A 15-Year Trend of Catastrophic Health Payment and its Inequality in China: Evidence from Longitudinal Data

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Abstract

Background:

The Chinese health care system has gone through two major cycles of reform since the 1980s. This study aims to comprehensively track the trends in the occurrence of catastrophic health payment and its inequality in the past 15 years, which may help better understand the influence of health system reforms on catastrophic health payment and its inequality.

Methods:

The study employed the subset of data from China Health and Nutrition Survey conducted from 1991 to 2015. Concentration index and decomposition analysis were used to measure the magnitude of income-related inequality in catastrophic health payment and decompose it into determinants respectively.

Results:

The incidence of catastrophic health expenditure in China increased from 3.10% in 1993 to 8.90% in 2004, and still maintained at a high level in the following years. The incidence gap of catastrophic health payment between the richest and poorest became increasingly wider over year. Moreover, the adjusted concentration indexes were all negative in each year, decreasing from -0.202 in 1991 to -0.613 in 2015. The basic medical insurance didn't decrease the incidence of catastrophic health payment and showed the second largest contribution on the inequality in catastrophic health payment before 2004. However, this contribution began to decline after 2006.

Conclusions:

After the New Health Care Reform, although the Chinese government has taken many measures to protect poor households from catastrophic health payment, the incidence gap between the rich and poor has widened. China has nearly achieved universal coverage in recent years, however, the basic medical insurance in China was not enough to protect households from catastrophic health payment. Our study suggests that improving the generosity of existing basic medical insurance, and reforming the medical insurance payment

system would be helpful to reduce the incidence of catastrophic health payment. The use of big data tools and techniques to effectively screen the poor households, and strengthening the social medical aid system would be helpful to decrease the pro-rich inequality in catastrophic health payment.

Keywords: Catastrophic health payment; Income-related inequality; Concentration index; Multi-level model

Background

In recent decades, many countries around the world have been optimizing their health care systems to provide their citizens access to essential services to achieve universal coverage [1-3]. Based on the basic national conditions and realities, China has also carried out important reforms in its health care system.

With the implementation of the reform and “opening-up policy” to the outside world in 1978, China has gained unprecedented economic growth and marvelous success in many areas. To replicate the success of other areas, market-oriented health care reform was introduced in predominantly public financed system in 1980s [4]. Remarkable achievements have been made under the market-oriented health care reform. The resource allocation in health care was more efficient, more innovative, and more responsive to consumer preferences. However, China’s state funding for health care declined and traditional coverage plans collapsed, leaving the rural and urban residents exposed to potentially damaging health care cost[5-7]. “Getting medical treatment is difficult and expensive” has become a social and economic problem in China. Data from China Health Statistical Yearbook showed that, although the absolute value of government investment in medical and health care rose from 3.544 billion yuan in 1978 to 155.253 billion yuan in 2005, the share of government health investment on health expenditure decreased from 32.2% in 1978 to 17.9% in 2005 [8] . During this period, the proportion of out-of-pocket expenditure in total health expenditure showed a rapid increase trend from 20.4% to 52.2% [8]. The health payment imposed heavy burden to the

society and families. The problem of "Poverty caused by illness and return to poverty due to illness" has become one of the biggest challenges faced by Chinese people.

After summarizing the reasons for the failures of the 1990s health care reform, China officially launched a new round of health care reform, which called New Health Care Reform (NHCR) in 2009. The NHCR reform is a comprehensive reform on every domain of the health care system. The strategy includes establishing and improving the basic health system covering urban and rural residents, strengthening the public health care system, improving the medical system, and completing a secured pharmaceutical supply system. One of the primary objectives of this reform is to provide the people with affordable health care services, and alleviate the problem of "Getting medical treatment is difficult and expensive". By 2019, over 95% of residents in China enrolled in one of three basic medical insurance schemes: New Rural Cooperative Medical Insurance for rural residents, Urban Employee Basic Medical Insurance for urban residents with formal work, and Urban Residents Basic Medical Insurance for urban residents without formal work [9].

The use of several waves of cross-sectional survey, numerous studies have been published to investigate the distribution and the determinants of catastrophic health expenditure. These studies found that, despite the continuous improvement in Chinese social security and the implementation of universal health insurance, the incidence of catastrophic health payment was still higher in China[10]. Besides, these studies consistently demonstrated that some household characteristics, (e.g. income and geographic regions) were associated with the incidence of catastrophic health payment. However, due to the heterogeneity of the study design, there is a controversy on whether basic medical insurance could effectively protect households from catastrophic health payment. Some comparative studies using the one-wave of cross-sectional survey before and after reimbursement reported that Chinese medical insurance effectively decreased the incidence of catastrophic health payment, while some comparative studies using the repeated cross-sectional data or short-term longitudinal data showed that medical insurance failed to prevent households from catastrophic health payment and impoverishment[11, 12]. Longitudinal data could more accurately reflect the fluctuation

of potential influencing factors over time, and thus it virtually always results in more reliable and more accurate results than cross-sectional data. However, there was no report of studies that aimed at identifying the prevalence trends and inequalities of catastrophic health payment combined with the dynamic process of health system reform over a long period of time. The study aims to comprehensively track the trends in the occurrence of catastrophic health payment and its inequality, in order to better understand the influence of health system reform on catastrophic health payment and its inequality. Our study will provide readers an overall picture of how the catastrophic health payment and its distribution changed under the background of health system reform of China. Our study contributes to existing studies in two ways. Firstly, providing a unique insight into how catastrophic health payment changed at different time points during the process of health system reform and exploring some of the reasons why these developmental shifts took place. Secondly, providing policy makers with evidence to examine the effectiveness of current policies, and inform new directions for future policy development.

Methods

Data

The study used the data from the China Health and Nutrition Survey (CHNS). CHNS is an ongoing open cohort survey conducted by the Carolina Population Center at the University of North Carolina at Chapel Hill and the National Institute for Nutrition and Health (NINH, former National Institute of Nutrition and Food Safety) at the Chinese Center for Disease Control and Prevention (CCDC). The first wave of the survey was conducted in 1989 and took place every 2 to 4 years. A multistage, random cluster process was adopted to draw participants in 15 Chinese provinces and municipal cities that vary substantially in geography, economic development, public resources, and health indicators. The objective of the survey was to examine the effects of the health policies and programs implemented by central and local governments and to investigate how the social and economic transformation of Chinese

society affects the health and nutritional status of its population. The data underlying this article is available at <https://www.cpc.unc.edu/projects/china>.

Variables

Outcome measures

The primary outcome in this study was catastrophic health payment. Although economists and epidemiologists have the consensus that a household is in catastrophe if its out-of-pocket health payment exceeds a chosen threshold that results in financial distress, however, uniformly accepted threshold are not reported in previous studies [13]. In the literature, the chosen threshold at which health payments are catastrophic varied from 5% to 40% of the household income or consumption expenditure[14-17]. In this study, threshold value of 40% of net household income was used to investigate the incidence of catastrophic health payment.

Independent variables

With reference to previous studies, a set of independent variables that may be associated with incidence of catastrophic health payment were included in the study. Household characteristics included were household size (1, 2-5, ≥ 6 , basic medical insurance, living areas, geographic regions (Eastern China, Central China, and Western China, and per capital net income. Basic medical insurance is a binary variable taking on the value of one if all household members were covered by basic medical insurance, and vice versa. Living areas is a binary variable taking on the value of one if investigated household located in urban areas, and vice versa. Household head characteristics were age, gender, educational attainment (illiteracy, elementary, middle school, high school, and university, and marital status (unmarried, married, others) of household head.

Statistical analysis

Descriptive statistics were used to describe the basic feature of the samples in the study. Longitudinal data are often conceptualized as multilevel data where the repeated observations are nested within individuals. With the sharp increasing in longitudinal research designs, multilevel models have recently received more attention in a variety of different disciplines. Compared to models applied in cross-sectional studies, multilevel analysis enables the control

of individual heterogeneity to avoid bias in the resulting estimates. In multilevel models for longitudinal data, the lowest level of data is the measurement at a specific time point and individual constitutes the second level of nesting [18]. The two-level null model could be written as follows:

Level-1 (repeated-measures level) model:

$$y_{ti} = \beta_{oi} + e_{ti}$$

where t represents the investigation in years and i represents the i -th individual. β_{oi} is the estimated average y for the i -th individual. e_{ti} is the within-individual random error which captures the difference between the observed y at time t and the predicted y of the i -th individual. e_{ti} is assumed to be normally distributed which captures the within-individual variation.

Level-2 (individual level) models can be presented as follows:

$$\beta_{oi} = \gamma_{00} + U_{0i}$$

where γ_{00} is the grand mean of the dependent variable, U_{0i} is the difference between the i -th average dependent variable and the grand mean, U is assumed to be normally distributed with the expected value of 0 and the variance σ_u^2 .

The multi-level random intercept model with independent variables can be written as follows:

$$y_{ti} = \beta_{oi} + \beta_{1i}x_{1ti} + e_{ti}$$

where β_{1i} is unknown coefficients to be estimated.

Concentration index is a widely used approach to measure socioeconomic-related inequality in health. It is defined as twice the area between the concentration curve and the equality line, running from the bottom-left corner to the top-right. The value of concentration index lies between the -1 and 1. A negative value indicates the interested health variable concentrated on the poor, and vice versa. In the case where there is no income-related inequality, the concentration index would be zero. The concentration index can be written as follows:

$$C = \frac{2}{\mu} cov(y_i, R_i)$$

Where μ is the mean of dependent variable, R_i is relative rank of individual i in the

distribution of incomes.

Based on the regression model, concentration index can be decomposed into the contributions of a set of determinants. For any regression model, such as

$$y_i = \alpha + \sum_k \beta_k x_{ki} + \varepsilon_i$$

The concentration index for y, C can be written as

$$C = \sum_k (\beta_k \bar{x}_k / \mu) C_k + GC_\varepsilon / \mu$$

where β_k , C_k , and $\bar{x}_k$ are the estimated coefficient, concentration index, and mean of kth independent variable, respectively.

Data management and statistical analysis was performed using SAS and Stata software.

Results

Table 1 shows the characteristics of households and the heads of household over time. Great changes have taken place in the demographic characteristics of household heads. The mean age of household heads increased from 45.64 years old to 57.87 years old from 1991 to 2015, whereas the proportion of male household heads dropped from 84.2% to 77.69% at the same period. The characteristics of households also have undergone huge changes in the past 15 years, with the per capita net income increasing from 1.07 thousand yuan in 2001 to 28.11 thousand yuan in 2015, and the proportion of households with 6 members and over decreased from 34.02% to 14.06%. During the past 15 years, the households living areas and geographic regions also dramatically changed in samples, with the proportion of households lived in urban areas increasing from 32.28% to 48.58%, and the proportion of household living in Eastern China jumping from 36.49% to 58.97%.

Figure 1 shows the distribution of catastrophic health payment among income groups over time. There was an upward trend in the incidence of catastrophic health payment in China from 1993 to 2004. Although this upward trend was changed after the 2004, the incidence of catastrophic health expenditure maintained at a high level in the following years. Poorest

households continuously had the highest incidence of catastrophic health payment compared to households with better economic status in each year. The incidence of catastrophic health payment for richest households decreased rapidly after the year of 2000. The incidence gap of catastrophic health payment between the richest and poorest became increasingly wider over time.

Table 2 presents the determinants of catastrophic health payment obtained from two-level logistic random intercept model. Age of household head and living in Central China increased the risk of catastrophic health payment incidence. Higher income, having university education, living in urban areas and larger household size decreased the risk of suffering from catastrophic health payment. It is worth noting that being covered by basic medical insurance didn't result in a reduction of the incidence of catastrophic health payment.

The crude concentration indexes, and adjusted concentration indexes of catastrophic health payment over time are shown in Table 3. The concentration indexes were all negative in each year, indicating there was pro-rich inequality in the incidence of catastrophic health payment. The poor households were more likely to incur catastrophic health payment. In general, the values of concentration indexes were diminishing over time, indicating there was an upward trend in the inequality of catastrophic health payment from 1991 to 2015.

Table 4 shows the contribution of determinants on the concentration indexes of catastrophic health payment over years. Income consistently showed the largest contribution on this pro-rich inequality in each year. Insurance showed the second largest contribution on the inequality of catastrophic health payment in 2004 and before. However, this contribution began to decline after 2006. Educational attainment of household head increased the contribution of catastrophic health payment inequality over time.

Discussion

In theory, a sound national financing system could effectively protect households against health shocks. Our study found that the incidence of catastrophic health payment increased

from 1990s to 2010s. After the 1978 economic reform, China's economic development had been on a fast track ever since. In 2018 the per capita disposable income of Chinese residents was 28,228 yuan, 165 times more than that in 1990 [18]. The health system in China experienced dramatic change in the same period. The Chinese government explored market-based ways to allocate health resources for all of the country from 1990s. Under such circumstances, the Chinese government only contributed 17.1% of the country's total health expenditure in 2004 [20]. Rural residents who make up the majority of the population and urban residents without formal employment were not covered by any social medical insurance. 53.6% of China's health care cost was paid by mass individuals. Due to the long-time low government investment, the public hospitals were in blind pursuit of economic interests, causing phenomena such as "over treatment" and "doctors make living on prescribing medicines" [21]. Therefore, it is easy to explain why the incidence of catastrophic health payment increased rapidly from 1991 to 2004. The insurance schemes for rural residents and urban residents were conducted by Chinese government in 2005 and 2008 respectively[22-24].

In 2009, China officially launched a new health care system reform. One aim of the reform is to tackle the issue of "It is too expensive to get the medical treatment". The Chinese government investment on health has been largely increased, the coverage of medical insurance has been expanded, a national essential medicine system has been established to reduce medicine prices and free medical treatments has been promoted for targeted populations[25, 26]. In this scenery, it is worth discussing the potential reasons that, although the incidence of catastrophic health payment was slightly decreased after 2004, it is still at a high level in China. WHO has pointed out three factors that contributed to the occurrence of catastrophic health payment: the availability of health services requiring out-of-pocket payments; low household capacity to pay; and lack of prepayment mechanisms for risk pooling [27]. Since the household capacity to pay and the government investment in health have been largely improved with the development of Chinese economy and NHCR respectively, the rapid increase in health services cost and the design of medical insurance

reimbursement may be the main reasons for the increased incidence. Although the medical service prices for the most popular medical services are regulated by Chinese government, health care providers are more likely to choose to provide new health services items without the price restriction by government as alternatives, e.g. new medicines, new technologies, which will increase the cost for patients. China has achieved universal coverage in recent years; however, the actual reimbursement ratio of basic medical insurance has been maintained at a low level for a long time. Take Shaanxi Province for example, our unpublished data showed that the actual reimbursement ratio for New Rural Cooperative Medical Insurance Scheme was still over 50% in 2013. The study also provided evidence that the current medical insurance system is not generous enough to prevent the risk of suffering from catastrophic health payment. Under such circumstances, it is not enough to protect households from catastrophic health payment or poverty by only increasing the breadth of medical insurance coverage. Furthermore, fee-for-service is still the predominately adopted provider payment method transferring funds from the insurance agency to the providers of health services. Since the provider payment methods could influence the provider income and costs for providing the service, different payment methods result in varied provider behavioral incentives related to service supply [28]. Previous studies have found that, although a fee-for-service system has good organizational access, continuity, and accountability, this kind of reimbursement method encourages more consultations, more diagnostic tests, higher drug use, higher surgical rates and higher costs than other pre-payment systems through providing incentives for high volume of care rather than efficient care [29]. In this context, more introduction of pre-paid reimbursement methods, e.g. diagnosis-related group (DRG)-based payment, capitation, and global payment, would be helpful to control the irrational increase of health care cost of urban and rural residents. Previous international literature and evidence from pilot studies in some areas of China have found that the financial access of these prospective payment system is better than fee-for-services in motivating health services providers to control the rising cost actively [30, 31]. Some papers have been published to measure the incidence of catastrophic health payment in China in the context of health care

reform[14, 32-35]. These studies have found that the incidence of catastrophic health payment in China was higher than most countries in the world. However, since the methods used in the measurement of catastrophic health payment are different, comparison between our study and other studies should be interpreted with caution.

Our study found that there was inequality in the incidence of catastrophic health payment in China. The poor households were more likely to incur catastrophic health payment. This phenomenon was also observed in previous studies [36, 37]. The phenomenon may be predominately caused by two factors: poor ability to pay, and lack of generous health insurance. There is still some disparity in insurance generosity for publicly-financed medical insurance schemes in China. While Urban Employee's Basic Medical Insurance generously benefit the targeted participants, Urban Resident Basic Medical Insurance and New Rural Cooperative Medical Insurance provide limited benefits to their participants [38].

Unemployed urban and rural residents were less likely to enroll in private medical insurance. Another finding of our study was that pro-rich inequality of catastrophic health payment increased over time. The poorest households faced more severe catastrophic health payment which may cause the “illness- engendered poverty” in the later stages of the investigation.

The Chinese government has been trying to solve the problem of poverty alleviation with the implementation of New Health Care Reform in the past decades. However, the question is who benefit the most from these initiatives. Our study observed that the poorest households actually benefit less from these initiatives. Poor financial access and geographical distance were frequently mentioned factors considered as barriers to benefit the package provided by the Chinese government. In the policies implementation process, the key consideration would be an accurate identification of the poorest households to receive the support provided by the Chinese government. Our study suggests that the use of big data tools and techniques to effectively identify economic status of households could significantly improve the precision of the policies targeted at poor households. Furthermore, social medical aid system should also be strengthened in the future reform.

Similar to previous studies, our study found that income is the largest contributor on the pro-

rich inequality of incurring catastrophic health payment in each year [36, 37]. Since higher income is considered as a protecting factor of catastrophic health payment, this characteristic makes the incidence of catastrophic health payment is more concentrated among the poor. Our study observed that the contribution of basic medical insurance on the inequality of catastrophic health payment varied in each year. The basic medical insurance showed the second contribution in 2000 and 2004, whereas it showed just a little contribution after 2009. The expanding basic medical insurance coverage for the poor and the rich may be the main reason for this phenomenon. Most rural and urban residents without formal employment have been covered by medical insurance since 2005 and 2008, respectively. The distribution of cover by medical insurance was severely concentrated in the rich before the implementation of Urban Resident Basic Medical Insurance and New Rural Cooperative Medical Insurance. The gap between different income groups narrowed after implementation of universal coverage.

This study has some limitations. Firstly, the data were collected at multiple points, and those observation periods were pre-determined and could not take into account whatever happened in between those touch points. Secondly, all data were self-reported. This may introduce reporting bias. Thirdly, the determinants of the catastrophic health payment considered in the study were from the preselected questions in the CHNS, other unobserved confounders were not included in the multi-level logit regression model.

Conclusions

In conclusion, although China has experienced a remarkable increase in economy, the incidence of catastrophic health payment increased from 4.67% in 1991 to 7.63% in 2015. Furthermore, the income-related inequalities of CHE were also increased during this period. Although many measures have been taken by Chinese government, there is still an upward trend in the incidence of catastrophic health payment for the poorest households. Using big data tools and techniques to effectively identify the economic status of the households, and

strengthening the social medical aid system would be beneficial to decrease the pro-rich inequality in catastrophic health payment. Higher income, living in urban areas, and large household scale were negatively associated with the occurrence of catastrophic health payment, whereas age, gender, and living in central and western China were positively associated with the incidence of catastrophic health payment. Income made the largest contribution of catastrophic health payment in each year. Our study suggests that improving the generosity of existing basic medical insurance, and reforming medical insurance payment system are helpful to reduce the incidence of catastrophic health payment.

Abbreviations

NHCR: New Health Care Reform; CHNS: China Health and Nutrition Survey; NINH: National Institute for Nutrition and Health; CCDC: Chinese Center for Disease Control and Prevention; DRG: diagnosis-related group

Declarations

Ethics approval and consent to participate

Approval for this study was given by the medical ethics committee of Health Science Center of Xi'an Jiaotong University (approval number 2019-1168). All respondents gave written informed consent prior to data collection.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed during the current study are available at <https://www.cpc.unc.edu/projects/china>.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YJX conceptualized, designed the study, and wrote the manuscript; YTZ contributed to data analysis and data interpretation; YTZ and AP performed a critical revision of the manuscript. All authors read and approved the final manuscript.

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Figures

Figure 1

Incidence of catastrophic health payment over years