

# Targeting vulnerable groups of health poverty alleviation in rural China— what is the role of the New Rural Cooperative Medical Scheme for the elderly population?

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## Research article

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## Abstract

**BACKGROUND :** Based on the health poverty alleviation policy, we explored whether the New Rural Cooperative Medical System (NRCMS) had effectively reduced the economic burden of the rural elderly population and impoverished vulnerable groups with regard to medical expenses, providing further evidence for increasing the medical insurance system.

**METHODS:** Data were obtained from the 2015 China Health and Retirement Longitudinal Study. The method was adapted from WHO to calculate the catastrophic health expenditure (CHE) and impoverishment by medical expense (IME). The treatment effect model was used to identify the determinants of CHE in the rural elderly residents.

**RESULTS:** The incidence of CHE in rural China for the elderly is 19.65%, and the impoverishment by medical expense has reached 6.94%. The households enrolled in NRCMS suffered higher CHE (21.9%) and IME (8.0%), than unenrolled households (20.6%, 7.7%). The NRCMS did not provide sufficient economic protection from CHE for households with 3 chronic diseases, inpatients, or adults over 65, Risk factors for CHE included education levels, households with inpatients, people over 65 years old, disabilities, and so on.

**CONCLUSIONS:** Although the NRCMS had reduced barriers to the use of household health services while reducing their out of pocket payments, in some respects, it was still not effective to reduce the risk of residents falling into poverty. Our research identifies the characteristics of vulnerable groups that the NRCMS does not provide enough support for, and are at risk of falling into poverty through health impoverishment.

## Background

Poverty is a silent war. According to the World Bank's international poverty line standard of \$1.90 US dollars a day, the global poverty population accounted for 10% of the total population in 2015.<sup>1</sup> In fact, 75% of the poor are mainly concentrated in middle-income countries after 2007.<sup>2</sup> Poverty has always been a common challenge for all countries in the world. In 2013, one of the 17 goals of sustainable development proposed in the UN's Post-2015 Development Agenda Report was to end all forms of poverty by expanding social protection by 2030, which would further support global sustainability.<sup>3</sup> By the end of 2017, the number of rural poor people in China has decreased from 770 million to 30.46 million, and the total number of people brought out of poverty nationally is about 740 million. The average of poverty reduction is close to 19 million people that are lifted out of poverty each year. The contribution rate of China alone to total global poverty reduction exceeds 70%.<sup>4</sup> Before the reform and opening up, China's rural poverty rate was as high as 97%, which means only 3% of the rural population was not poor. However, since the reform and opening up 40 years ago, by the end of 2017 China's rural poverty rate was only 3.1%.

China's exploration of poverty alleviation in rural areas can be divided into five steps since the reform and opening up. In the first stage, systematic rural reform promoted poverty alleviation from 1978-1985. The unreasonable management system in the 1980s restricted the development of China's rural economy.<sup>5</sup> According to the current poverty standard, the rural poverty population in 1978 was 770 million.<sup>6</sup> The subsequent reform of the rural land management model greatly liberated the rural labor force and created more non-agricultural production activities. This economic development promoted parts of the rural population to get out of poverty.<sup>7</sup> In 1985, the number of rural poor people decreased from 770 million to about 660 million, and the incidence of IME fell to 78.3%. At this stage, the average annual poverty reduction rate in rural areas was 2%. In the second stage, 1986-1993 was a development-oriented poverty alleviation stage. In some areas, it was difficult to get rid of poverty due to geographical restrictions. The imbalance of rural development in China had gradually emerged. The Chinese government had set up a special agency to use special poverty alleviation funds for development-oriented poverty.<sup>8</sup> In 1993, the proportion of poor people in the total rural population fell from 14.8% to 8.7%. Through economic development, the isolated poverty-stricken areas in central and western regions were lifted out of poverty, and the annual poverty alleviation rate reached 5.12%. The third stage was when the National Plan for Poverty Reduction was introduced, because the distribution of rural poverty still presented geopolitical characteristics from 1994 to 2000. With the implementation of the "Seven-Year Priority Poverty Alleviation Program" (known as the 8-7 Plan), China's rural poverty alleviation work entered a stage of rapid promotion. In the three years from 1997 to 1999, every year about 8 million people solve the problem of food and clothing and poverty. China's rural areas ushered in the highest poverty alleviation since the 1990s.<sup>9</sup> The resulting rapid economic growth doubled the annual average poverty alleviation rate in rural areas—up to 10.41%. The fourth stage brought about the implementation of a consolidation-oriented comprehensive poverty reduction strategy (2001-2012). At this stage, poverty-reducing factors were diversified.<sup>10</sup> The economy was no longer the only factor causing poverty among rural residents. Aging and the high incidence of chronic and major diseases increased the economic burden on individuals and increased the risk of falling into poverty. The New Rural Cooperative Medical Scheme (NRCMS) and the New Rural Social Pension Insurance (NRSPI) were established to support rural residents. In 2012, the poor in Chinese rural areas had decreased to 98.99 million, and the incidence of IME fell to 10.2%. In 2001-2012, the economy continued to develop at a relatively fast pace in 2001-2012, but the annual average poverty reduction rate has dropped from 10.41% to 7.1%. The trickle-down effect of economic development was not enough to drive the remaining part of the population out of poverty.

In this context, the marginal diminishing effect of previous antipoverty policies and the changes in the characteristics of poverty population, posed great challenges to poverty alleviation that cannot be effectively solved by existing strategies. In order to achieve the goal of getting all people out of poverty by 2020, the target identification and poverty reduction strategies of China's poverty alleviation strategies had to change with the times.<sup>11</sup> Therefore, China initiated the strategy of Targeted Poverty Alleviation (TPA) in 2013, which was important for innovating the mechanisms of poverty alleviation and development.<sup>12</sup> Under the influence of this policy, the annual average poverty reduction rate increased to 15.97% in this period from 2013 to 2018. However, the long-standing urban-rural dualistic structure, with natural resources and social factors that restrict rural development, left a total of 43.4 million still living in poverty at the end of 2016. At the same time, according to the statistical bulletin issued by the National Bureau of Statistics of China, among the poor people in rural China in 2016, the number of people in poverty due to an illness was 44.1%, and long-term chronic diseases reached 22.14%.<sup>13</sup> The rural population

had a serious economic burden. Impoverishment from medical expenses or returning to poverty due to illness had become one of the largest factors contributing to the poverty of the rural population.

It is estimated that the annual growth rate of medical expenses for the elderly in China will increase to 2.2% in 2010-2030, which is much higher than that of the United States and other Organization for Economic Cooperation and Development (OECD) countries (0.3%–0.5%)<sup>14</sup>. The number of poor people in rural China is three times that of urban areas.<sup>15</sup> At the end of 2017, China's rural population reached 576.61 million, of which the population aged over 60 reached 240.9 million, accounting for about 41% of the total rural population. Moreover, the elderly have always been susceptible to chronic diseases.<sup>16,17</sup> The economic burden of diseases caused by chronic illnesses accounts for 70% of the total disease economic burden.<sup>18</sup> Older people with chronic diseases must respond to their accompanying burden of disease through their remaining lives.<sup>19</sup> As the most direct and effective means of health poverty alleviation, the medical insurance system aims not only to protect the health of residents, but to also avoid economic risks caused by the utilization of medical services.<sup>20</sup> In 2017, the coverage rate of NRCMS had reached more than 98%. However, the NRCMS had gradually exposed some disadvantages in the development process. While the NRCMS had reduced the threshold for the utilization of medical services for the rural population, it also increased the economic burden resulting from diseases. In 2016, the urban employee medical insurance hospitalization reimbursement ratio reached 75%, which was 20% higher than the NRCMS reimbursement rate. Although the coverage of NRCMS is the highest among the three basic medical insurances, it lagged behind the other two types of insurance in terms of depth of coverage and height.<sup>21</sup> Changes in the demographic structure have led to changes in household demand. Can health poverty alleviation accurately target the weakest people in the operational processes? As a carrier of health poverty alleviation, has the NRCMS really alleviated the economic burden of the rural population? Has the overall health poverty alleviation reached the expected goal? These questions still deserve a definite answer. Therefore, from a multi-dimensional perspective, we scanned the characteristics of poverty-stricken groups aged over 45 years in rural areas, and identify the key challenges that lead to the failure of the NRCMS.

## Method

### Data source and sampling method

This study used the China Health and Retirement Longitudinal Study (CHARLS) database, which is a large-scale interdisciplinary survey project jointly conducted by the National Development Research Institute and the Social Science Research Center of the Peking University. In 2015, using multi-stage sampling and PPS sampling methods, CHARLS randomly selected 45-year-olds from the survey households that were, in turn, selected from 450 communities in 150 counties of 28 provinces (autonomous regions and municipalities) across China. After data cleaning (eliminating abnormal and incomplete data), 7,080 households and a total of 13,740 people remained for the calculation of catastrophic health expenditure (CHE). This database will be openly and freely available to academia one year after the survey is completed.

### Statistical analysis: Catastrophic health expenditure calculation method

The method recommended by the World Health Organization (WHO) was used to calculate catastrophic health expenditure. The key variables in the algorithm included: Out-of-pocket health expenditure (OOP): The amount paid by a family member in cash when purchasing health care services. Household consumption expenditure (exp) refers to the currency and goods used in all goods and services consumed by the family. A household's capacity to pay (CTP) is the non-subsistence spending of a household as a share of total household consumption expenditure.

When OOP exceeds 40% of the family's ability to pay, the family is considered to have catastrophic health expenditures.<sup>22</sup>

### Treatment-effect model and instrumental variables

This study selected whether a household was incurring catastrophic health expenditure as the main outcome variable. Since the interpreted variable is a binary variable and based on the nature of the voluntary participation in the NRCMS, the use of traditional ordinary least squares (OLS) regression leads to biased results. A binary selection model will more scientifically reflect the impact of medical insurance on CHE. Therefore, we choose the treatment effect model with the following model parameters.

The medical insurance scheme was included in the model as the primary factor in mitigating catastrophic health expenditures, but it had been identified by other studies as an endogenous variable that affects the OOP and CHE. If there is endogeneity, NRCMS cannot truly reflect the impact on CHE. In this regard, tool variables were introduced on the basis of the treatment effect mode model to correct the model and to prevent errors in the results.

The selection of the tool variables for this research primarily refers to the existing literature, selecting the same community participation rates of medical insurance schemes, self-assessment health, and provinces as the initial instrumental variables. Firstly, the weak tool variable was tested by the Stata software. When  $F > 10$ , there is no weak instrument variable. After F-test, the  $F = 46.84$  is greater than 10, so there is no weak instrument variable. Secondly, the redundant tool variable test was carried out, and the self-rated health and provinces were excluded according to the results of the redundancy test of the tool variables. As a tool variable for residents to participate in medical insurance, the rate of community participation is higher in life, and the probability of individuals participating in medical insurance is relatively high. However, the same rate of participation in the community does not generally affect the incidence of catastrophic health expenditures (CHE) in other households. Therefore, we can determine whether the participation rate and the explanatory variable are stored in the correlation, and if the variables are independent of the random error term of the CHE, and if the variables conform to the application condition of the instrumental variable method.

## Results

## Basic information

**Table 1** Sample characteristics

The total sample comprised 7080 households and 13740 individuals, the final participation rate of the sample population was 85.8%. 53.1% of household heads were male, and about 32% of family members have 65-year-olds. Primary and junior high school education accounted for 66.5%, and more than half (62.5%) of elderly members had chronic diseases.

**Table 2: Overall prevalence, utilization of health services**

Among populations with chronic diseases (Table 2): the prevalence rate of populations with three chronic diseases was the highest (17.2%). The higher demand for medical services was converted into higher health service utilization, with the highest hospitalization rate of 15.1% for populations with three chronic diseases. However, its hospital reimbursement rate was only 45.8%, nearly 7% lower than that of the populations with two chronic diseases. Populations with members over 65 years of age achieved high utilization while high demand and the hospitalization reimbursement rate had reached to 53.7%, which was 1.3 times than that of households without 65 years old members. Disabled people also showed the same trend. Meanwhile, the prevalence rate of disease decreased with the increase of the educational level. Compared with populations with a high school education, populations who were illiterate had a higher utilization of health services, hospitalization rate (14.3%), and outpatient rate (20.6%), but its outpatient reimbursement rate (13.3%) was 10.6 percentage points lower. Compared with the central region, the health demand and utilization in the western region were both higher, with 5% prevalence and 3.2% hospitalization, respectively. Meanwhile, the western region had the highest reimbursement rate of the three regions. The prevalence of the uninsured population (15.9%) was higher than that of the insured population (14.8%), but whether outpatient or hospitalization, the uninsured populations were lower than the insured population, and the payment ability of the two was almost the same.

**Table 3: CHE, and IME in different households**

The above data showed that the highest incidence of CHE were concentrated in households with members that have three chronic diseases (38.0%), inpatients members (31.0%), or members over 65 years old (30.5%). As can be seen in Table 3, the capacity to pay medical expenses in households with three chronic disease was the weakest, but they also had the heaviest economic disease burden. The NRCMS is insufficient for the reimbursement of households that have various chronic diseases, resulting in the highest incidence of CHE (38.0%), and the households members with 65 members were more at risk to incur impoverishment by medical expense; the incidence of IME (11.1%) was 4.7% higher than households without 65 members. The capacity to pay increased with the increased of the educational level. The lowered capacity to pay of the illiterate group leads to the incidence of IME (10.3%) which is 4.3% higher than the high school education level.

Among the different regions, the incidence of CHE in the eastern, central and western regions exceeded 20%, the highest of which was in the central region at 22.6%. Surprisingly, the incidence of insured families (21.9%) was higher by 1.3% than uninsured households, and the incidence of IME was also higher, at 8.0%.

**Table 4: Prevalence rate and utilization of health service demand under different insurance conditions**

Since the incidences of CHE and IME in the insured group were higher than that in the uninsured group, we analyzed the health needs, utilization, and OOP payment of different insured groups using different characteristic dimensions and found two kinds of results (Table 4):

Firstly, the results showed that for people with three chronic diseases, inpatients, and families with a general economic level below with a general economic level below health insurance increased the use of residents' health services while also increasing the amount of OOP payment. Among families with chronic diseases, the prevalence of the insured population (15.7%-16.9%) was lower than that of the uninsured group (16.6%-17.6%). The families with 3 chronic diseases who were insured had the highest hospitalization rate (15.6%), which was 6.1% higher than the uninsured. Although participating in insurance increased the utilization of health services, the OOP payment for insured families with three chronic diseases was 1.3 times than that of uninsured households. However, in other families with one or two species of chronic disease, the OOP payments for insured families were much lower than that of uninsured families. In the economic group for the households with a general economic level or below, participation in insurance significantly improved their utilization of medical services. The utilization rate of outpatients in the poorest insured households (20.7%) is higher by 7.8% than in uninsured households. But the OOP payment (58.38-216.97 yuan) of the insured households was generally higher than that of uninsured households (54.09-192.09 yuan).

Secondly, for people with disabilities, an education level below primary education, and a family size with 2 persons or less, participation in insurance had increased the utilization of health services, but their OOP payment did not increase. Among the groups with disabled people, the prevalence of households participating in insurance (17.1%) was lower than that of uninsured (17.7%). Their hospitalization and outpatient utilization rates were higher than the latter, especially the outpatient utilization rate (20.8%) which was 2% higher than the uninsured households. Participation in insurance reduced the threshold of health service utilization and provided corresponding economic protection with the OOP payment 0.89 times higher than the uninsured. It can be seen in the families of 2 or less, although the NRCMS made insured households with lowered health demand access higher utilizations, with the outpatient rate (20.1%) 3.9% higher than the uninsured family. Households with lower educational levels also showed the same trend. In the context of high health service utilization, the OOP payment of illiterate population (N = 276.49) who participated in insurance was far lower than the 406.03 yuan of uninsured people. Among the wealthiest groups, although the OOP payment of uninsured households was 1158 yuan higher than the insured households, their utilization of health services was also higher. The hospitalization rate of uninsured was 17.3% higher than that of the insured households, which demonstrated that medical expenses increased with the availability of health services, so the choice of participating in the insurance had little effect on the wealthiest families.

**Figure 1. CHE and IME under different insurance schemes**

From the perspectives of different insurance schemes (Figure 1), except for the sub-poor households, regardless of the incidence of CHE or IME, the insured households were higher than the uninsured households. The riskiest households were the insured households with three types of chronic diseases (39.44%), inpatients (32.64%), and had members above 65 (30.9%). Among the households with three chronic diseases, the incidence of CHE from those enrolled in medical insurance was 8.58% higher than the uninsured; for the households with inpatients, the incidence of CHE for enrolled households was 1.4 times than that of the latter; for the households with 65-year-olds members, the incidence of CHE for households participating in medical insurance was 2.82 times higher than the latter, but even for the households with 65+ members but no participating in medical, the incidence of CHE was still 1.2 times than that of households with two chronic diseases enrolled in medical insurance. Secondly, for the sub-poor families, regardless of whether they had medical insurance, the incidence of IME were both high (22.97% and 22.14% respectively), but it is worth noting that the incidence of CHE in the sub-poor households was not the highest (23.93/26.96%) the second highest incidence of IME was the households with 3 chronic diseases, 15.8% for insured families and 13.58% for uninsured families; and finally, 11.71% of the insured families with inpatients occurred the IME 1.4 times higher than that of inpatients (7.95%) who did not have insurance. Regardless of whether the household head had a university level education and was insured or not, the incidence of CHE and IME were both zero. And it can be clearly seen that CHE and IME decreased with the degree of education for both CHE and IME.

#### **Table 5 :The result of treatment-effect model**

Since the instrumental variables must meet the two main indicators of effectiveness and relevance, according to the regression results of the first part of the treatment effect model, the invalid tool variables self-evaluation health ( $p = 0.383$ ) and provinces ( $p = 0.377$ ) were excluded, and the community participation rate of medical insurance was finally selected. The participation rate ( $p = 0.000$ ) was finally used as a tool variable. Moreover, the OLS test demonstrated that it was a reliable tool variable ( $F = 46.84$ ). Since there was only one endogenous variable and one instrument variable, it was just recognized, so there was no over-recognition and under-recognition.

From the results of the treatment effect model (Table 5), we can see that of the education level of the head of the household, households with inpatients, people over 65 years old, disabilities, family size, disease types, as well as whether participating in the insurance are all determinants affecting catastrophic household expenditure for the elderly population in this study. Among them, households with hospitalization, elderly people over 65 years old, disabled members and chronic disease types as the most significant ( $p < 0.001$ ) factors impacting CHE. In rural China, income seemed to have no significant association with the occurrence of CHE and IME for the elderly.

The CHE decreased by 2.94% with the increase of education level. The increase in education level had a protective effect on the family. Inpatients in the family increased the incidence of CHE by 13.11%. The number of elderly people over the age of 65 increased the risk of CHE by 8%. The larger the family size was, the less likely the family was to incur CHE. The increase in family size reduced the incidence of CHE by 2.9%. Disability increased the incidence of CHE by 4.54%. However, participation in the insurance increased the risk of CHE, and the CHE of the participating families will increase by 13.79% compared with the uninsured households.

## **Discussion**

According to existing research, in 2010, 808 million people worldwide experienced CHE in China, accounting for 12% of the global population.<sup>23</sup> Presently, the overall incidence of CHE in rural China is 19.65%, and the IME was 6.94%. Among them, the incidence of CHE in families with three chronic diseases was up to 38.09%, and the rate of IME was 14.84%, which is higher than that of China's urban areas.<sup>24</sup> And far exceeds the rate of other developing countries in the world.<sup>25,26</sup> and our research found that the IME rate of insured families was much higher than that of uninsured families, and the highest peak was 22.97% of the sub-poor households. The NRCMS reduced the barriers to the use of the three categories of household health services and decreasing their OOP payment, affecting groups such as the disabled household, the elementary and junior high education level households, and the family size of two or less. However, in some respects, it was still not sufficient in reducing the overall risk of residents falling into poverty.<sup>27</sup> Therefore, we summarized the data and locked in several critical links for the failure of the NRCMS:

First, the reimbursement rate for the high-demand and high-utilization population of the NRCMS is not high enough, especially for people with three chronic diseases and low education. A variety of chronic illnesses and hospitalizations create high demand for medical services, which leads to higher utilization of those medical services and the weakest ability to pay compared to ordinary households. The results of the treatment effect model showed that hospitalization increased the incidence of CHE by 13%. As the number of diseases increases, the risk of CHE increased by 5.5%. Compared with ordinary families with lower demand for health services, the risk of IME increased by 2.7 times. The high demand and utilization of medical services are some of the most important factors leading to impoverishment. Although the NRCMS has lowered the threshold for the utilization of health services, it has also increased the cost burden of groups of three chronic diseases, 65-year-olds, and inpatients, increasing the risk of falling into poverty. Participating in insurance makes the self-paying households with three kinds of chronic diseases pay 1.32 times more than the uninsured, the rate of poverty caused by illness is 1.5% higher than that of uninsured families, and the risk of poverty among the elderly over 65 years old is as high as 11.18%. Chronic diseases are the main factor of disease burden in the elderly. More and more elderly people with chronic diseases increase their health care expenditures because the use of health care resources increases with age and the number of chronic diseases.<sup>28</sup> The elderly and families of chronically ill patients have increased the demand for medical systems and medical expenditures. If these families lack financial protection for health risks, high medical expenditures may plunge them into poverty.<sup>29,30</sup>

Although the NRCMS has achieved better protection in groups with one or two chronic diseases, the protection is still insufficient in the superposition of various chronic diseases. The incidence of IME in the superimposed family reached 15.08%, which was 2.73 times that of families without chronic diseases. The OOP ratio for health services for the older adults over 45 years old in China was 55%, which was higher than the residents OOP 30% in 2016,<sup>31</sup> and much higher than the national average of 18.6% published by WHO in 2015. Therefore, in order to truly provide the economic protection of the NRCMS for rural middle-aged and older people over 45 years old in China, it is necessary to give further policy coverage to chronic diseases, hospitalized patients, and high-risk

families over 65 years old by increasing the reimbursement rate and expanding the coverage of benefit packages, which not only involves direct medical expenses but also considers the compensation for indirect medical expenses such as time loss due to long-term care of chronic diseases. Secondly, the design of the NRCMS does not give enough coverage to people in lower socio-economic groups, which is one of the reasons for the poverty of the disabled or illiterate households with lower capacity to pay. The increase in education levels reduces the incidence of CHE by 2.9%, and the ability to pay increases with the increase of education level. The rate of IME decreases with the increase in education level. 0% of the high-education groups in universities and above also showed the protective effect of education on poverty caused by disease. Compared to ordinary families, disability increases the risk of CHE by 4.5%, and the disabled households had a weaker capacity to pay, and their incidence of CHE is higher than that of uninsured families (27.64%). At least 500 million of the world's 650 million people with disabilities are the poorest.<sup>32</sup> Disability is a complex situation that affects not only an individual but also their family, and it reduces the income available to individuals and families.<sup>33</sup> The risk of poverty due to illness decreases as the size of the family increases and the rate of IME in a family of one person reaches 9.24%. The risk of CHE in a larger family is also reduced by 2.9%. Therefore, based on our summary of the key aspects of the failure of the NRCMS, it is found that the crux of insurance failures lies in the severe problem of identification and locking of the poor.

The NRCMS did not accurately identify and lock the characteristics of the poor in terms of system design. As an important area under China's precision poverty alleviation, health poverty alleviation constitutes an institutional means to promote health and poverty alleviation through the integration of basic medical insurance, major medical insurance, medical assistance, and bottom-up protection. However, health alleviation only builds on the basis of the original poor population and ignores other potentially poverty-stricken people. Measuring the poverty based on income seems to be the most common, but based on the above research, it is found that the rural poor are not only originally economically disadvantaged, but also those with high demand for many health services, families with low economic and educational factors, and low risk of mutual aid, which may cause the un-poor family into a poverty-stricken situation because of the cost of medical care. In the process of connecting the basic medical system with medical assistance, the NRCMS is of considerable significance to the accurate docking of the poor to maximize the effectiveness of health poverty alleviation.

## Conclusion

As the basic medical insurance, the NRCMS must accurately and comprehensively target the characteristics of the poor in the primary stage, comprehensively cover all the vulnerable people who are at risk due to the disease, and minimize the economic burden of the disease in the basic medical insurance stage, which can reduce the risk of people living in poverty due to illness. For those who are still in poverty and cannot afford high medical expenses, further in-depth protection is provided through major medical insurance and medical assistance. Medical assistance has developed a general framework for identifying the poor, that is, the economically disadvantaged, those with special needs, and the elderly population. However, for middle-aged and older people in rural areas above 45, these high-risks overlap between groups, and so medical assistance still lacks a more detailed and accurate definition of poverty. The existing medical security system is only concerned with people with low-income, special hardship, and major diseases. The definition of vulnerable people is only measured from a single economic dimension, but some people in society do not meet the basic conditions for medical assistance. However, this group of people cannot afford to suffer from chronic diseases and major diseases. Therefore, we must consider not only poor households and five-guarantee households, but also focusing on the people who are at risk of poverty due to age, education level, family size, chronic diseases, disabilities, and hospitalizations. Based on the above research data, illiterate people, three chronic diseases, 65-year-olds, inpatients, and small family size should be included in the policy inclination of the Chinese rural middle-aged and elderly medical assistance system.

Health poverty alleviation is a comprehensive strategy that requires the convergence of different medical systems. The key points of convergence are to capture the characteristics of the poor. Our research locks and identified the characteristics of vulnerable groups by multi-dimensional analysis, trying to provide direction and targeted basis for accurate poverty alleviation work.

## Abbreviations

Catastrophic Health Expenditure:CHE;

Impoverishment by Medical Expenses :IME;

New rural Cooperative Medical System:NCMS;

New Rural Social Pension Insurance: NRSPI

Targeted Poverty Alleviation: TPA

Organization for Economic Cooperation and Development :OECD

A household's capacity to pay :CTP

Out-of-pocket health expenditure :OOP

Household consumption expenditure:EXP

## Declarations

**Ethics approval and consent to participate:**ethics approval and consent to participate was not applicable due to the retrospective nature of your study.

**Consent for publication:**All authors agree to publish.

**Competing interests:**The authors declare that they have no competing interests.

**Availability of data and materials** Database available from the CHARLS repository,  
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**Authors' contributions**NSW,MYM conducted literature search, planned the study, carried out data collection, performed data analysis and interpretation and drafted the manuscript.YL and QHW conducted frame design,and helped conceptualize the project, LHS and MLJ reviewed literature search and data analysis,LML,YHH revised the manuscript and gave critical feedback.LJG,WXT,QX conducted quality control and review of manuscripts.All authors have read and approved the manuscript.

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## Tables

**Table 1 Selection and description of variables**

Variable	Variable Value	Percentage(%)
Outcome variable	0 = CHE occurred	78.2
	1 = CHE did not occur	21.8
Endogenous variable	0 = Uninsured	14.2
	1 = Insured	85.8
Gender of household head	1 = Male	53.1
	2 = Female	46.9
Educational level of household head	1 = Illiterate	24.7
	2 = Primary and junior high school	66.5
	3 = High school	8.6
	4 = University and above	0.1
Career of household head	1 = Agriculture	54.1
	2 = Industry	20.9
	3 = Unemployed	19.5
	4 = Retired	5.5
Households with member above 65 years' old	1 = Yes	32.7
	2 = None	67.3
Households with disabled member	1 = Yes	33.1
	2 = No	66.9
Households with inpatients	1 = Yes	12.5
	2 = No	87.5
Households' member with chronic disease	0 = 0	37.5
	1 = 1	35.3
	2 = 2 species	20.0
	3 = 3 or more	7.2
Family size	1 = 1 person	61.8
	2 = 2-3 persons	31.6
	3 = 3 or more persons	6.7
Area	1 = East	34.7
	2 = Central	42.0
	3 = West	23.3

**Table 2. Health-care needs and service utilization**

Variable	Variable value	Prevalence(%)	Hospitalization rate(%)	Outpatient rate(%)	Hospitalization reimbursement ratio
Whether to participate in insurance	Insured	14.8	13.2	20.4	45.5
	Uninsured	15.9	12.5	16.6	/
Having members over 65 years old	Yes	16.4	15.3	21.0	53.7
	No	14.2	12.1	19.6	39.9
Species of chronic diseases	0 species	13.4	11.2	18.8	43.0
	1 species	15.60	13.8	20.8	45.1
	2 species	16.0	14.9	21.0	52.7
	3 species	17.2	15.1	19.6	45.8
Educational level	Illiterate	16.0	14.3	20.6	44.5
	Elementary school and junior high school	14.8	13.1	20.2	44.6
	High school	13.0	12.1	19.2	45.2
	University and above	12.5	22.2	11.1	30.5
Classified family size	1 person	15.1	13.4	19.7	47.9
	2--3 people	15.1	12.5	20.2	42.8
	>3 people	13.9	14.0	22.0	43.5
Whether or not disabled	Yes	17.2	14.9	20.5	47.8
	No	13.8	12.2	19.7	45.2
Inpatient	Yes	23.8	100	34.9	46.2
	No	13.9	/	17.8	/
region	East	10.6	10.7	18.0	44.3
	Central	15.6	13.2	19.9	44.6
	West	20.6	16.4	23.2	50.4

**Table 3. CHE, and IME in different households**

Variable	Variable Value	Out-of-pocket/capacity to pay(%)	Incidence of catastrophic health expenditures(%)	Incidence of (%)
Whether to participate in insurance	Insured	19.0	21.9	8.0
	Uninsured	19.9	20.6	7.7
having members over 65 years old	Yes	25.9	30.5	11.1
	No	16.9	17.6	6.4
Species of chronic diseases	0 species	15.7	16.1	5.6
	1 species	19.3	21.7	7.6
	2 species	23.2	26.5	10.6
	3 species	34.1	38.0	14.8
Educational level	Illiterate	21.5	26.2	10.3
	Elementary school and junior high school	20.3	21.6	7.7
	High school	14.9	17.0	6.0
	University and above	5.6	0.0	0.0
Classified family size	1 people	23.0	24.6	9.0
	2-3 people	15.3	17.1	6.3
	> 3 people	16.1	16.5	6.1
Whether or not disabled	Yes	26.0	27.3	10.2
	No	16.7	19.0	6.9
Inpatient	Yes	29.7	31.0	11.0
	No	17.6	20.4	7.6
region	East	17.8	20.8	7.8
	Central	20.8	22.6	8.4
	West	18.5	21.5	7.5

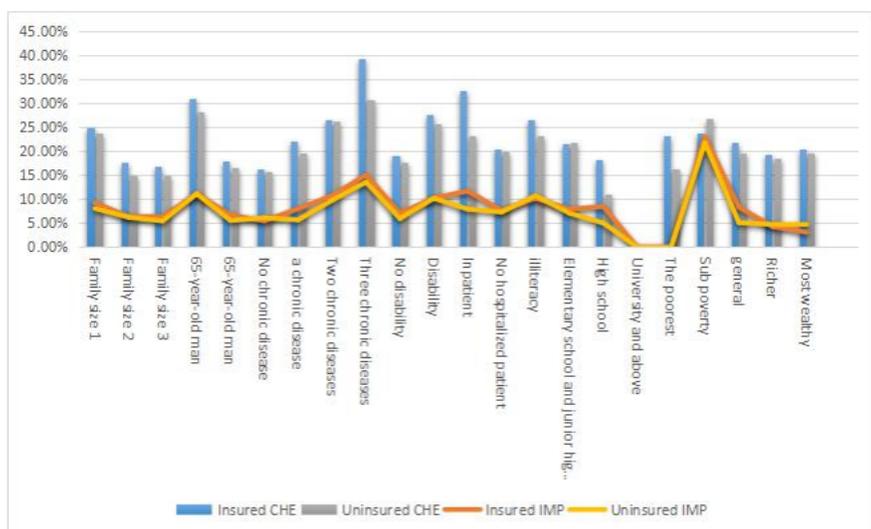
**Table 4 Utilization of health service needs under different insurance conditions**

	Insured				Uninsured			
	Prevalence rate(%)	Hospitalization rate (%)	Outpatient rate(%)	Out-of-pocket	Prevalence rate(%)	Hospitalization rate (%)	Outpatient rate(%)	Out-of-pocket
Family size 1	14.8	13.5	20.1	310.46	16.9	12.3	16.2	330.35
Family size 2	15	12.4	20.5	332.16	16.2	13.3	17.7	421.5
Family size 3	14.6	14.2	22.8	343.22	8	11.8	15.7	392.24
Having 65-year-old man	16.6	15.3	21.6	321.13	14.7	15.5	17.1	368.12
Have not 65-year-old man	14	12.2	20	323.00	16.3	10.8	16.8	349.33
Having No chronic disease	13.11	11.1	19.1	306.69	14.8	11.7	16.2	319.49
Having a chronic disease	15.7	14.8	21.3	322.50	16.6	13.5	17.6	342.64
Having Two chronic diseases	15.8	13.8	21.6	343.78	16.7	13.8	17.6	500.61
Having Three chronic diseases	16.9	15.6	20.5	409.75	17.6	9.5	11.7	310.44
No disability	13.6	12.3	20.2	304.34	15	11.4	15.4	352.03
Disability	17.1	14.9	20.8	349.58	17.7	14.7	18.8	391.15
Inpatient	23.4	100	34.5	536.26	27.3	100	38.6	467.06
No hospitalized patient	13.8	0	18.3	289.03	14.7	0	13.5	354.54
Illiteracy	15.5	13.1	20.2	276.49	16	17	16.5	406.03
Elementary school and junior high school	14.6	13.4	20.6	317.94	16.8	10.3	16.2	356.1
High school	13.1	12.1	19.8	367.78	12.7	11.4	14.6	412.58
University and above	12.5	22.2	11.1	115.47	/	/	/	312.5
The poorest level	14.6	13.3	20.7	58.38	17.6	10.8	12.9	54.09
Sub poverty level	14.8	13.1	19.7	129.18	15.6	11.3	17.9	121.97
General level	14.5	12.4	20.7	216.97	14.9	11.5	14.3	192.09
Richer level	15.5	12.4	19.8	393.53	17.7	13	17	369.3
Most wealthy level	14.8	15.3	21.3	1131.39	13.6	17.6	22.9	1158.42

**Table 5 : The results of treatment-effect model**

	Coefficient	SE	Z	P
Household head gender	0.0059	0.0137	0.43	0.668
Household head marriage	-0.0005	0.0183	-0.03	0.977
Household Revenue logarithm	0.0131	0.0161	0.81	0.415
Household head Educational level	-0.0294	0.0125	-2.35	0.019
Inpatient	-0.1311	0.0193	-6.78	0.000
Region	-0.0117	0.0086	-1.35	0.177
Type of jobs	0.0073	0.0070	1.04	0.296
having members over 65 years old	-0.0808	0.0146	-5.51	0.000
Classified family size	-0.0297	0.0105	-2.82	0.005
Type of chronic diseases	0.0552	0.0072	7.63	0.000
Whether or not disabled	0.0454	0.0141	3.22	0.001
Whether to participate in insurance	0.1379	0.0683	2.02	0.043

**Figures**



**Figure 1**

