

Environmental Pollution, Population Aging And Social Medical Insurance Fund Expenditure

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ABSTRACT

Although China's economy has maintained rapid growth since 21st century, the problem of environmental pollution has become increasingly serious. Environmental pollution has a serious impact on people in all aspects of clothing, food, housing and transportation. Based on the panel data of 31 provinces and regions in China from 2005 to 2017, this paper establishes a fixed-effect model and divides China into three regions of central, east and west and analyzes the impact of environmental pollution and the population aging on the expenditure of China's social medical insurance funds (SMIF). The study found that the more severe environmental pollution, the worse health status of the residents, then induces the higher SMIF; the more serious aging of population, the higher risk of disease and cause higher SMIF. It is recommended to innovate clean energy technologies, increase environmental governance, in order to reduce health care expenditures and restrain the increase of the health care cost.

Keywords: environmental pollution; population aging; expenditure of SMIF; environmental governance.

INTRODUCTION

The deterioration of environmental pollution is caused by population growth, increased economic activities, increased motor vehicle flow, and increased intensity and frequency of sandstorms, which in turn increases the consultation rate and mortality rate of the respiratory system and other related diseases. In recent years, China's medical expenses, outpatients, the number of inpatients, expenditure, and so on have increased sharply. Problems such as excessive consumption of resources and ecological destruction also hinder economic development and the improvement of life quality. In fact, the impact of environmental pollution on human health has aroused widespread concern.

From a global perspective, the economic cost of 34 OECD countries dying from ambient air pollution increased by about 7% between 2005 and 2010, reaching a huge loss of US \$1.6 trillion in 2010 [1]. PHE (2018) believes that the main environmental cause of premature mortality is air pollution, accounting for about 5% of global deaths [2]. Unless the air is purified, by the middle of this century, one person will die prematurely from air pollution every five seconds (OECD,2016) [3]. The European Commission (2018) predicts that 6 to 9 million premature deaths will occur each year by 2060, based on scenarios of rising PM2.5 and ozone levels [4]. Epidemiological

related research evidence supports the estimate of the death toll, while economic research evidence shows that global environmental and household air pollution also causes trillions of dollars in economic losses to society every year [5].

The extensive damage of environmental pollution to human health has attracted more and more attention. In particular, air pollution and its harm to health are particularly prominent in the environment. According to the report on the state of the ecological environment in China in 2018, the ambient air quality of 217 of the 338 cities exceeded the standard, accounting for 64.2%.

REVIEW OF EXISTING RESEARCH

Health of Residents and Economic growth

The research on the impact of environmental pollution on residents' public health has always been a topic of concern. There is growing evidence that environmental pollution will lead to a decline in the health of human and other species. Rico, Iris et al. (2005) used OLS model to study the effects of health on economic growth. Taking capital growth, labor force participation rate, education level, lifestyle, environment and health services as independent variables, it is concluded that all variables are positively correlated with economic growth. The study also shows that improved health contributes to economic growth, thereby reducing poverty [6]. Pan, Chen et al. (2014) found that traffic and industry-related pollutants (CO, NO₂) affected the number of hospitalizations and outpatients for asthma. The increase of emergency department and hospitalization of asthma is related to the increase of O₃, SO₂, and PM10 levels [7]. WTO (2016) found that children under the age of 5 in low-income countries are more than 60 times more likely to die from air pollution than children in high-income countries. Air pollution is not only a health risk but also hinders development, resulting in the loss of productive labor and reducing national income [8]. Daniel, Ramona et al. (2019) took the relevant data of EU countries from 2000 to 2014 as an example to investigate the effects of economic growth, environmental pollution, and non-communicable diseases on health expenditure. The results show that GDP has the greatest impact on health expenditure. In the long run, countries with higher GDP per capita have greater potential for health expenditure growth. The impact of CO₂ emissions on health expenditure depends on economic growth, which in turn leads to higher health expenditure [9].

Medical Expenses of Residents and SMIF Expenditure

Scholars have also carried out a lot of research on the impact of environmental pollution on medical expenses of residents and SMIF expenditure. Karatzas (2000) found that income, the number of doctors, nurses and health management costs have a positive impact on health expenditure, while the health price index, the number of hospital beds and cities with a population of more than 100000 in the United States have a very significant negative impact on health expenditure [10]. Jerrett, Eyles et al. (2003) found that areas with high pollution output in Ontario, Canada tend to have higher per capita medical expenditure, while areas that spend more on protecting environmental quality have lower spending on health care [11]. Yazdi, Tahmasebi et al. (2014) examined the role of environmental quality and income in determining health expenditures in Iran during 1967-2010, where pollutant emissions had a statistically significant positive impact on health expenditures in both the short and long term [12]. Preker, Adeyi et al. (2016) found that cancer, chronic respiratory diseases, and cardio-cerebrovascular diseases were the most expensive medical items related to pollution [13]. Raeissi, Khalilabad (2018) found that long-term air pollution had a significant positive impact on health costs. For every 1.00% increase

in the carbon dioxide index, public health costs increased by 3.32% and private health costs increased by 1.16% [14]. Blázquez, Cantarero et al. (2019) analyzed the relationship between air pollution and health expenditure in 29 OECD countries between 1995 and 2014. The results show that per capita income has a positive impact on health expenditure, but after the inclusion of lag time, its statistical significance is not as good as expected [15]. Tianlei, Hongyan et al. (2019) found that there is a negative correlation between air pollution and medical insurance: the higher the degree of air pollution, the worse the self-rated health status, and the less chance to buy medical insurance. Air pollution affects the health of the elderly, which indirectly has a negative impact on the cost of health insurance costs [16]. Fengyi, Li et al. (2020) used the generalized additive model of Poisson distribution to prove that air pollution hurts the hospitalization cost of asthma, in which male and non-elderly subgroups are more significant than female and elderly subgroups [17].

Overview

Scholars in related fields have also measured the increase in mortality and morbidity related to air pollution. As there is growing evidence of the cumulative effects of air pollution on health, WHO and European governments have begun to use the data from these studies to inform environmental policies. This paper explores the impact of environmental pollution and population aging on SMIF expenditure.

MATERIALS AND METHODS

Research Hypothesis

Hypothesis 1 (H1): The more serious the environmental pollution, the worse the health status of residents, and the higher the SMIF expenditure.

Hypothesis 2 (H2): The more serious the aging of the population, the higher the risk of disease, and the higher the cost of SMIF.

Sources of Data and Variables

The study selects the panel data of 31 provinces in China from 2005 to 2017, the data source from China Statistical Yearbook and provincial statistical yearbooks. The explained variable is SMIF expenditure, and the main explanatory variables are environmental variables and population aging variables. Other variables include the number of people participating in social medical insurance, the level of economic development, the economic level of residents, the health level of residents, the education level of residents, and medical expenditure of residents (See Table 1). Sample characteristics are presented in Table 2.

Table 1. Variable description.

	variable indicator	Represent ation	variables label
Explained variable	social medical insurance fund expenditure	lnm_exp	Ln (SMIF (ten thousand yuan))
Explanato ry variables	environment	lnp_air	Ln (sulfur dioxide emissions (tons))
		lnp_water	Ln (total waste water discharge (ten thousand tons))
		lnp_solid	Ln (Industrial solid waste generation (ten thousand tons))
	aging	age	Percentage of population aged 65 and over in permanent population (%)
Control variables	the number of people participating in social medical insurance	lnm_peo	Ln (Number of people participating in social medical insurance (ten thousand people))
	the level of economic development	lngdp	Ln (Per capita GDP (yuan))
	the economic level of residents	income	Per capita disposable income of households in the city (ten thousand yuan)
	the health level of residents	lnhos_peo	Ln (Number of patients in hospital (ten thousand people))
	the education level of residents	edu	The proportion of the population with a junior college degree and above to the population aged 6 and above
	and medical expenditure of residents	cost	Per capita medical expenses for inpatients (ten thousand yuan)
	region	region	East, Central, West

Table 2. Variable descriptive statistics.

Variables	average	Standard error	median	min	max
lnm_exp	4.5244	1.2472	4.6396	0.2624	7.1269
lnp_air	12.9617	1.2879	13.2493	7.5496	14.5102
lnp_water	11.8426	1.0335	11.9613	8.0870	13.7518
lnp_solid	8.4918	1.3361	8.7195	1.7029	10.7271
age	0.0932	0.0188	0.0917	0.0482	0.1441
lnm_peo	6.8656	1.1164	6.9905	2.7213	9.2506
income	1.5229	0.9287	1.3606	0.3425	5.8988
lngdp	10.3599	0.6377	10.4293	8.5275	11.7675
edu	0.1060	0.0684	0.0896	0.0089	0.4761
lnhos_peo	8.5609	0.9526	8.6500	5.5415	10.5226
cost	0.6794	0.3115	0.6235	0.2020	2.1737

Model

This article mainly explores the impact of environmental pollution and population aging on the expenditure of SMIF, so the model is as follows:

$$\text{Lnm_exp} = \alpha_0 + \alpha_1 \text{lnp_air} + \alpha_2 \text{lnp_water} + \alpha_3 \text{lnp_solid} + \alpha_4 \text{lnm_peo} + \alpha_5 \text{income} + \alpha_6 \text{lngdp} + \alpha_7 \text{edu} + \alpha_8 \text{lnhos_peo} + \varepsilon_{it} \quad (1)$$

$$\text{Lnm_exp} = \alpha_0 + \alpha_1 \text{age} + \alpha_2 \text{lnm_peo} + \alpha_3 \text{income} + \alpha_4 \text{lngdp} + \alpha_5 \text{edu} + \alpha_6 \text{lnhos_peo} + \varepsilon_{it} \quad (2)$$

Formula (1) represents the model of the impact of environmental pollution on SMIF expenditure, and formula (2) represents the model of the impact of population aging on SMIF expenditure.

Series Testing of Panel Data

Unit Root Test

Since pseudo-regression can occur in regression analysis using non-stationary time series data, the results derived from the model are not relevant to the actual study. To ensure the accuracy of the regressions, the data were first subjected to a unit root test. As shown in Table 3, most of the variables passed the ADF-Fisher test; only the per capita household disposable income, which represents the economic level of the population, did not pass the test.

Table 3. Unit Root Test (ADF-FisherTest).

Variables		lnm_exp		lnp_air		lnp_water		lnp_solid	
Test		Statistic	P-value	Statistic	P-value	Statistic	P-value	Statistic	P-value
Inverse chi-squared (62)	P	159.1959	0.0000	89.5784	0.0125	122.6041	0.0000	144.7177	0.0000
Inverse normal	Z	-6.4564	0.0000	-2.5946	0.0047	-4.7960	0.0000	-6.0902	0.0000
Inverse logit t (159)	L*	-6.7771	0.0000	-2.5463	0.0059	-4.7825	0.0000	-5.9925	0.0000
Modified inv. chi-squared	P _m	8.7285	0.0000	2.4766	0.0066	5.4424	0.0000	7.4283	0.0000
Variables		age		lnm_peo		income		lngdp	
Test	P	Statistic	P-value	Statistic	P-value	Statistic	P-value	Statistic	P-value
Inverse chi-squared (62)	Z	-6.4990	0.0000	-6.5508	0.0000	1.2371	0.8920	-6.4976	0.0000
Inverse normal	L*	-6.4834	0.0000	-6.6917	0.0000	1.3996	0.9182	-6.9527	0.0000
Inverse logit t (159)	P _m	7.4642	0.0000	8.2274	0.0000	0.1557	0.4381	8.6951	0.0000
Variables		edu		lnhos_peo		cost			
Test	P	Statistic	P-value	Statistic	P-value	Statistic	P-value		
Inverse chi-squared (62)	Z	-7.8818	0.0000	-5.0784	0.0000	-6.0645	0.0000		
Inverse normal	L*	-8.1594	0.0000	-5.0245	0.0000	-6.2095	0.0000		
Inverse logit t (159)	P _m	10.0954	0.0000	5.5029	0.0000	7.6880	0.0000		

Co-integration Test

There are several methods for the co-integration test of panel data, and the Kao test is used in this paper. Kao test includes DF test and ADF test. The null hypothesis of test is that there is no co-integration relationship between panel variables. As shown in Table 4, the null hypothesis is rejected (CI95%, $p < 0.05$), indicating that the panel variables are co-integrated.

Table 4. Co-integration Test (Kao Test).

		National Total	East	Middle	West
DF test	t-statistic	-4.0249	-3.1872	-5.4686	-5.4680
	P-value	0.0000	0.0007	0.0000	0.0000
ADF test	t-statistic	-1.7020	-2.7730	-7.5380	-1.8105
	P-value	0.0444	0.0028	0.0000	0.0351

RESULTS**Scatter Plot**

Before the regressions, the scatter plot of the relationship between Sulphur dioxide, waste water, solid waste, the aging of the population and the expenditure of SMIF was roughly derived (See Figure 1.). It can be concluded that Sulfur dioxide, waste water and solid waste are positively correlated with the expenditure of SMIF. There is also a positive correlation between the population aging and the expenditure of SMIF.

It shows that the more serious the pollution and the population aging, the higher the expenditure of SMIF.

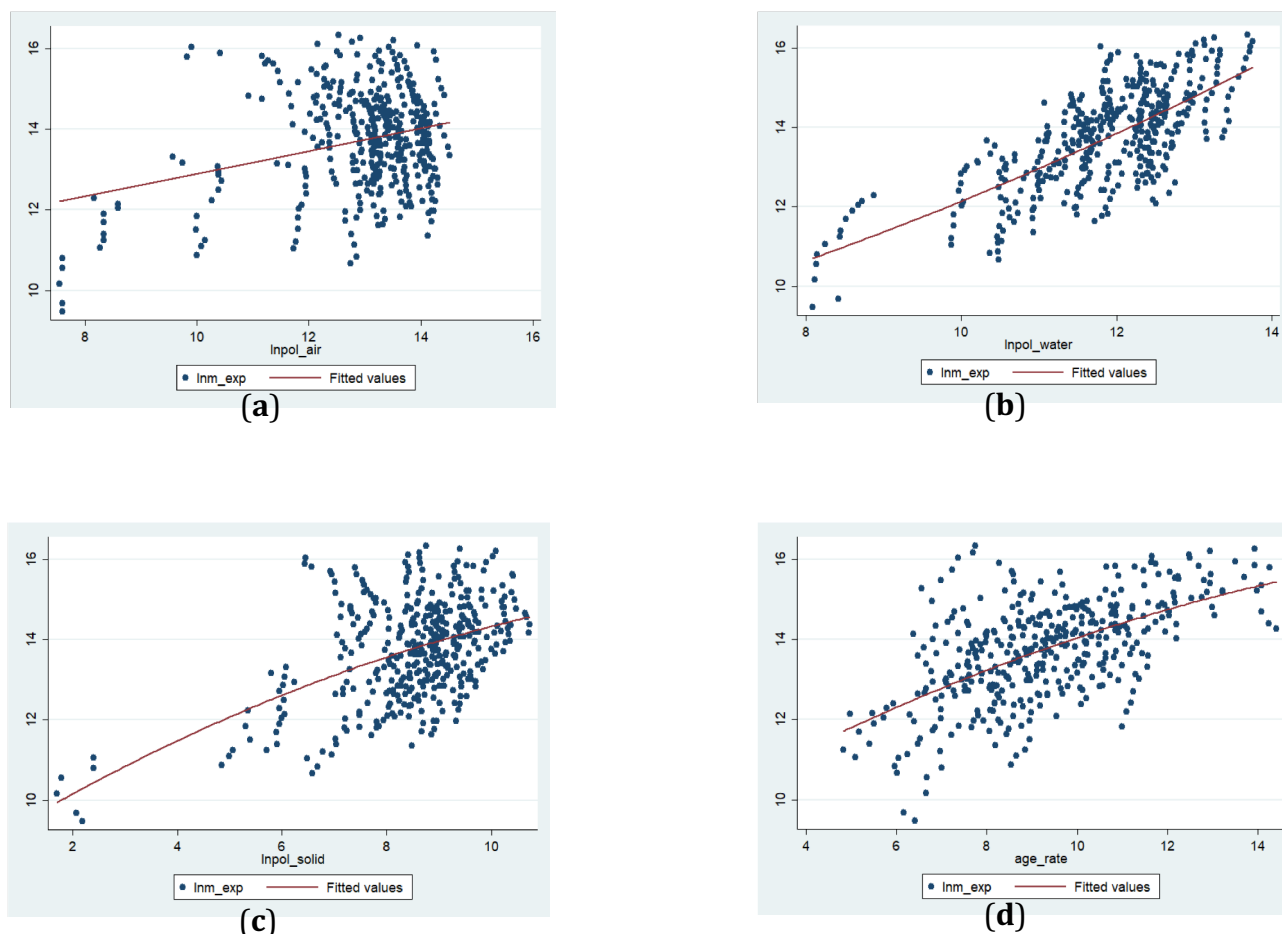


Figure 1. Scatter Plot: (a) Sulphur dioxide and SMIF expenditures; (b) Wastewater and SMIF expenditures; (c) Solid waste and SMIF expenditures; (d) Population aging and SMIF expenditures.

Type Discrimination of Panel Model

The Hausman test was used to determine the form of the panel model. The null hypothesis of the test was to establish an individual random effects model; the alternative hypothesis was to establish an individual fixed effects model. As shown in Table 5, the $p\text{-value}=0.0000$, so the null hypothesis was rejected and the model established in this paper should be the individual fixed-effects model.

Table 5. Hausman Test.

	Fixed Effect	Random Effect
lnp_air	0.00800	-0.0170
	(0.03)	(0.03)
lnp_water	0.0330	-0.0770
	(0.06)	(0.06)
lnp_solid	0.0250	0.072***
	(0.02)	(0.02)
age	3.212***	2.997***
	(0.82)	(0.83)
lnm_peo	0.390***	0.397***
	(0.02)	(0.02)
income	0.0580	0.142***
	(0.05)	(0.04)
lngdp	0.667***	0.657***
	(0.06)	(0.04)
edu	1.178**	0.667
	(0.49)	(0.49)
lnhos_peo	0.400***	0.421***
	(0.10)	(0.08)
cost	0.690***	0.334**
	(0.14)	(0.14)
_cons	-10.180***	-8.881***
	(0.65)	(0.47)
Hausman Test		
chi2(10) = 98.29	Prob>chi2 = 0.0000	

Notes: * p<0.1; ** p<0.05; ***p<0.01; The standard errors were in parentheses.

Analysis of Regression

Table 6 shows that the regressions derived from both the total sample and the sub-sample are generally positive in terms of the coefficient values for the three indicators of environmental pollution and the population aging, but not all of them are significant in terms of the significance test. For the regression of sub-samples in the East, Central, and the West, the wastewater pollution is very significant, indicating that the greater the discharge of wastewater, the greater the positive impact on the expenditure of SMIF. For the population aging, it is significant in the total sample regression and in the central regression, indicating that the more severe the population aging, the expenditure of SMIF. Among the control variables, it can be concluded that the higher the level of socio-economic development, the higher the expenditure of SMIF; the more people participated in social medical insurance, the higher the level of the expenditure of SMIF. From the perspective of residents, the higher the economic level and the poorer the health level of residents (the more hospital visits), the higher the expenditure on health care, and the higher the level of education, the higher the level of expenditure on medical insurance.

Table 6. Results of Regression.

	National Total		East		Central		West	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lnp_air	-0.0340		0.0190		-0.0250		0.0500	
	(0.03)		(0.05)		(0.05)		(0.05)	
lnp_wat er	0.0440		0.341**		0.441***		-0.164**	
	(0.06)		(0.14)		(0.11)		(0.08)	
ln_solid	0.0260		0.0340		-0.0130		0.00700	
	(0.02)		(0.07)		(0.07)		(0.02)	
age		2.945***		1.173		-3.562**		1.747
		(0.77)		(0.94)		(1.46)		(2.13)
lnm_peo	0.390***	0.385***	0.444***	0.444***	0.385***	0.372***	0.338***	0.354***
	(0.02)	(0.02)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
income	0.0370	0.0310	0.186***	0.114**	0.600***	0.599***	0.231**	0.121
	(0.05)	(0.04)	(0.06)	(0.05)	(0.13)	(0.11)	(0.11)	(0.10)
lngdp	0.675***	0.704***	0.629***	0.669***	0.226**	0.231***	0.555***	0.577***
	(0.06)	(0.05)	(0.12)	(0.09)	(0.09)	(0.08)	(0.09)	(0.09)
edu	1.471***	1.203**	0.453	0.672	-1.852**	-1.606**	3.019***	2.955***
	(0.50)	(0.49)	(0.73)	(0.71)	(0.80)	(0.79)	(0.70)	(0.70)
lnhos_pe o	0.425***	0.416***	0.361**	0.546***	-0.223	-0.0790	0.463***	0.317**
	(0.11)	(0.10)	(0.18)	(0.16)	(0.19)	(0.18)	(0.16)	(0.16)
cost	0.663***	0.743***	0.0840	0.128	1.921***	2.193***	0.600*	0.946***
	(0.14)	(0.14)	(0.19)	(0.19)	(0.25)	(0.23)	(0.31)	(0.26)
_cons	- 9.756***	-9.933***	-13.431***	-10.841***	-5.256***	-1.388	-7.149***	-7.647***
	(0.66)	(0.48)	(1.47)	(0.91)	(1.36)	(1.33)	(0.90)	(0.78)
N	403	403	143	143	104	104	156	156
r2	0.980	0.980	0.982	0.981	0.994	0.993	0.985	0.985
r2_a	0.977	0.978	0.979	0.978	0.993	0.992	0.983	0.983
F	1927	2576	731.9	915.7	1553	1818	997.4	1267

Notes: * p<0.1; ** p<0.05; ***p<0.01; The standard errors were in parentheses.

DISCUSSION

Modeling environmental pollution may include only long-term impacts since it is unlikely that short-term peaks may be modeled within annual estimates. This is mainly due to the unpredictability of air pollution in terms of time and geography, driven by short-term weather conditions. Air pollution changed daily or weekly in a highly dynamic way. Through model analysis: the worse of environmental pollution, the poorer the health of the residents, and the higher the expenditure of SMIF; and the older the population, the higher the risk of disease and the higher the expenditure of SMIF.

Environmental pollution has become a major barrier for developing countries to tackle development problems since the 21st century. Environmental pollution is particularly acute in some of the fastest-growing cities worldwide where more economic activity leads to higher levels of pollution. Environmental pollution is also a serious problem in rural areas, where billions of people worldwide still rely on the burning of solid fuels such as wood, charcoal, and coal for cooking and heating. Consequently, health risks associated with environmental pollution have the

most influential effect on developing countries [18]. In recent years, extreme weather conditions such as haze and gales have occurred frequently, affecting the urban landscape and people's daily lives. The health impacts and consequent social costs of environmental pollution sources such as motorized road transport, household fuel combustion, and agricultural and industrial coal combustion have also attracted concerns. Specifically, In particular, the increased incidence of respiratory and pulmonary diseases and the accompanying rapid rise in health costs have become a serious consequence of air pollution.

CONCLUSIONS

Enhancing Government Spending and Budgets for Health and Environmental Governance

The health impacts of air pollution have many significant economic consequences, not only in terms of the social costs of mortality and morbidity but also in terms of household, hospital, and public budgets, which affect the decision-making of the health sector, as well as social equity within and between countries. As environmental pollution increases the cost of health care leading to financial losses, the government cuts spending in other sectors to develop, which will put more pressure on the government budget. Recognizing the significant effects of air pollution on health expenditures, especially in the public sector, and that several pollution reduction policies could be implemented to relieve the financial burden of government expenditures. For example, better monitoring and control of fuel quality; expanding and developing public transportation, and paying more attention to environmental quality can play an important role in reducing health care expenditures in both the public and private sectors. Improving the environmental performance of health can reduce expenditures directly by decreasing waste and saving energy, or indirectly by relieving the pollution burden on public health, such as improving the quality of health services.

Promoting Environmentally Friendly Government Programs and Enhancing Regulation

The fact of environmental pollution indicates the need to use cleaner fuels and to promote the use of energy vehicles to reduce energy consumption. For example, the introduction of a congestion charging scheme in central London has been successful in drastically reducing the number of kilometers traveled by vehicles, which not only reduces congestion but also reduces fuel consumption and air pollution. Tackling air pollution will not only improve the environment but also have a positive impact on public health. Local governments can consider implementing a range of effective interventions to encourage residents to move to low or zero-emission areas. In terms of supervision, strengthening, and complying with existing regulatory measures and effective regulation can also reduce environmental pollution. Maintain and strengthen regulatory controls on environmental pollution and related compliance systems, and improved when needed.

Encouraging the Development of Commercial Health Insurance

Although the development of social medical insurance is becoming more and more comprehensive, social medical insurance provides only the most basic protections for the public, and residents still have to pay out-of-pocket for the costs of medicines not included in the social medical insurance reimbursement list and for medical expenses that exceed the maximum line. Many commercial health insurance schemes can partially or completely cover costs that are not covered by social medical insurance, so the development of commercial health insurance can relieve the financial pressure on residents as well as the government.

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