A Study on the Balance of Income and Expenditure in the Urban and Rural Residents' Medical Insurance Fund in the Northern Mountainous Region

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Abstract: *Since 2012, Guangdong Province has implemented a policy of integrating basic medical insurance for urban and rural residents in accordance with the instructions of the State Council, which has effectively met the medical needs of urban and rural residents and promoted social stability. However, the balance of revenues and expenditures of the medical insurance fund is still a major challenge. This study takes the basic medical insurance fund for urban and rural residents in five cities in the mountainous region of northern Guangdong as the object of research, aiming to identify problems and propose countermeasures. Firstly, the health insurance system in the region is outlined, and then the 2015-2022 data and GM(1,1) model are used to predict the situation in the next 20 years. The projections show that the health insurance fund may be at financial risk due to slow growth in revenues, increasing expenditures, and a continuing decline in the insured population. The main reasons for this are the decrease in the number of insured people, the ageing population, the increasing financial pressure, and the rapid growth of expenditures. In response to these challenges, a series of solutions have been proposed: strengthening publicity to increase the participation rate, controlling expenditure growth to improve the settlement mechanism, strengthening supervision to combat insurance fraud, adopting diversified financing methods to increase the fund's value-added capacity, upgrading the level of health insurance co-ordination to establish a wider system of inter-region and inter-sectoral health insurance co-ordination, and strengthening health education to promote changes in the medical service model. The comprehensive implementation of these measures will not only effectively balance the income and expenditure of the health insurance fund, but also provide practical experience and reference for the reform of the health insurance system in other regions.*

Keywords: *urban-rural residents' health insurance; fund balance; northern Guangdong mountainous areas; population ageing*

1. Introduction

Medical insurance is an important area concerning people's livelihood, and the issue of balancing the income and expenditure of the medical insurance fund has always been of great concern. Since 2012, Guangdong Province has actively responded to the instructions of the State Council and implemented the policy of integrating the basic medical insurance for urban and rural residents, which has made a positive contribution to improving the level of medical protection and promoting social stability. However, during the implementation of the policy, the issue of balancing the income and expenditure of the medical insurance fund has become a major problem. Especially in the five cities in the mountainous regions of northern Guangdong, the operation of the basic medical insurance fund for urban and rural residents has attracted much attention. Against this background, this study aims to explore in depth the root causes of the problem of balancing the income and expenditure of the medical insurance fund in this region and to propose effective countermeasures.

2. Review of domestic and foreign studies

2.1. Review of domestic studies

2.1.1. The basic medical insurance system for urban and rural residents is facing sustainability challenges.

According to Pang Ruyue (2021), since 2016, China's urban and rural residents' health insurance system has begun to operate on a parallel track and has made remarkable achievements, accelerating the pace of socialist modernization. The number of urban and rural residents insured has steadily increased, eliminating urban and rural identity restrictions and avoiding the problem of duplicate participation. However, the increase in the number of insured persons has also increased the pressure on the income and expenditure of the health insurance fund. Although the performance of the income and expenditure balance of the health insurance fund is relatively stable, the growth rate of income is slower than the growth rate of expenditure, and the growth rate of the accumulated balance has slowed down, which still exists in an unstable state and may pose a challenge to the sustainability of the fund [1]. Zheng, Lili and Wu, Yue (2019) pointed out that Beijing's urban workers' medical insurance fund faces multiple challenges, such as the slow growth of the insured population, the slow growth of the fund's income, and the failure of enterprises to report the full amount of medical insurance premiums, which exacerbates the management difficulties. At the same time, people's health concerns have increased, and the demand for medical care has increased, especially the demand for services for the elderly and key populations, exacerbating the pressure on the fund's payments [2]. The study by Meng Lanshan and Sun Jing (2023) also pointed out that the basic medical insurance fund for urban and rural residents is facing multiple challenges, such as the continuous decline in the number of insured people, and the unreasonable financing structure relying too much on government financial subsidies, leading to an increase in the pressure on the government's finances [3].

2.1.2. Research Methods of Balance of Payments and Revenues of Urban and Rural Residents' Medical Insurance Fund

Scholars have adopted a variety of research methods to solve the problem of balance of income and expenditure of urban and rural residents' medical insurance funds. Wu Lanyi and Wang Qian (2021)[4] reviewed the income and expenditure of China's basic medical insurance fund from 2009 to 2019 and predicted the future trend by using the GM(1,1) model from the perspective of gray system theory, which provided a new research method for the sustainable development of the medical insurance fund. Qianli Ye (2023)[5] studied the impact of demographic structure on the expenditure of the health insurance fund by collecting and processing inter-provincial panel data from 2007 to 2020 and utilizing empirical methods such as dynamic panel modeling to ensure the robustness of the research results. For their part, scholars such as Gao Runguo and Ma Anning[6](2018) used time series data and mathematical models to study the balance of income and expenditure of the basic medical insurance fund for urban workers, and assessed the forecast of fund income and expenditure through the revised model, which showed that there would be no annual overspending in the future. These research methods provide different perspectives and strategies in order to solve the problem of balance of income and expenditure of the medical insurance fund.

2.1.3. Strategies for realising the balance of income and expenditure of the medical insurance fund for urban and rural residents

Scholars have put forward a number of recommendations on the balance of income and expenditure and sustainable development of the urban and rural residents' health insurance fund. Gu Yuge (2018)[7]suggests establishing a multiple financing mechanism to reduce reliance on individual contributions and government subsidies, as well as upgrading the level of primary healthcare services. She advocates accelerating the national coordination of health insurance, solving the problem of cross-location reimbursement, and promoting the free movement of labor. Ma Guifeng and Zhu Zhongchi (2018)[8], on the other hand, emphasize controlling the growth rate of health insurance fund expenditures and reforming payment methods to prevent fund overspending. Yang Mingxu and Chen Xiaoshan (2023)[9] call for strengthening the legalization of health insurance, doing a better job of classifying insurance participation, strengthening actuarial and risk assessment, enhancing transparency, and encouraging the academic community to strengthen actuarial research on health insurance.

2.2. Review of foreign studies

The problem of balancing the income and expenditure of the health insurance fund is a worldwide problem, and there are more related researches in foreign countries, mainly focusing on the financing, expenditure and fee-control researches of the health insurance fund.

2.2.1. Studies related to the financing of health insurance funds.

Through in-depth interviews with private providers, Sieverding M (2018) points out that health insurance expansion of participation coverage requires coordinated efforts from multiple parties. The participation of private providers as stakeholders in health insurance is conducive to boosting the revenues of the health insurance fund, which helps to improve the sustainability of the health insurance system [10]. Wang (2011) in his study analysed the data on total international health care expenditures of 31 countries around the world over a 21-year period from 1986 to 2007, and concluded that the increase in health care expenditures is closely related to the economic conditions are closely linked to improvements in the economy. He noted that the decentralisation of the MBF and the insufficient level of pooling hampered the risk-sharing of the MBF. In view of this, he suggested innovations in the settlement of medical expenses and an appropriate increase in the level of co-ordination of the fund [11]. A study by P.J. Veugelers and A.M. Yip (2003) pointed out that the government should play a leading role in the promotion of universal health care insurance, especially in the operation of the health care insurance fund. In addition, Barr (2003) pointed out in his study of the health insurance financing model in the United Kingdom that the government's adoption of mandatory collection of health insurance premiums can effectively prevent the occurrence of adverse selection [12].

2.2.2. Analysis of Factors Affecting the Rise in Expenditure of the Health Insurance Fund.

Newhouse's (1992) study found that there is a positive correlation between per capita health care costs and GDP, indicating that the level of development of GDP is related to health care expenditures [13]. Foster Richard S (2000), using data collected on Medicare expenditures during the period of 1966-2000, analysed that in the case of seniors aged 65 years and above, the personal total health care costs, Medicare's share has gradually increased. In particular, the growth rate of Medicare fund expenditures for the elderly population has gradually increased and has been much faster than the growth rate of Medicare fund revenues [14]. Rodrigo Moreno-Serra and Adam Wagstaff (2010) analysed data on health care costs before and after health care payment reforms in 28 countries during the period 1990-2004 in their study. Their study found that health care expenditures increased in countries that adopted both capitation and fee-for-service payments compared to itemised payments. In this case, the increase in fee-for-service led to an increase in the number of inpatient admissions, while payment by item reduced the average length of stay [15].

2.2.3. Countermeasures to control rising health care costs.

Markv.Pauly (1996) proposed an idea of co-payment of health insurance costs, in which the insured party and the health insurance fund share the costs, with the insured party sharing part of the costs incurred due to moral hazard [16]. This type of co-payment is believed to help avoid moral hazard to a greater extent, thus enhancing the cost control effect of the health insurance fund.Cagatay K (2004), using theoretical modelling, found that the inadequacy of the health insurance system is a major factor contributing to the surge in health care costs. He argued that the increasing expenditure of the health insurance fund is mainly due to the inadequacy of the health insurance system, which can easily lead to overmedication and increase the expenditure of the fund. At the same time, he put forward the theory of doctor-induced demand, pointing out that the information superiority of healthcare service providers may lead to patients accepting excessive medical services and increasing costs. Therefore, he called for promoting the improvement of the health insurance regulatory system to solve this problem [17].Tosatto L (2013) proposed the health insurance cost DRGs (Disease Diagnosis Related Groups) payment method as the current more advanced payment method. This payment method standardises and modularises the expenditure of the health insurance fund by formulating uniform disease diagnosis classification indexes and health insurance treatment standards, limiting excessive medical practices. This method is expected to solve the problem of surging medical costs to a certain extent and improve the efficiency and sustainability of medical insurance [18].

3. Existing policies on medical insurance for urban and rural residents in the mountainous areas of northern Guangdong Province.

3.1. Existing basic medical insurance fund-raising policy for urban and rural residents.

The medical insurance system for urban and rural residents in the mountainous regions of northern Guangdong is an important part of China's medical security. The fund mainly consists of individual contributions and financial subsidies. In 2021 in Qingyuan City, for example, the financing standard is 839 yuan, with individual contributions of 289 yuan and financial subsidies of 559 yuan. In terms of the level of coordination of the health insurance fund, the management mode of municipal coordination is adopted. The local financial departments give subsidies according to a certain percentage, and the funds are remitted to the municipal fund account, and the medical insurance department pays them uniformly to the county and district medical insurance accounts. At the same time, the proportion of financial subsidies for special populations is 25% at the provincial level, 25% at the prefecture level, and 50% of the local urban and rural basic medical assistance fund, to ensure that the basic medical needs of special populations are met The policy also pays attention to low-income families, the chronically ill, the elderly, and children, and provides appropriate subsidies.

3.2. Current urban and rural residents' basic medical insurance fund payment policy

The payment policy of the Basic Medical Insurance Fund for Urban and Rural Residents covers a wide range of medical expenses, including hospitalization, outpatient care and emergency care[23]. However, there are obvious differences in different regions, such as the starting line, maximum payment limit and reimbursement ratio. In Qingyuan and Heyuan, for example, the starting payment standard for hospitalization is 150-300 yuan for first-level hospitals, 600 yuan for second-level hospitals and 900 yuan for third-level hospitals in Qingyuan, and 250 yuan for first-level hospitals, 350 yuan for second-level hospitals and 500 yuan for third-level hospitals in Heyuan. The maximum payment limits are 200,000 yuan and 500,000 yuan respectively. The reimbursement rates for different levels of hospitals are also different, and the reimbursement rates for hospitalization within and outside the city are also different: 90% for first-level hospitals, 75% for second-level hospitals and 60% for third-level hospitals within the city, and 80%, 65% and 50% outside the city respectively.

4. Implementation of medical insurance for urban and rural residents in the mountainous areas of northern Guangdong Province

4.1. The insured population

As indicated in Table 1,Over the past eight years, the resident population of the five cities in the mountainous regions of northern Guangdong province has continued to decrease. between 2015 and 2022, the number of residents decreased from 16,640,700 to 15,943,700, a year-on-year decrease of 4.18 per cent. This reflects the outflow of local population, which may be affected by economic and social factors.In contrast, the decline in the number of urban and rural residents enrolled in medical insurance was even more significant. Over the same period, the number of insured persons fell from 15,865,300 to 13,768,500, a decrease of 13.26 per cent. The participation rate fell from 95.34 percent to 86.36 percent, showing a clear downward trend and highlighting negative growth.

Table 1: Overview of the insured population in the mountainous regions of northern Guangdong.

Year	Resident population (Ten thousand)	Insured population (Ten thousand)	Participation rate
2015	1664.07	1586.54	95.34%
2016	1603.14	1579.20	98.51%
2017	1600.60	1569.55	98.06%
2018	1597.39	1531.44	95.87%
2019	1595.67	1503.82	94.24%
2020	1591.96	1487.78	93.46%
2021	1595.40	1465.78	91.88%
2022	1594.37	1376.85	86.36%

4.2. Fund balances

As shown in figure 1, we can understand the fund income, expenditure and balance of the urban and rural residents' health insurance in the mountainous towns in northern Guangdong.

4.2.1. Expenditure and income of the Fund

The health insurance fund shows a range of trends in terms of revenue and expenditure among urban and rural residents in the mountainous regions of northern Guangdong. From 2015 to 2022, the revenue of the health insurance fund grows from $8.210 billion to $13.280 billion, with an average annual growth rate of 6.30 percent. During this period, revenues continue to grow, especially from 2015 to 2019, at a double-digit average annual growth rate, demonstrating the government's continued investment in health care and the population's increased demand for health care. However, the lower growth rates of 2.95 per cent and 0.63 per cent in 2020 and 2021, respectively, may have been affected by the global New Crown Epidemic, which led to stagnation in the deployment of healthcare resources and services, thereby affecting the healthcare behaviour of the population. Although the growth rate picks up in 2022, it is still relatively low, which may be due to the economic recovery and government restructuring reforms after the epidemic.

Expenditures of the health care fund also experienced significant growth compared to revenues. It grows from $6,414 million in 2015 to $13,552 million in 2022, at an average annual growth rate of 10.34 per cent.The expenditure growth rate in 2016 reached 35.64 per cent, which may be due to rising healthcare costs or policy adjustments. In subsequent years, the expenditure growth rate fluctuated, but generally showed steady growth. The relatively low expenditure growth rates in 2019 and 2021 may reflect the effectiveness of the government's efforts to control healthcare expenditure or be related to the economic environment. However, healthcare expenditure increased significantly in 2020, with a growth rate of 9.12 percent, which was attributed to the increased demand for healthcare services due to the impact of the New Crown Epidemic. Despite the gradual containment of the outbreak in 2021, Medicare expenditures continue to grow, demonstrating the continued demand for healthcare services. By 2022, expenditure continues to grow, but at a slightly reduced rate of 2.09 per cent, which may be the result of the Government's efforts to control the rate of growth of health insurance expenditure in order to maintain the sustainability of the fund.

4.2.2. Fund balance situation

The balance of the urban and rural residents' health insurance fund from 2015 to 2022 shows fluctuations. In 2015, the balance amounted to 1.796 billion yuan, with a balance rate of 21.88 per cent, demonstrating a balanced fund. However, the balance gradually decreased in the following years, dropping to 416 million yuan in 2016, with a balance rate of 4.56 per cent, showing that expenditures began to exceed revenues.In 2017 and 2019, the balance was positive but the balance rate was significantly lower, showing a trend of expenditures growing at a higher rate than revenues.From 2018 to 2021, the fund had consecutively negative balances, with the most notable one in 2018, which amounted to 529 million yuan, with a balance rate of -4.74 percent, and in 2021 the deficit is reduced to 427 million yuan, with a balance rate of -3.32 percent, reflecting a continued trend of higher expenditure growth than revenue growth.In 2022, although the balance is reduced to -272 million yuan, it is still negative, with a balance rate of -2.05 per cent, and in general the financial situation of the urban and rural residents' medical insurance fund of the mountainous regions of Guangdong is not optimistic.Detailed data are shown in Figure 1.
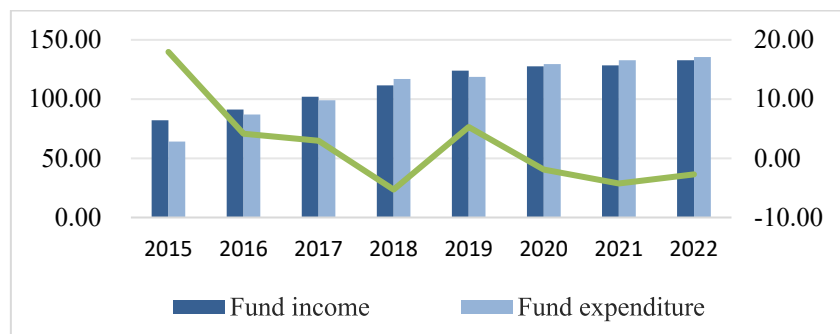

Figure 1: Balance of income and expenditure of the Urban and Rural Residents' Health Insurance Fund over the years.

5. Analysis of forecasts of income and expenditure of the Urban and Rural Residents' Medical Insurance Fund

5.1. Introduction to the grey prediction GM(1,1)

GM model is a forecasting model based on gray system theory, which is suitable for short-term forecasting. By accumulating the original series, generating more regular series, and establishing differential equations to fit the system law, the gray parameters are obtained, and the prediction equation model is constructed. The GM model performs better in short-term prediction, and it is suitable for less samples and irregular data[4]. In areas such as health insurance funds, the GM(1,1) model can be used to improve forecasting accuracy, reduce the impact of irregular data, and enhance credibility.

5.2. Construction of model equations

Sequence construction: the sequence of original values of fund income (expenditure) is shown in equation 1. The sequence of cumulative values of fund income (expenditure) is shown in equations 2 and 3.

$$X^{(0)} = \{X^{(0)}(1), X^{(0)}(2), \cdots\cdots, X^{(0)}(N)\} \tag{1}$$

$$X^{(1)} = \{X^{(1)}(1), X^{(1)}(2), \cdots\cdots, X^{(1)}(N)\} \quad = \tag{2}$$

$$X^{(1)}(N) = \begin{cases} X^{(0)}(1), N = 1 \\ X^{(1)}(N-1) + X^{(0)}(N), N = 2,3,\cdots,N \end{cases} \tag{3}$$

Equation establishment and parameter solution: the establishment of the health insurance fund income and expenditure cumulative forecast value equation is shown in equation 4.where α, u are the functions to be found from the grey parameter matrix ā:

$$\hat{X}^{(1)}(t) = \left(X^{(0)}(1) - \frac{u}{a}\right)e^{-a(t-1)} + \frac{u}{a} \tag{4}$$

In Equation 5, the sliding average matrix (B) and the data vector (y_n) are shown in Equation (6) and Equation (7); substituting α,υ derived from Equation 5 back into Equation 4, the expression of the equation of the cumulative predicted value of the income (expenditure) of the urban and rural residents' health insurance is obtained, and how to reduce the predicted value of the income (expenditure) of the tth year by decreasing, the equation of the predicted value of the income (expenditure) of the tth year is obtained as Equation [8]

$$\hat{a} = \begin{bmatrix} a \\ u \end{bmatrix} = (B^T B)^{-1} B^T Y_n \tag{5}$$

$$B = \begin{bmatrix} -\frac{1}{2}(X^{(1)}(1) + X^{(1)}(2) & 1) \\ -\frac{1}{2}(X^{(1)}(2) + X^{(1)}(3) & 2) \\ \vdots & \vdots \\ -\frac{1}{2}(X^{(1)}(N-1) + X^{(1)}(N) & 1) \end{bmatrix} \tag{6}$$

$$Y_n = \begin{bmatrix} X^{(0)}(2) \\ X^{(0)}(3) \\ \vdots \\ X^{(0)}(N) \end{bmatrix} \tag{7}$$

$$\hat{X}^{(0)}(t) = \begin{cases} \hat{X}^{(1)}(t), t = 1 \\ \hat{X}^{(1)}(t) - \hat{X}^{(1)}(t-1), t \geq 2 \end{cases} \tag{8}$$

5.3. Empirical model predictions

5.3.1. Forecast of urban and rural residents' medical insurance fund revenue in the northern mountainous areas of Guangdong Province

In this paper, the grey prediction model GM(1,1) is used to predict the income of basic medical insurance fund for urban and rural residents in the northern mountainous areas of Guangdong Province from 2015 to 2022, and the simulation results in the development coefficient of the grey model a=-0.058,

the grey effect amount b=901697.417, and the average value of relative simulation error is 3.225%, which is a good simulation accuracy.Table 2 shows the data derived from the model for the years 2015-2022. The difference from the actual data is small. It can be proved that the GM(1,1) model has high credibility

Table 2: Results of Fund Income Model Fit.

Year	Original value	Projected value	Residual	Relative error (%)
2015	82.10	82.10	0	0
2016	91.16	97.67	-6.51	7.14
2017	101.91	103.45	-1.53	1.51
2018	111.62	109.57	2.04	1.83
2019	124.01	116.06	7.95	6.41
2020	127.66	122.93	4.73	3.71
2021	128.47	130.21	-1.74	1.35
2022	132.79	137.91	-5.12	3.86

Note: Data related to the Urban Residents' Medical Insurance Fund from 2015 to 2022 are from the Guangdong Provincial Statistical Yearbook.

Result 1: Model fitting results

The grey prediction model GM(1,1) is based on the historical period data to predict the future period data: the average relative error of the model is 3.225%, according to Figure 2 can be seen that the actual value of the urban and rural residents' medical insurance fund is very close to the predicted value from 2015 to 2022, which means that the GM(1,1) model D1 is well fitted, and can accurately predict the future urban and rural residents' medical insurance fund income.
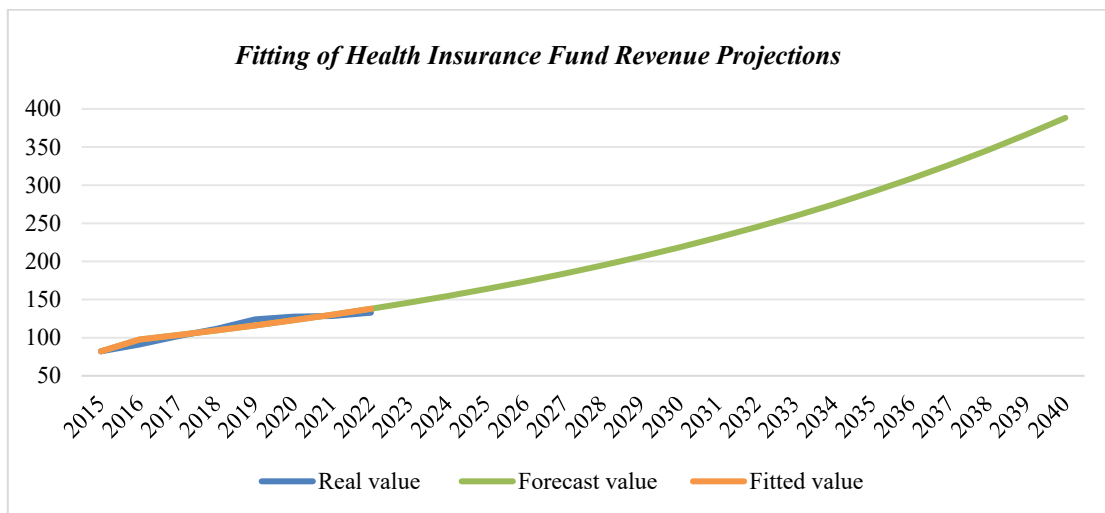

Figure 2: Fitting of Health Insurance Fund Revenue Projections.

Table 3: Projected Revenue Results for the Health Insurance Fund.

Year	Fund income (billion)	Year	Fund income (billion)
2015	8.21	2028	19.474
2016	9.116	2029	20.627
2017	10.192	2030	21.848
2018	11.162	2031	23.141
2019	12.401	2032	24.511
2020	12.766	2033	25.962
2021	12..47	2034	27.499
2022	13.280	2035	29.126
2023	14.608	2036	30.850
2024	15.473	2037	32.676
2025	16.389	2038	34.611
2026	17.359	2039	36.659
2027	18.386	2040	38.829

Result 2: Model prediction fitting results

The forecast of the income of the medical insurance fund for urban and rural residents in the mountainous regions of northern Guangdong from 2023 to 2040 is shown in Table 3. The model predicts that the income of the medical insurance fund for urban and rural residents in the mountainous regions of northern Guangdong in 2023 will be 14.608 billion yuan, and 10 years later, in 2033, the value of the income of the fund will be 25.961 billion yuan, which is 12.891 billion yuan more than the predicted value of the fund's income in 2023, and the The growth rate reaches about 8.8 percent. By 2040, the income on health insurance for urban and rural residents in the mountainous regions of northern Guangdong will grow to 38,829 million.

5.3.2. Forecast of expenditure of medical insurance fund for urban and rural residents in mountainous areas of northern Guangdong Province

Result 1: Table of model fitting results

The projections of urban and rural residents' medical insurance fund expenditures are based on the 2015-2022 expenditure data, and the GM(1,1) model is used to simulate the projections.The GM(1,1) model utilizes historical data to predict future data, and Table 4 shows the original expenditures and the projected values, with an average simulation error of 3.416%. The model parameters are the gray model development coefficient a = -0.031 and the gray effect size b = 219.99. indicating a good model fit. Figure 3 shows that the actual expenditures from 2015 to 2022 are extremely close to the predicted values, which verifies the accuracy of the GM(1,1) model and can reliably predict the future expenditures of the urban and rural residents' health insurance fund.

Table 4: Results of fitting the health insurance fund expenditure model.

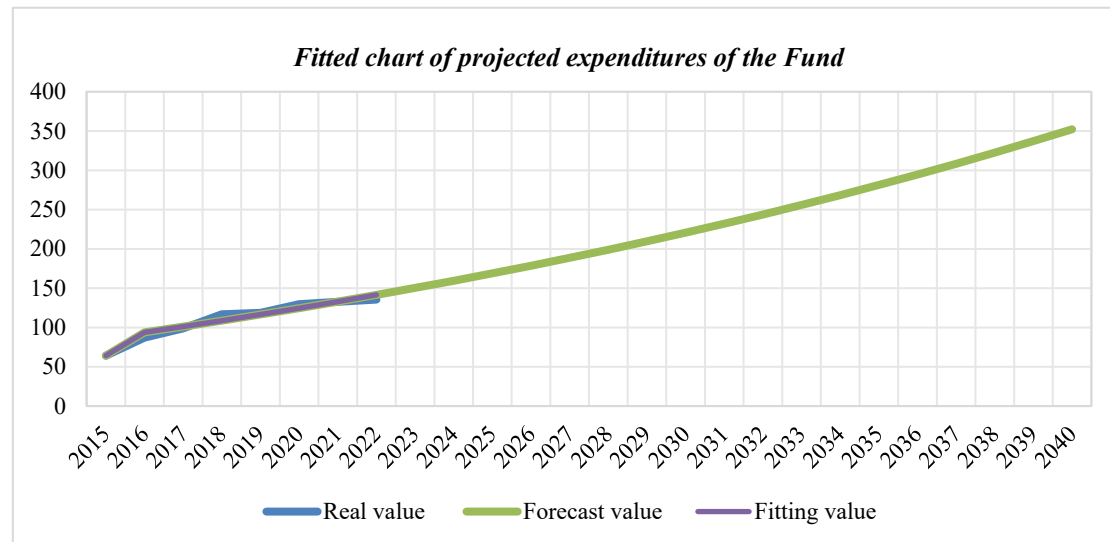| Year	Original Value	Projected Value	Residual	Relative error (%)
2015	64.14	64.14	0	0
2016	87	93.86	-6.86	7.89
2017	98.95	101.19	-2.24	2.26
2018	116.91	108.75	8.16	6.98
2019	118.74	116.56	2.18	1.84
2020	129.56	124.61	4.95	3.82
2021	132.74	132.92	-0.18	0.14
2022	135.52	141.49	-5.98	4.41

Figure 3: Fitting results of the expenditure of the Health Insurance Fund.

Result 2: Results of the model prediction

The forecast of urban and rural residents' medical insurance fund expenditures in the mountainous areas of northern Guangdong Province from 2023 to 2040 is shown in Table 5 below. According to the model, the forecast of urban and rural residents' medical insurance fund expenditures in northern Guangdong Province in 2023 is 15.034 billion yuan. Ten years later, i.e., in 2033, the value of the fund expenditures will be 25.592 billion yuan, which is 10.558 billion yuan more than the forecasted value of

the fund expenditures in 2023, and the growth rate reaches about 7.0%. By 2040, the value of health insurance expenditures for urban and rural residents in the mountainous regions of northern Guangdong will grow to 35.232 billion.

Table 5: Results of the projected expenditures of the Health Insurance Fund.

Year	Expenditure forecast (billion)	Year	Expenditure forecast (billion)
2023	15.034	2032	24.381
2024	15.947	2033	25.592
2025	16.889	2034	26.842
2026	17.862	2035	28.132
2027	18.865	2036	29.462
2028	19.900	2037	30.835
2029	20.968	2038	32.252
2030	22.070	2039	33.714
2031	23.208	2040	35.223

5.3.3. Forecast of the shortfall of income and expenditure of the medical insurance fund for urban and rural residents in the mountainous areas of northern Guangdong Province
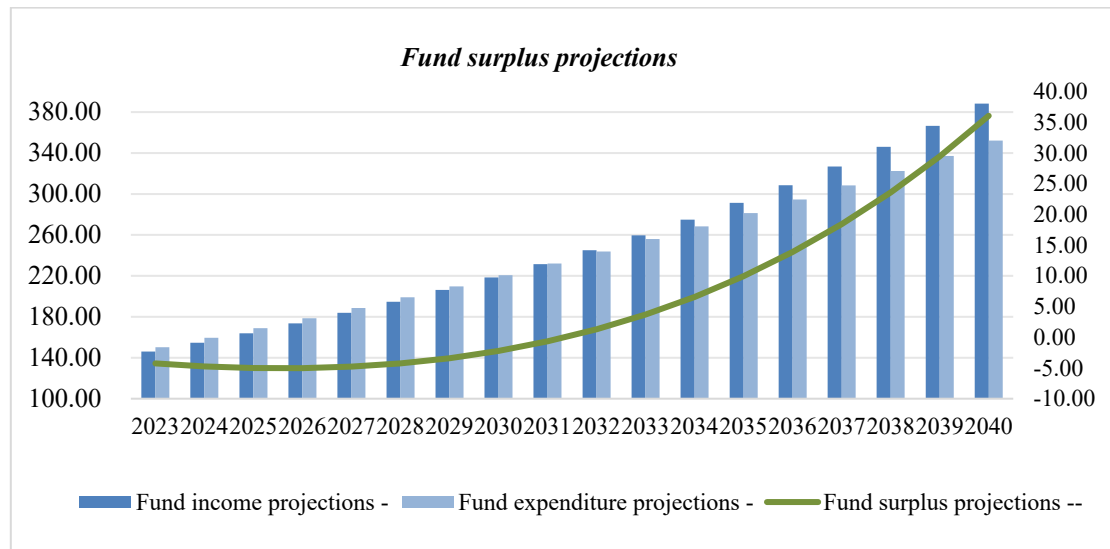

Figure 4: Projections of the Health Insurance Fund Surplus.

Table 6: Projected results of the health insurance fund balance.

Year	Fund income projections	Fund expenditure projections	Fund surplus
2023	146.08	150.34	-4.26
2024	154.73	159.47	-4.75
2020	163.89	168.89	-5.01
2026	173.59	178.62	-5.03
2027	183.86	188.65	-4.79
2028	194.74	198.99	-4.25
2029	206.27	209.68	-3.41
2030	218.48	220.70	-2.22
2031	231.41	232.00	-0.66
2032	245.11	243.81	1.30
2033	259.62	255.93	3.70
2034	274.99	268.42	6.57
2035	291.26	281.32	9.95
2036	308.50	294.62	13.88
2037	326.76	308.35	18.41
2038	346.11	322.52	23.59
2039	366.59	337.14	29.45
2040	388.29	352.23	36.06

Forecast analysis: the results of the forecast of the income and expenditure of the basic medical insurance fund for urban and rural residents in the mountainous areas of Guangdong Province (as shown in Figure 4 and Table 6), the income and expenditure of the medical insurance fund in the 10-year period from 2023 to 2033 showed a steady upward trend, and the fund balance in 2023 was -426 million yuan, and the fund balance in 2033 will rise to 130 million yuan, with a specific value of 12.988 billion , according to the Guangdong Province Statistical Yearbook data, in 2018, the medical insurance fund expenditure is greater than the fund income for the first time, the fund income and expenditure gap, the gap value of 520 million , Combined with the forecast data, the urban and rural residents of the northern mountainous areas of Guangdong Province, the income and expenditure of the fund continues to be a shortfall in the 12-year period from 2020 to 2031, with an average shortfall amount of about 360 million yuan, and the fund begins to break even after 2032. It can be seen that under the current system, there is a risk that the health insurance fund will not balance its income and expenditure.

6. Analysis of the problem of the balance of income and expenditure of the Urban and Rural Residents' Medical Insurance Fund and the reasons for it

6.1. Decline in the number of insured persons and slow growth in fund collection revenue

In Heyuan City, for example, as of November 2023, the number of basic medical insurance participants has covered 98% of the city's resident population, with relatively limited room for expansion. Meanwhile, the contribution to the residents' medical insurance has been rising year by year, reaching RMB 380 per person as of 2024, close to the contribution level of PRD cities, making it difficult to increase fund revenue by raising the contribution level. It is worth noting that the specific data of the mountainous areas in northern Guangdong shows a downward trend in the number of insured people. As shown in Figure 5 below, since 2015, the number of insured people in the mountainous regions of northern Guangdong has decreased from 15,865,300 to 13,768,500 in 2022, with an average annual reduction rate of -1.65%. The main reason for the decrease is the large-scale exodus of the labor force, which leads to a decrease in the number of local participants. The growth of the Fund's income depends to a large extent on the steady increase in the number of insured persons and the financing standards. As can be seen in Figure 6, the income from the collection of the Medical Insurance Fund, the Fund's income from the collection of the Fund has dropped significantly in 2018, from 9,885 million in 2017 to 3,447 million. It can be seen that simply increasing the funding standards no longer seems to be effective enough and that the growth of the Fund's collected income lacks an intrinsi cmotivate.
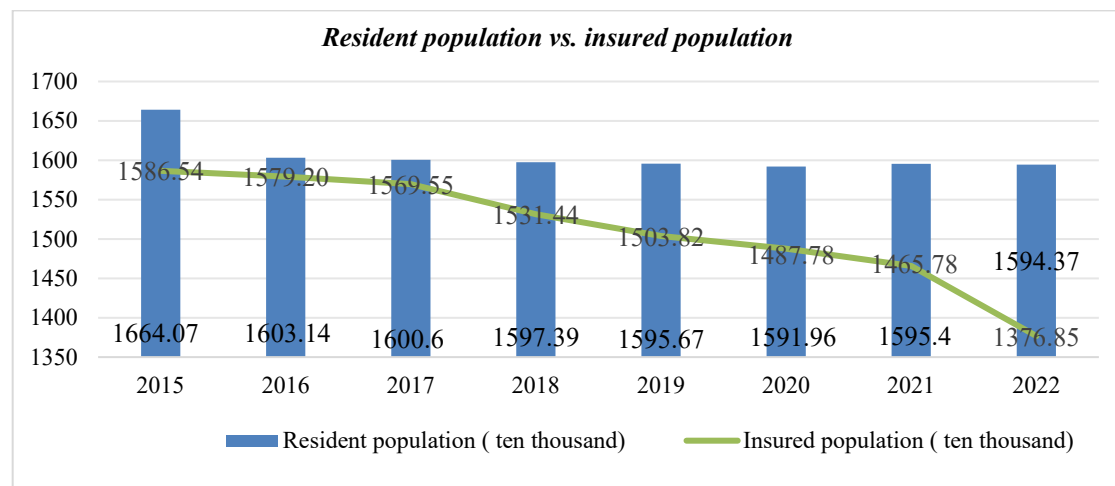

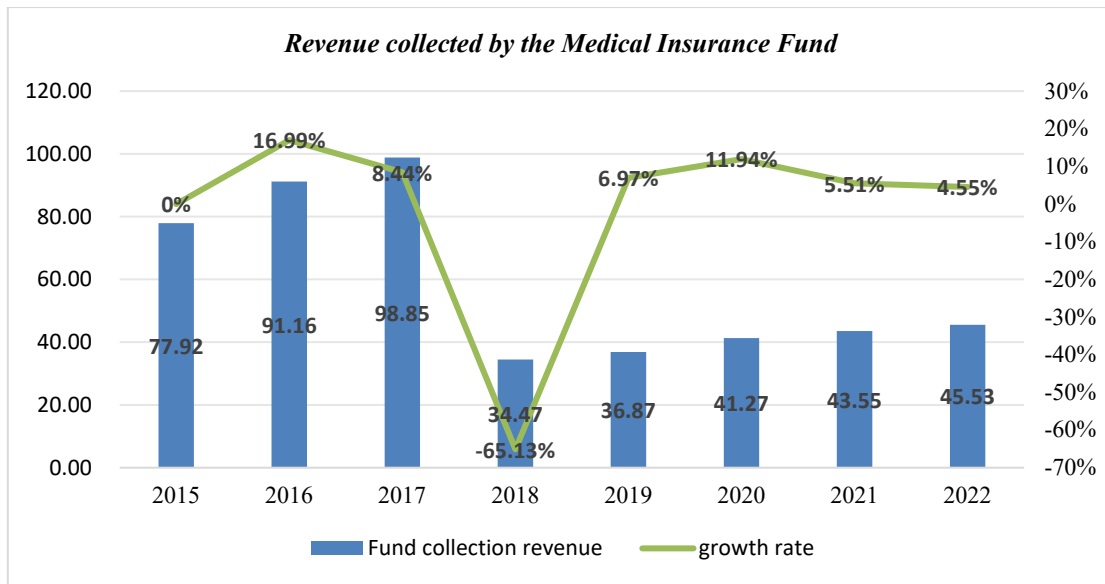*Figure 5: Comparison of the insured population of the resident population.*

Figure 6: Income collected by the Urban and Rural Residents' Health Insurance Fund.

6.2. Excessive growth of expenditure and inverse growth of income and expenditure

From the data in Figure 7, it can be seen that the income and expenditure of the Medical Benefits Fund show certain trends and problems. From the data of recent years, the income and expenditure of the Fund show a trend of growth, but the growth rate of expenditure is significantly faster than the growth rate of income, and there is a phenomenon of inverted growth rate of income and expenditure.From 2015 to 2022, the income of the Fund has increased year by year, from $8,210 million to $13,280 million. At the same time, fund expenditures also increase, from $6.414 billion to $13.552 billion. While fund revenues increased during this period, expenditures increased even more, resulting in sometimes high and sometimes low balances, and even negative balances in some years. Specifically, from 2018 to 2021, fund expenditures exceeded revenues and the balance showed negative growth, especially in 2018 and 2021, when the balance declined more significantly.
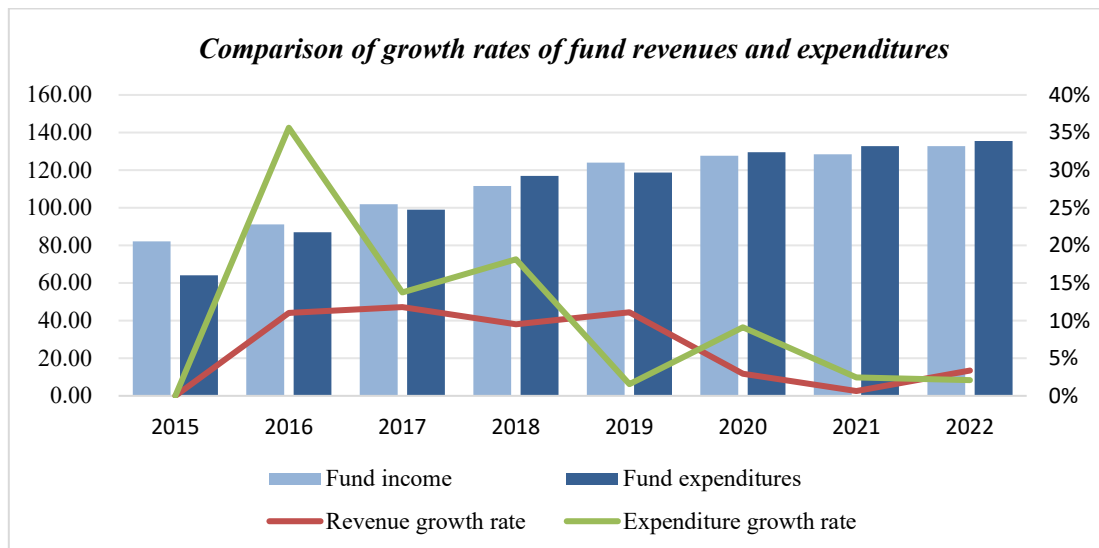

Figure 7: Comparison of the growth rate of income and expenditure of the health insurance fund.

6.3. Government faces excessive pressure to underfund financial subsidies

The government is under pressure to provide financial subsidies, which may lead to a shortage of funds for urban and rural residents' health insurance. Although financial subsidies for urban and rural residents' health insurance in the mountainous regions of northern Guangdong increased from 360 yuan to 610 yuan from 2015 to 2022, with an average annual growth rate of 6.90 per cent, the growth rate of

financial subsidies has shown a slowing down trend since 2018, highlighting the increasing financial pressure (see figure 8). The urban and rural residents' health insurance integration programme advocates the unification of protection benefits and contribution standards to promote the equalisation of urban and rural health insurance levels. However, the current rapid growth in health insurance fund expenditures and relatively slow growth in revenues indicate that the current model of individual contributions and government subsidies is difficult to effectively address the challenges faced.[7].
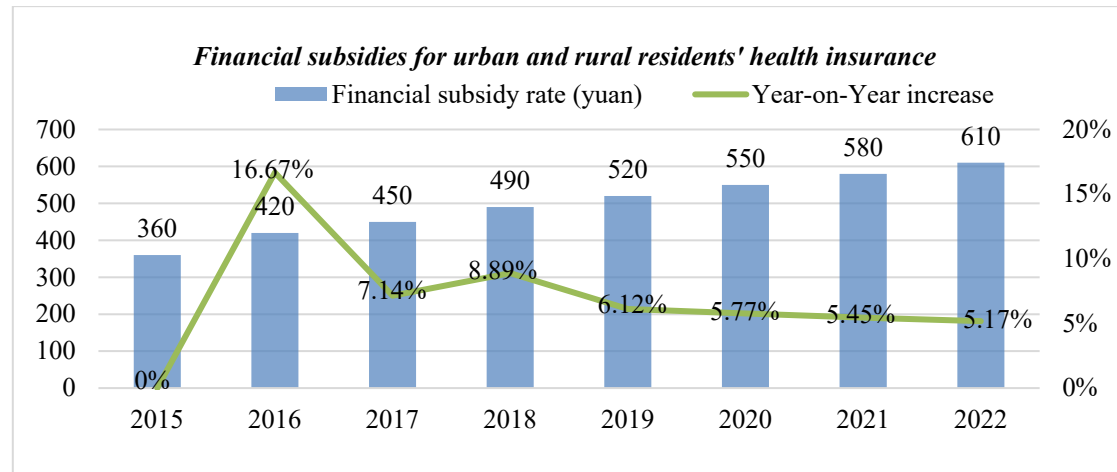

Figure 8: Share of financial subsidies in the Fund's income.

6.4. The level of fund co-ordination is too low, and the development of municipalities is unbalanced.

At present, the urban and rural residents' health insurance system in the mountainous regions of northern Guangdong is based on a municipal co-ordination model. This practice has led to some cities and counties with better economic conditions accumulating large fund balances and problems such as misuse of the fund; while some cities and counties with poorer economic conditions are caught in a predicament where the fund's income is insufficient to meet the day-to-day demand for fund payments. The insufficiency of the medical insurance fund will further intensify social conflicts and affect the stability of the medical insurance fund. At the same time, the low level of urban and rural residents' medical insurance coordination has weakened the mobility of labor force to a certain extent, which may have an impact on the rapid development of the economy. China's urban and rural residents' medical insurance fund has a low level of coordination and serious management "fragmentation". The main reasons for this situation are: unbalanced economic development in cities and counties, leading to large differences in the level of medical consumption; uneven levels of medical service management; and problems with the financial management system, such as "eating from separate stoves" and the authority to manage the surplus fund. These factors have led to a situation in which the basic medical insurance for urban and rural residents, and the level of coordination, are 'low but not high, and starting from a low base'.

6.5. Serious ageing of the population and imbalance in the structure of the insured population

The Figure 9 shows the proportion of the elderly population in each municipality in the mountainous regions of northern Guangdong, the five cities in the mountainous regions of northern Guangdong all have a population aged 60 years or older accounting for more than 15 per cent of the total population, specifically, 16.32 per cent in Heyuan, 18.38 per cent in Shaoguan, 16.47 per cent in Heyuan, 20.04 per cent of the elderly population in Meizhou, and 17.44 per cent in Yunfu. It is generally accepted internationally that when the elderly population aged 60 or above accounts for 10% of the total population in a country or region, or when the elderly population aged 65 or above accounts for 7% of the total population, it means that the country or region is in an ageing society. Population ageing is a global dilemma that has an impact on all aspects of social development, particularly in terms of the challenges posed by old-age insurance and health insurance[19].In China, the ageing population and increased longevity pose significant challenges to the operation of health insurance funds. The increase in the aging population has led to an aging and advanced age trend in the medical insurance participants, and the increased incidence and prolonged duration of chronic diseases have increased the risk of imbalance between income and expenditure of the medical insurance fund[20].
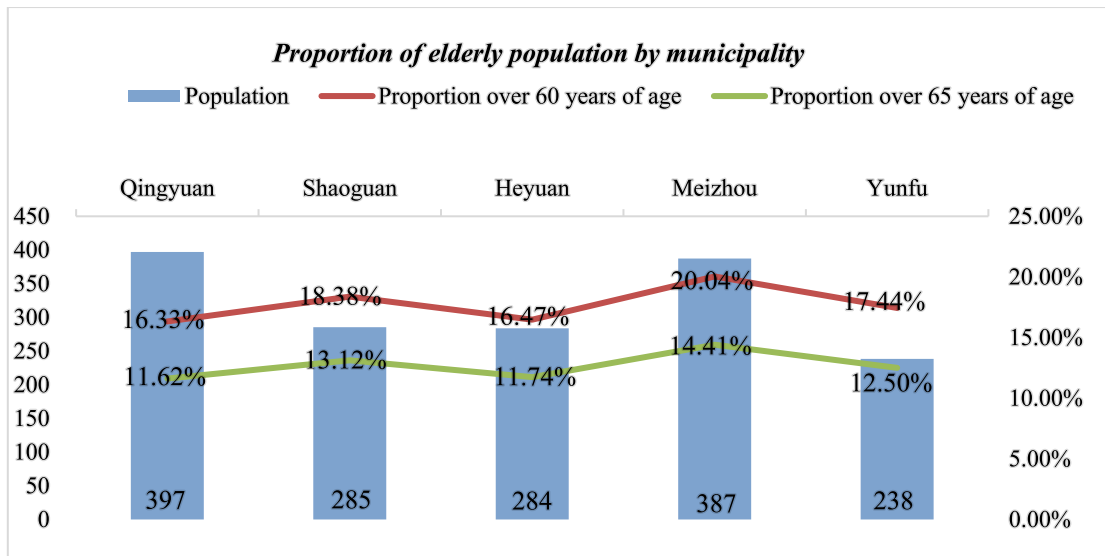
Figure 9: Percentage of Elderly Population in Municipalities in the Mountainous Regions of Northern Guangdong Province.

7. Countermeasures to achieve a balance between the income and expenditure of the medical insurance fund for urban and rural residents

7.1. Strengthening publicity to motivate residents to take out insurance

Raising health awareness through comprehensive health education and diversified publicity campaigns, establishing personal health records and providing personalized health management services, and promoting the participation of residents in insurance. Regularly providing free or preferential health check-ups, adjusting health insurance policies to increase reimbursement rates or expand the scope of reimbursement, establishing incentives for continuous participation, and lowering the participation threshold for low-income groups in order to increase the participation rate of the population as a whole. It has also strengthened publicity and education on health insurance in rural areas, formed health promotion teams, and worked with rural medical institutions to provide consultation services to ensure that residents understand and trust the health insurance system, and to promote their willingness to participate. These comprehensive measures have been effective in increasing the participation rate in the health insurance system and in meeting the health needs of more residents.

7.2. Controlling the rate of increase in the expenditure of the medical insurance fund and improving the settlement methods for medical insurance.

The establishment of an early warning mechanism for health insurance fund revenues and expenditures is crucial. First, it is necessary to set up an early warning center and train professionals to ensure the smooth operation of the institution. Second, an intelligent early warning platform should be set up to identify risks and adjust measures in a timely manner in order to maintain the balance of the fund. At the same time, investment in primary healthcare organizations should be increased, including diversification of funding sources and infrastructure renovation. In addition, a payment system based on illnesses should be implemented to control the growth of medical costs, enhance management efficiency and improve the doctor-patient relationship. As the economy develops, health insurance payment rates should be flexibly adjusted, and reasonable reimbursement ranges should be established to meet different medical needs.

7.3. Enriching financing channels and improving the value-keeping and value-adding capacity of the health insurance fund

In order to enrich the health insurance fund and increase its value-added capacity, first, the health insurance financing policy should be adjusted to take into account the local economy, fiscal revenues and individual incomes, balancing the financing responsibilities of individuals and the Government, reducing the proportion of fiscal subsidies, expanding the channels of social financing, ensuring the universality

of the policy, and establishing a sustainable financing mechanism. Second, explore long-term contribution guarantee mechanisms, encourage full participation in insurance, and give policy preferences to families with continuous contributions to incentivize continuous participation and improve fund stability. In addition, increase special taxes, such as taxes on pharmaceutical companies, into the health insurance fund to reduce the government's financial pressure and increase the fund's value-added capacity. Expanding financing channels through social donations and other means will increase the diversity of revenues and promote the healthy development of the health insurance system[21].

7.4. Upgrading the level of medical insurance fund co-ordination and establishing inter-regional and inter-departmental medical insurance co-ordination mechanisms

Upgrading the level of medical insurance fund coordination and establishing a mechanism for cross-regional and cross-sectoral medical insurance coordination is a key measure for realizing the sustainable development of a universal medical insurance system. China's current basic medical insurance system for urban and rural residents is mainly coordinated at the provincial level, but in order to achieve more effective resource allocation and risk sharing, it must be gradually upgraded to the level of national coordination. This requires starting with municipal coordination, gradually transitioning to provincial coordination, and ultimately realizing national coordination. National coordination will help solve the problem of reimbursement for medical treatment in different places, promote free movement of labor and simplify administrative procedures. It is vital to establish a linkage mechanism: promote cooperation between all levels of government and establish a unified planning and resource-sharing mechanism. Through the establishment of unified policies and standards, the effective articulation of basic medical insurance, medical assistance and major illness insurance will be realized, and a multi-level medical insurance network will be constructed [22].

8. Conclusion

This study aims to gain a comprehensive understanding of the current financial situation of the medical insurance fund in the region, as well as the future development trend, and to analyse in-depth the challenges involved and propose corresponding solution strategies. In order to achieve this, the study will explore the balance of income and expenditure of the basic medical insurance fund for urban and rural residents in the mountainous areas of northern Guangdong. By collecting relevant data and policy documents, and considering the evolution and practice of health insurance policies, we identified potential risks of fund imbalance. The GM(1,1) model was applied to systematically forecast the income and expenditure of the health insurance fund for the next 20 years, and the results showed that the fund continued to show a deficit, which presented an unstable trend. Furthermore, a series of problems were identified, including a declining number of participants, increasing financial pressure, a low level of coordination and insufficient supervision. In order to ensure the balanced operation of the health insurance fund in the long run, a series of solutions were proposed, including measures to encourage residents to participate in the scheme, increase fund revenue, control expenditure, strengthen supervision and upgrade the level of coordination. This study offers theoretical and policy insights that can inform the improvement of the health insurance system for urban and rural residents. Its academic and practical significance is considerable.

Acknowledgements

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