, and the gap between the two has been increasing year by year. By 2018, the coal consumption of rural residents was 6.95 times that of urban

residents. The excessive consumption of coal directly leads to the continuous increase of exhaust emissions in rural areas, exacerbating the level of air pollution in rural areas.

### **2.2.3. Industrial development level**

Numerous studies have found that industrial production activities are closely related to air pollution. This chapter uses the ratio of industrial added value to GDP to reflect the level of industrial development in a certain region. The trend of the proportion of added value of the secondary industry to GDP and AQI value is consistent, indicating that the lower the proportion of added value of the secondary industry, the better the local air quality. In recent years, China has vigorously developed high-tech industries, extended the industrial chain, and continuously optimized the structure of the tertiary industry. The proportion of the tertiary industry is increasing, while the proportion of the primary industry remains basically unchanged, and the proportion of the secondary industry is decreasing. At the micro level, large-scale high energy consuming industrial enterprises have been eliminated, and a large amount of excess steel production capacity has been eliminated or replaced. The country has strict control over new high energy consuming projects, and it can be said that reform measures in this area have promoted the improvement of air quality. However, from the analysis above, it can be seen that the regional characteristics of air pollution are obvious. In provinces with strong industrial foundations, the air quality is still not high, indicating a close relationship between industrial development and air pollution. The layout of green industries urgently needs further improvement.

### **2.2.4. Population density**

Urban population density reflects the degree of population agglomeration in a certain region and is a core indicator that can reflect the degree of urbanization. In recent years, the scale of Chinese cities has been continuously expanding, with a large number of people flowing into cities. However, the urban area has not changed significantly, resulting in a continuous increase in population density and the emergence of the urban "heat island effect". High population density means more frequent human economic and social activities, increased impact on the environment, and higher energy consumption levels (energy consumption trends have been proven). Therefore, areas with high population density will experience a decline in air quality. However, when the population density exceeds a certain threshold, the process of urbanization and urbanization will promote the improvement of air quality, which is manifested in the fact that metropolitan areas and urban agglomerations attract a large number of technical talents and high-tech environmental protection enterprises to gather. Local governments have more effective, transparent, and strict environmental governance, with top-level design, measures, and environmental protection technology capabilities to control air pollution. Therefore, air quality gradually improves, showing a trend of inverse changes in AQI and population density.

## **2.3. Health Status and Labor Supply of Rural Residents**

### **2.3.1. Health status of rural residents**

The lack of medical resources and weak medical conditions in rural areas have led to the prominent problems of "difficult" and "expensive" medical treatment for rural residents, which directly results in a decline in their health status. From 2003 to 2018, the two-week prevalence rate of urban residents in

the surveyed area showed a trend of first going up and then going down, reaching its peak in 2013 (28.2%) and then decreasing slightly. The two-week prevalence rate of rural residents has shown an increasing trend year by year. In 2018, the two-week prevalence rate of rural residents in the surveyed areas was 32.2%, which was 2.32 times that of 2003. From this, it can be seen that the health status of rural residents is not optimistic and should receive widespread attention.

Chronic diseases have become the main factor endangering the health of rural residents, especially cardiovascular and respiratory diseases, which have become the main causes threatening the health of rural residents. From 2002 to 2011, the discharge rate of cardiovascular and respiratory diseases per thousand population in urban areas was higher than that of rural residents. However, after 2012, the discharge rate of cardiovascular and respiratory diseases per thousand population in rural areas exceeded that of urban residents and gradually widened the gap. In 2016, the discharge rate of cardiovascular and cerebrovascular diseases per thousand population in rural areas was 8.76 ‰, which was 1.41 times that of urban areas; The discharge rate of respiratory diseases per thousand population in rural areas is 11.12 ‰, which is 1.65 times that of cities.

Meanwhile, the mortality rate of rural residents due to cerebrovascular and respiratory diseases is higher than that of urban residents. From 2002 to 2016, the mortality rate of rural residents due to cerebrovascular diseases showed a fluctuating upward trend and was higher than that of urban residents; Except for 2013, the mortality rate of rural residents due to respiratory diseases is higher than that of urban residents. This is sufficient to indicate that compared to urban residents, rural residents have a heavier burden of respiratory and cardiovascular diseases. In addition, more than half of the top ten agricultural provinces in China are located in areas with high incidence of air pollution. Compared to other industries, farmers work in the fields and are exposed to polluted air for a longer period of time, making their bodies more susceptible to damage. From this, it can be seen that under the same air pollution conditions, rural residents exhibit stronger vulnerability and sensitivity, and health problems caused by ambient air pollution have a greater influence on the labor supply of rural residents.

### **2.3.2. Current situation of rural labor supply**

Due to the lack of data reflecting middle-aged and elderly people in rural areas, and the fact that a considerable amount of field research has shown that the majority of rural labor force is composed of middle-aged and elderly people. Based on this, this article uses the number of people engaged in the primary industry in rural employment to reflect the current supply of rural labor, with data sourced from the "China Statistical Yearbook" and "China Rural Statistical Yearbook".

From a trend perspective, from 2000 to 2019, the number of employed people in the primary industry in rural areas has been decreasing year by year, from 360 million in 2000 to 194 million in 2019, a decrease of 46.11%. The situation is not optimistic. The proportion of primary industry employment to total employment has decreased from 50% in 2000 to 25.1% in 2019, a decrease of nearly 100%. With the acceleration of urbanization, more and more rural population is flowing into cities, and the siphon effect of big cities and metropolitan areas is becoming increasingly evident, with young labor force gathering in cities. On the contrary, the population of mid-aged and elderly tends to cluster in rural areas. As they

age, although they continue to engage in agricultural activities, their working hours and efficiency decrease, resulting in a reduction in effective labor supply.

From the perspective of regional distribution, the three point maps of 2008, 2013, and 2019 all show that China's provinces with large grain, fruit, and vegetable output are areas with high labor supply. Henan, Anhui, Hebei, Shandong, Yunnan, Hunan, Guangxi, Guangdong and other provinces are high concentration areas for labor supply. Over time, the distribution characteristics of labor supply level are obvious, concentrated in the Central Plains and the Yunnan-Guizhou Plateau. Since ancient times, the eastern and central regions, as well as the central and southern regions, have had abundant sunshine and rainfall, making them very suitable for agricultural production. The low level of labor supply in Xinjiang, Xizang and Inner Mongolia is due to the fact that their total population is lower than that in the Central Plains, and the harsh ecological environment makes agricultural production difficult. In economically developed urban areas such as Beijing, Tianjin, Shanghai, Zhejiang, and Chongqing, the level of rural labor supply is low. This is because the proportion of the primary industry in these areas is not high, and abundant urban population is engaged in the secondary and tertiary industries. Most rural land has been converted into urban construction land, or the degree of agricultural mechanization is high. The process of agricultural modernization is fast, and the unit labor supply time is decreasing, causing surplus rural labor to shift to other industries. Overall, the spatial distribution of China's rural labor supply level has not changed significantly over time and is consistent with the overall layout of agricultural production.

### **2.3.3. The relationship between the health level of rural residents and working time**

Health is an important dimension of human capital, and an individual's health status directly affects their labor supply behavior. When suffering from illness, individuals may reduce their labor supply time and seek medical treatment at medical institutions to cure the disease. In addition, to restore the body to a healthy state, individuals may increase their health investment time, increase their rest time, and reduce their working hours. Relevant data shows that rural residents have a greater loss of labor supply time due to illness than urban residents. In 2008 and 2013, the number of bedridden days per thousand rural residents due to illness for two weeks was 193 days and 181 days, respectively, both greater than urban residents. At the same time, illness will directly lead to a significant reduction in working hours. In 2003, 2008, and 2013, rural residents in the surveyed areas took 218 days, 97 days, and 177 days off work due to illness for two weeks, respectively, which were significantly more than the number of days off work for urban residents due to illness. Due to the fact that most rural residents engage in outdoor physical labor with high work intensity, health is an important capital for them to obtain job opportunities and earn wages. Impaired health will directly weaken their physical fitness, reduce their ability to work and work efficiency, decrease working hours, and even face the risk of unemployment. Therefore, compared to urban residents engaged in the secondary and tertiary industries, the impact of diseases on rural residents' working hours will be greater.

### **3. Research Conclusions and Policy Recommendations**

#### **3.1. Research Conclusion**

This paper describes the current situation of air pollution, rural residents' health level, and rural labor supply in China through data comparison, and analyzes the correlation between the three.

(1) Analyze the characteristics and trends of air pollution in China from both temporal and spatial dimensions using monthly AQI data and annual data on the number of days with good air quality. Through analysis, it is found that air quality is jointly influenced by human economic and social development as well as natural environmental factors. Among them, human social activities and economic development are the main sources of air pollution, and there is a close correlation between air quality in various regions and local economic development, energy consumption, industrial development level, and population density. Air pollution exhibits significant seasonality, with severe air pollution in winter and relatively mild air pollution in summer, which is related to factors such as meteorology, heating, and production. From a regional perspective, the air quality in the northern region is lower than that in the southern region, and shows significant seasonality, which may be related to the heating season in the northern region.

(2) There has been a significant improvement in air quality, but we still need to be wary of any rebound. With the implementation of a series of policy measures such as the Blue Sky Defense Campaign, China's air quality has been improving year by year, and the level of air pollution has been further reduced. However, in the process of urbanization and industrialization, the development of large projects and infrastructure often comes with high energy consumption and emissions, leading to a significant rebound in air pollution. Although this is only a turning point in terms of trend, it indicated a decrease in air quality at the time, which could potentially bring about a series of adverse effects. This is a situation where if you don't move forward, you will fall behind. Therefore, in the next step of work, air pollution prevention and control is still very important and urgent.

(3) The situation of rural labor supply is not optimistic. From 2000 to 2019, the number and proportion of employees in the primary industry showed a significant downward trend. Meanwhile, compared to urban residents, the health level of rural residents is lower. And due to the fact that rural residents mainly engage in high-intensity physical labor, their labor supply time is more sensitive to the impact on their health level. If the health status of rural residents is not improved in a timely manner, it may lead to an imbalance in the supply structure of rural labor. From a layout perspective, areas with good natural environmental conditions, abundant sunshine and rainfall, suitable temperatures, and less fertile soil and disasters are regions with sufficient rural labor supply. The obvious resource endowment will attract a large number of rural laborers. In contrast, the eastern coastal areas such as Fujian Province, Zhejiang Province, and Shanghai have a fast urbanization process, with the primary industry accounting for a relatively low proportion of the entire economic structure. A large number of rural laborers have transferred to the secondary and tertiary industries, and the aging of rural labor force is severe. At the same time, a large amount of agricultural land has been converted into construction land, further reducing the scale of agricultural production and

causing a significant loss of agricultural labor.

#### **3.2. Policy Recommendations for Improving the Health Level and Labor Supply of Middle-Aged and Elderly People in Rural Areas**

At present, the age distribution of China's population shows an inverted triangle structure, and the proportion of middle-aged and elderly people in the population is increasing year by year. With the acceleration of industrialization and urbanization, a large number of young labor force flows from rural areas to urban areas. The siphon effect of metropolitan areas and central cities is significant, making the aging problem of China's population more significant in rural areas. From the previous research conclusions, it can be concluded that the health of middle-aged and elderly people in rural areas is significantly affected by air pollution, and this impact is long-term. The damage caused is cumulative, and the reduction in labor supply time is increasing. To reduce the negative impact of air pollution on rural labor force, it is indicate that the national and local governments to work together to improve the health level of rural population and ensure the effective supply of rural labor force.

##### **3.2.1. Take multiple measures to curb air pollution**

Although China's current air pollution control has achieved positive results and has not caused large-scale cross regional health incidents, the control of air pollution cannot be relaxed. Therefore, the primary task of the government is to formulate relevant measures to improve air quality.

One is to strengthen local efforts to control air pollution. At the national level, institutional reforms have strengthened the enforcement of air pollution at the local level, which is an important guarantee and lever for curbing air pollution. In terms of top-level design and system, it is necessary to further refine laws and regulations, introduce specific rules and regulations, and provide objective basis for local law enforcement teams in the process of executing tasks. Using the air pollution control work in various regions as a performance indicator to assess local party and government leaders, and linking it to the promotion of job positions, forces them to pay more attention to air pollution control and change the traditional "GDP only theory". Strengthen the monitoring of air pollution, create a comprehensive supervision model of "grid+ground air monitoring station+mobile monitoring equipment", and weave a tight "heavenly net" for preventing and controlling air pollution. Construct multi-level automatic monitoring stations for air quality at the provincial, municipal, and county levels, as well as micro monitoring stations in urban areas, to achieve three-dimensional monitoring and component monitoring of air.

The second is to eliminate outdated production capacity and reduce excess production capacity. Viewing air pollution from the perspective of industry and production capacity, tracing the origins of pollutants, and strictly preventing the closure of pollution sources. Local governments have set strict environmental entry thresholds for new projects and, in conjunction with industry regulatory authorities, have taken punitive measures to strictly control the addition of steel, coking, casting, cement, and flat glass production capacity, and increase efforts to eliminate outdated capacity and reduce excess capacity. In the process of urban construction, we will continue to curb low-level redundant construction and prohibit casting enterprises from installing outdated

ironmaking equipment.

The third is to implement a reward and punishment mechanism through ecological compensation. Because the scope of air pollution is affected by weather, there is no significant causal relationship between the areas and administrative divisions covered by air pollution. So the ecological compensation mechanism for air pollution cannot be carried out according to the forest and watershed ecological compensation model. The country should establish an air pollution compensation mechanism, with funding compensation as the main compensation method, supplemented by tax compensation and fiscal exchange. In the context of developing urban agglomerations and metropolitan areas, it is recommended to propose a cross regional linkage compensation mechanism, which means that a certain place (including multiple cities) emits a large amount of pollutants, which overflow and affect the surrounding areas. Surrounding cities can apply to the state for punishment within the pollution source area. At the same time, local governments should clarify the beneficiaries, and the punishment funds can be compensated to the polluted areas through the national treasury system by the local finance department. The funds are designated for the treatment of cardiovascular and cerebrovascular diseases in rural areas under the new rural cooperative medical scheme or for improving rural medical infrastructure.

### **3.2.2. Improve the medical service system for middle-aged and elderly people in rural areas**

From the analysis in this paper, it can be seen that most of the chronic diseases induced by air pollution among rural mid-aged and elderly are cardiovascular diseases, which belong to medium - to long-term chronic diseases. They not only seriously threaten the health of rural residents, but also greatly reduce the supply of effective working time. In the face of chronic diseases induced by air pollution, the core lies in continuous care and phased treatment, with a focus on building a sustainable and targeted medical service system that serves the elderly population in rural areas.

One is to improve the medical service records. To address the persistent characteristics of chronic diseases, family archive data is constructed on a household basis, and the health status of sub healthy or diseased populations is regularly tracked. Breaking down barriers between local government departments, integrating information from health, statistics, rural areas, and other departments, with prefecture level cities as units and counties as the main body, led by data management departments to establish a health information database covering the life cycle of rural middle-aged and elderly people, containing personal health information, family member information, diagnosis and treatment prescription information, nursing needs information, and other elements, achieving patient information sharing while integrating medical resource information from various regions, enabling effective connection between community hospitals, nursing homes, and other institutions, and enhancing the collaborative ability of the medical service system.

The second is to innovate the ways and models of the new rural cooperative medical insurance. Considering the characteristics of rural grassroots population, we will strongly support the medical insurance payment of rural medical institutions in terms of medical insurance and assistance policies, and explore the implementation of differentiated medical insurance payment policies for medical institutions

in rural areas of central and western regions. For rural populations suffering from cardiovascular and cerebrovascular diseases, increasing the upper limit and reimbursement ratio for on-site outpatient treatment can not only increase the demand for local medical services, but also reduce the time and medical expenses of patients who have to travel to large hospitals for chronic diseases all year round. Chronic diseases are usually accompanied by comorbidities, and an integrated settlement model for basic medical insurance, major illness treatment, medical rehabilitation, and other reimbursement methods should be established.

The third is to encourage social forces to participate in the construction of the integrated medical and elderly care model. Chronic diseases among middle-aged and elderly people in rural areas require long-term treatment and rehabilitation, and require the participation of multiple parties. Establish a diversified funding mechanism, introduce a series of policies that benefit and assist enterprises, attract social forces to participate in the construction of rural medical, physical examination, rehabilitation, and elderly care institutions, fully participate in rural medical services, and build a rural medical and elderly care integrated elderly care model system. To address the psychological reluctance of rural mid-aged and elderly to seek medical treatment, third-party service agencies cooperate with medical professionals to provide on-site services, using big data methods and relying on medical service records to enable rural medical forces to truly enter villages and households, and strive to establish a long-term cooperation mechanism for rural elderly care, medical rehabilitation, and medical care, where conditions permit.

### **3.2.3. Vigorously promote the green development of agriculture**

Research has found that rural mid-aged and elderly engaged in agricultural production suffer greater health and labor time losses than non-agricultural workers. To this end, we must implement the new development concept of "green mountains and clear waters are as valuable as mountains of gold and silver", take agricultural supply side structural reform as the main line, green development as the guide, and institutional reform and mechanism innovation as the driving force, and embark on a path of agricultural modernization that is efficient in output, safe in products, resource efficient, and environmentally friendly.

One is to accelerate the pace of technological innovation to support green development in agriculture, improve resource utilization and agricultural productivity. Currently, the constraints on agricultural resources such as water and soil are becoming increasingly severe, agricultural non-point source pollution is worsening, agricultural ecological service functions are weakening, and problems such as degradation of agricultural ecosystems are becoming more prominent. To implement the sustainable development strategy of agriculture, it is urgent to rely on technological progress to promote green agricultural production, build a green oriented agricultural technology system, steadily improve agricultural land output rate, and significantly increase agricultural labor productivity, resource utilization rate, and total factor productivity.

The second is to change the traditional labor-intensive farming mode and accelerate the promotion of agricultural mechanization. Agricultural mechanization is the core of the development mode of agriculture and improving rural productivity, and it is the fundamental guarantee for implementing the rural revitalization strategy.

The modernization of agriculture and rural areas cannot be separated from agricultural mechanization. Utilize advanced and applicable agricultural machinery and equipment to improve agricultural production and operation conditions, continuously enhance the level of agricultural production technology and economic and ecological benefits. By improving agricultural production efficiency, reducing the demand for agricultural labor, guiding surplus labor to transfer to the tertiary industry, and engaging in indoor non physical labor, outdoor labor time can be reduced.

The third is to focus on solving the problem of agricultural non-point source pollution. The development of agriculture not only needs to eliminate the ecological environment from owing new debts, but also gradually repay old debts and fight the battle against agricultural non-point source pollution. Adhere to investment reduction, green substitution, crop and livestock recycling, and comprehensive management. Promote the return of crop straw to the field, comprehensively prohibit straw burning, fulfill local regulatory responsibilities and grid based regulatory responsibilities, timely stop and investigate straw burning behavior in accordance with the law. We will deepen the improvement of arable land quality and the reduction and efficiency of chemical fertilizers, promote the resource utilization of livestock and poultry manure and the return of straw to the field, enhance the fertility of arable land, and rely on new business entities and socialized service organizations such as large-scale growers, family farms, farmer cooperatives, and agricultural enterprises to demonstrate and guide the construction of arable land quality and scientific fertilization.

#### **3.2.4. Develop a scientific and reasonable evaluation system and compensation system**

The research has found that the influence of air pollution on the health and labor supply of the rural mid-aged and elderly varies among different groups. Therefore, targeted assistance policies should be formulated according to local conditions and circumstances to ensure precise implementation and avoid policy bias. The development of a scientific and reasonable evaluation system for accurately measuring the negative impact of air pollution on the health and labor supply of rural residents is a prerequisite and key to the formulation of relevant policies. Firstly, based on practice, a professional investigation team should be established to scientifically and reasonably evaluate the negative impact of air pollution. Develop differentiated evaluation index systems based on different regions, pollution levels, and economic development levels, to accurately account for the negative impacts of air pollution in different regions and levels on the health and labor supply of local rural residents. Secondly, based on the development of an evaluation system, establish and improve a compensation system for air pollution, provide "pollution allowances" for rural labor suppliers affected by air pollution, and promote social equity. Due to the varying degrees of "pollution transfer" accompanying the transfer of urban and rural industries, ordinary rural workers can only passively accept the damage of air pollution, which will exacerbate social conflicts in the long run. Especially for low-income groups, on the one hand, they suffer greater health losses due to air pollution than other groups, but they find it difficult to afford medical expenses, resulting in delayed medical treatment; On the other hand, the health loss caused by air pollution further affects their labor supply capacity, putting them in a disadvantaged position in the labor market and affecting their income. Therefore, appropriate economic

compensation can alleviate the medical burden on low-income groups to a certain extent, increase their willingness to seek medical treatment, and reduce the damage caused by air pollution.

#### **3.2.5. Enhance the health awareness of rural residents**

Reducing the negative impact of air pollution, prevention is key. The empirical results indicate that improving individual health awareness can significantly reduce the health loss of rural middle-aged and elderly people caused by air pollution. To this end, on the one hand, we need to increase publicity efforts and promote health science popularization activities in rural areas. Promote and popularize health knowledge, establish a new trend of healthy eating, and cultivate good living habits. Regularly carry out medical services to grassroots activities, hold health knowledge lectures, free physical examinations, and on-site consultations for middle-aged and elderly people in rural areas. Raise the health awareness of rural residents, cultivate the good habit of regular physical examinations, and once there are abnormalities in the body, achieve "early detection and treatment" to avoid "minor illnesses turning into major illnesses". On the other hand, enhance the self-protection awareness of rural residents in dealing with air pollution. During periods of poor air quality, reduce unnecessary outdoor activities or wear protective equipment such as masks, wash hands frequently, and minimize direct contact with air pollutants as much as possible.

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