The comparison of catastrophic health expenditure and its inequality between urban and rural households in China

Xian-zhi Fu

Abstract

Background: In recent years, the goal of universal coverage of the basic medical insurance schemes has been basically achieved in China, but the heavy economic burden of diseases is still the main cause of poverty in many households. Exploring catastrophic health expenditure (CHE) and its inequality are highly important for forward-looking policymaking. This study aims to compare the incidence, intensity and inequality of CHE between urban and rural households in China.

Methods: This study was based on a national representative household survey—the China Family Panel Studies (CFPS)—that was conducted from 2012 to 2018. Concentration index (CI) was employed to measure the inequality of CHE incidence and overshoot, while the decomposition method of the CI was used to estimate the main influencing factors affecting inequality of CHE incidence.

Results: From 2012 to 2018, the CHE incidence of urban households increased from 11.01 to 11.88%, while the CHE incidence of rural households decreased from 18.42 to 18.31%. During the same period, the CI of CHE incidence for urban households decreased from $-0.1480$ to $-0.1693$, while that for rural households declined from $-0.1062$ to $-0.1501$. The major contribution to the pro-poor inequality in CHE incidence was associated with socioeconomic status, lagged CHE, receiving inpatient services, having elderly members, education of household head, and self-assessed health status of household head.

Conclusions: Rural households had higher risk of incurring CHE than urban households. The strong pro-poor inequality for CHE incidence and overshoot could be found in both two groups. The problem of poverty due to illness was more severe among low-income groups in rural areas than in urban areas. The relevant policy interventions should further focus on encouraging the development of supplementary medical insurance and increasing the reimbursement rate for hospitalization expenses in the medical assistance system.

Keywords: Catastrophic health expenditure, Inequality, Concentration index, Decomposition

Background

Universal health coverage (UHC), one of the key targets included in the Sustainable Development Goals (SDG), refers to all people will obtain the essential health services they need without experiencing financial hardship by 2030 [1, 2]. However, a global monitoring report from the WHO shows that in 2017, more than 122 million people globally were classified as “poor” due to health expenditures, and that increasing numbers of individuals were experiencing catastrophic health expenditure (CHE) [3].

One of the fundamental functions of health systems around the world is to improve the ability of households
to withstand the financial catastrophe associated with illness [4]. CHE is an indicator reflecting the impact of household health expenditure on household living standards and evaluating the status of financial protection in health system [5, 6]. The occurrence of CHE indicates that health expenditures exceed a certain threshold, and is likely to bring low-income households into poverty, the so-called “poverty caused by illness”.

The Chinese health system has been committed to protecting households from CHE. The Chinese government officially launched the “New Medical Reform” in early 2009, which aims to reduce out-of-pocket (OOP) medical expenditures and achieve universal coverage of essential healthcare by 2020 [7, 8]. Additionally, the establishment of the basic medical insurance system is an effective means of protecting households from CHE. In 1998, the Urban Employee Basic Medical Insurance (UEBMI) was implemented, which provided policy benefits for the employed urban residents to use health services [9]. For all rural residents, an insurance scheme called the New Rural Cooperative Medical Scheme (NRCMS) was piloted from 2003 [10]. In 2010, targeting for all urban residents not covered by the UEBMI, the Urban Residents Basic Medical Insurance (URBMI) was introduced nationwide [11]. In 2013, the coverage rate of basic medical insurance schemes in China exceeded 95%, indicating that the goal of universal coverage of the basic medical insurance schemes was basically achieved [12, 13]. Meanwhile, Chinese government put the development of supplementary medical insurance on the agenda to meet multi-level demand of health care. Specifically, supplementary medical insurance was the supplementary form of basic medical insurance, which included commercial medical insurance, public servant medical subsidy, enterprise supplementary medical subsidy, employee medical subsidy for large medical expenses, and employee mutual medical insurance [14]. In theory, medical insurance could protect households with patients from CHE by reducing OOP medical expenditure. The mutual-aid principle of medical insurance could also alleviate pro-poor inequality in the distribution of CHE by making policy benefits available to more low-income households.

However, evidence indicated that medical expenditure played an important role in the main causes of poverty in Chinese households, especially for rural households [15, 16]. Zhao (2019) observed that the incidence of CHE among rural households in China was as high as 17.70% in 2016 [17]. At the same time, the urbanization rate increased from 51.83% in 2011 to 63.89% in 2020 [18]. The high-speed development of urbanization in China may also lead to the migration of a flood of low-income group, potentially resulting in the occurrence of CHE. Therefore, it is necessary to pay attention to the current situation of CHE of urban and rural households in China. More importantly, the indicators related to the CHE are expressed as proportions, which only reflects the average level of the entire sample. The concentration index (CI), an indicator employed to measure the degree of inequality, could capture the distribution of CHE in different income subgroups. Hence, measuring the CI of CHE is also important for forward-looking policymaking.

Previous studies on CHE around the world have focused on measuring the incidence and inequality of CHE among vulnerable groups, and verifying the impact of relevant policy interventions on CHE. Evidence from Bangladesh, India and South Korean indicated that households with members suffering from chronic diseases were at high risk of incurring CHE [19–21]. Yazdi-Feyzabadi (2019) confirmed that Iran’s Health Transformation Program (HTP) had no considerable success in improving the pro-poor inequality for CHE [6].

In terms of the types of issues explored, the studies that have been conducted on China were also mainly concerned with the two aspects mentioned above. Xu (2015) identified that there was a strong pro-poor inequality of CHE in the rural areas of Shanxi province [22]. Yang (2016) observed that the empty-nest households were at higher risk for CHE than non-empty-nest in Shandong province [23]. Guo (2016) found that NRCMS had a limited role to play in alleviating the inequality for CHE in rural China [24]. Li (2019) verified that critical illness insurance decreased the CHE incidence but increased the intensity of CHE in Jiangsu province [25]. In contrast to other countries, most of the previous studies in China explored the issue of CHE at the provincial level rather than national level. Meanwhile, few of them focused on the disparity of CHE between urban and rural households.

Based on the national representative data in China, this study aimed to measure the CHE incidence, intensity and inequality of urban and rural households from 2012 to 2018, and to analyze the main determinants leading to the unfairness, and to provide policy implications for health system reform in China.

Methods

Data source

This research was based on the raw data from the four waves of China Family Panel Studies (CFPS) conducted between 2012 and 2018. CFPS is a national representative survey directed by the Institute of Social Science Survey (ISSS) of Peking University every 2 years from 2010 to 2018. The survey mainly involved a wide range of information including family socioeconomic status, family relationships, work and income, health status and demography characteristics, etc. A three-stage, stratified,
probabilistic-proportional-to-scale (PPS) sampling technique was adopted to select interviewed households from 25 provinces in China. The cases with missing values and logic error on the investigated variables were excluded. Meanwhile, we also excluded the cases that were investigated less than four times from 2012 to 2018. Finally, 6360 households from each round of the survey, including 2761 urban households and 3599 rural households, were included in this study. The detailed sampling process is presented in Fig. 1.

Measurement of CHE

In this study, CHE was set as the dependent variable. However, there was no consensus on the measure of CHE [26]. To be specific, one strand of literature chose total household expenditure as an indicator of household’s capacity to pay [27, 28], while other studies employed non-food household expenditure instead of total household expenditure [29, 30]. Non-food household expenditure was defined as the total expenditure of a household subtracting the food expenditure of the household. Compared with total household expenditure, non-food household expenditure as the denominator to calculate CHE was more accurate. This was because it partly avoided measurement deviations that were often overlooked in poor households [31, 32]. For the above reasons, and because of the wealth of household data available in the CFPS database, we calculated CHE based on the latter approach. In the previous studies [31], there were many different criteria for defining the threshold of CHE, including: 10, 20, 30, 40%, etc. In order to facilitate comparison with more research results, the threshold for CHE in this study was defined as 40%. Thus, it could be interpreted as households whose OOP medical expenditure that accounted for 40% or more of non-food household expenditure were classified as “households facing CHE”. Since the household questionnaire did not involve information on indirect medical expenditure (e.g., transportation, food, lost productivity due to illness), OOP medical expenditure only included direct medical expenditure in this study. A dummy variable, \( E_i \), was defined to determine whether a household experienced CHE, as shown in Eq. (1):

\[
E_i = \begin{cases} 
0 & \text{if } \frac{T_i}{(x_i-f_i)} < \text{threshold} \\
1 & \text{if } \frac{T_i}{(x_i-f_i)} \geq \text{threshold}
\end{cases}
\]  (1)

In the Eq. (1), \( T_i \) represents the OOP medical expenditure of household \( i \), \( x_i \) stands for the total expenditure of household \( i \), \( f_i \) denotes the food expenditure of household \( i \), and threshold is equal to 40%. The incidence and intensity of CHE can be calculated by the following Eqs. (2-4):

\[
H = \frac{1}{N} \sum_{i=1}^{N} E_i
\]  (2)
\[ O = \frac{1}{N} \sum_{i=1}^{N} E_i \left( \frac{T_i}{x_i} - z \right) \]  
\[ MPO = \frac{O}{H} \]  

Where \( N \) is the total sample size, \( H \) stands for the CHE incidence of the households. Intensity of CHE is measured by overshoot and mean positive overshoot (MPO). \( O \) represents overshoot, which is defined as the average percentage of OOP medical expenditure that exceeded the given threshold over all households [33]. MPO means the severity of overshoot in the households incurring CHE, and is defined as the average overshoot over all households incurring CHE [29]. The greater value of overshoot and MPO, the heavier economic burden of diseases for the households, and vice versa.

Definitions of independent variables
Referring to the published literature, a number of variables were incorporated into the random effects panel probit regression model as potential determinants of CHE and its inequality [31, 32, 34, 35]. These independent variables were related to the information of each household surveyed and its household head. Household information included eight variables: lagged CHE, the annual per capita household income, household size, receiving inpatient services, having elderly members, having members with chronic diseases, having members covered by supplementary medical insurance, and geographic location. The information of household head involved nine variables: gender, age, age square, education, marriage, employment status, self-assessed health status, smoking and drinking. Due to the short time series of the database, the lagged value of CHE was set to 2 years. Meanwhile, we used the natural logarithm of the annual per capita household income for regression analysis. All currency-related variables from 2014 to 2018 were deflated to 2012 using the corresponding consumer price index. The details of the independent variables are summarized in Table 1.

Methodology
The concentration index (CI), developed by Wagstaff and Van Doorslaer, was the indicator most commonly used to measure the inequity of CHE [36, 37]. The CI can reflect the situation of all sample households from socioeconomic dimension, and is sensitive to the

| Variables | Description |
|-----------|-------------|
| CHE | The OOP medical expenditure was higher than or equal to 40% of non-food household expenditure; Yes = 1; No = 0 |
| Household expenditure (Yuan) | Total consumption expenditure of a household |
| OOP medical expenditure (Yuan) | Total out-of-pocket medical expenditure of a household |
| Food expenditure (Yuan) | Total food consumption expenditure of a household |
| Lagged CHE | Did the household experience CHE 2 years ago? Yes = 1; No = 0 |
| Income (Yuan) | The annual per capita household income |
| Lnincome | The natural logarithm of annual per capita household income |
| Household size | The number of household members |
| Inpatient | At least one household member received inpatient services in last year; Yes = 1; No = 0 |
| Elderly members | At least one household member over 60 years old; Yes = 1; No = 0 |
| Chronic diseases | At least one household member with chronic diseases; Yes = 1; No = 0 |
| Supplementary medical insurance | At least one household member covered by supplementary medical insurance; Yes = 1; No = 0 |
| Geographic location | East = 1, Central = 2, West = 3 |
| Gender of household head | Female = 0; male = 1 |
| Age | The age of household head |
| Education of household head | Illiterate = 1; Primary school = 2; Middle school = 3; High school and above = 4 |
| Marriage of household head | Married = 1, Unmarried = 0 |
| Employment status of household head | Employed = 1, Unemployed = 0 |
| Self-assessed health status of household head | Healthy = 1; Unhealthy = 0 |
| Smoking | Has the household head smoked in the past month? Yes = 1; No = 0 |
| Drinking | Has the household head drunk more than three times a week in the past month? Yes = 1; No = 0 |

Note: * Reference group; CHE = Catastrophic health expenditure; OOP = Out-of-pocket medical expenditure
changes in the distribution of the households across socioeconomic groups [38, 39]. The concentration curve depicts the cumulative percentage of the households, ranked by household income from the poorest to the richest (x-axis), against the cumulative percentage of CHE (y-axis), while the CI is defined as twice the area enclosed by the concentration curve and absolute fairness line [36, 37, 40]. The value of the CI ranges from -1 to +1, and the smaller the absolute value of the CI is, the more fair is [38]. When the CI is equal to zero, the distribution of CHE is absolutely fair [29, 41]. A positive CI represents that the distribution of CHE is more conducive to the richer households, and vice versa [42].

The calculation of the CI is shown in Eq. (5):

\[
CI = \frac{2}{\mu} \text{cov}_w(y_i, r_i)
\]

where \(y_i\) denotes the relevant indicators for CHE, \(r_i\) is the fractional rank of the households in terms of income distribution and \(\mu\) represents the mean of CHE.

Given the differences in opportunity costs, we modify the CHE incidence and overshoot by giving greater weights to poorer households [28]. The specific calculations are based on the following two equations:

\[
H^W = H(1-CI_H)
\]

\[
O^W = O(1-CI_O)
\]

Where \(CI_H\) is the CI of CHE incidence, and \(CI_O\) denotes the CI for the overshoot.

As proposed by Wagstaff et al., the decomposition of CI was employed in this study to analyze the contribution of relevant independent variables to the inequality of CHE incidence [36]. The probit regression model was established to decompose the CI in this study. As the probit model is a non-linear model, the linear approximation to the non-linear model is calculated by estimating the marginal effect evaluated at the covariate means [36]. The specific regression model can be expressed as:

\[
y_i = \delta + \sum_k y_k z_{ki} + \varepsilon_i
\]

In the Eq. (8), \(y_i\) is whether the household has incurred CHE, \(z_k\) stands for the independent variable, and \(\delta, y_k\) and \(\varepsilon\) denote the constant term, marginal effect and disturbance term, respectively.

The method of decomposition of CI can be specified as:

\[
CI = \sum_k \frac{y_k z_k}{\mu} C_k + \frac{GC_x}{\mu}
\]

Where \(z_k\) denotes the mean of each independent variable, \(C_k\) represents the CI of each independent variable, \((y_i z_k/\mu)\) is the elasticity of CI, and \((GC_x/\mu)\) stands for the error term [33].

All analyses were performed in STATA software version 15.1.

Results

Descriptive statistics

Summary statistics regarding each variable of the urban and rural households is reported in Table 2. The average annual household consumption in urban areas rose from 45,150 YUAN in 2012 to 63,918 YUAN in 2018, while that in rural areas increased from 30,879 YUAN in 2012 to 37,587 YUAN in 2018. The household size in urban areas decreased from 3.60 in 2012 to 3.51 in 2018, while the household size in rural areas also showed a declining trend over the same period.

Compared with urban households, the rural households had higher probability in receiving inpatient services in the last 12 months, having elderly members and having married household head. The coverage rate of supplementary medical insurance for urban households was higher than that for rural households. In urban areas, more than half of household heads were female, while in rural areas the opposite was true. The education level of household heads in urban areas was mainly concentrated in high school and above, while the highest proportion of household heads in rural areas had almost no education. In addition, rural household heads had a higher percentage of smoking and drinking than urban household heads.

CHE and the inequality for CHE

Table 3 illustrates CHE incidence, intensity and inequality of urban and rural households. The concentration curves of CHE incidence and overshoot are shown in Figs. 2, 3, 4, 5, 6, 7, 8 and 9.

From 2012 to 2018, the CHE incidence of urban households increased from 11.01 to 11.88%, while the CHE incidence of rural households decreased from 18.42 to 18.31%. Similar trends were found for both overshoot and MPO. The CHE incidence and overshoot increased slightly for both urban and rural households, by giving greater weights to the poorer households. However, none of the above indicators showed a steady upward or downward trend.

The CI for CHE incidence and overshoot were both negative. These results showed an obvious pro-poor inequality in the distribution of CHE incidence and overshoot across socioeconomic groups. Similarly, the concentration curves of CHE incidence and overshoot were both above the line of absolute fairness, which also highlighted the pro-poor inequality of CHE incidence and overshoot (Figs. 2, 3, 4, 5, 6, 7, 8 and 9). From 2012
| Variables                        | 2012 Urban households | Rural households | 2014 Urban households | Rural households |
|----------------------------------|-----------------------|------------------|-----------------------|------------------|
|                                  | Mean(N)   | S.D. (%) | Mean(N)   | S.D. (%) | Mean(N)   | S.D. (%) | Mean(N)   | S.D. (%) |
| Sample size                      | 2761      | 100%     | 3599      | 100%     | 2761      | 100%     | 3599      | 100%     |
| Household expenditure (Yuan)     | 45,150    | 54,696   | 30,879    | 32,972   | 53,849    | 53,201   | 33,829    | 41,199   |
| OOP medical expenditure (Yuan)   | 3488      | 10,495   | 3581      | 11,904   | 4670      | 15,460   | 4273      | 12,341   |
| Food household expenditure (Yuan)| 16,911    | 14,396   | 13,060    | 12,070   | 20,034    | 14,869   | 10,084    | 9770     |
| Income (Yuan)                    | 16,721    | 22,577   | 9412      | 13,186   | 19,515    | 32,466   | 10,190    | 18,559   |
| Lnincome                         | 9.23      | 1.14     | 8.64      | 1.16     | 9.39      | 1.09     | 8.68      | 1.21     |
| Household size                   | 3.60      | 1.54     | 4.21      | 1.82     | 3.59      | 1.60     | 4.18      | 1.83     |
| Inpatient                        | Yes       | 649      | 23.51     | 883      | 24.53     | 786      | 28.47     | 1000     | 27.79   |
| Noa                             | 2112      | 76.49    | 2716      | 75.47    | 1975      | 71.53    | 2599      | 72.21    |
| Elderly members                  | Yes       | 998      | 36.15     | 1360     | 37.79     | 1225     | 44.37     | 1703     | 47.32   |
| Noa                             | 1763      | 63.85    | 2239      | 62.21    | 1536      | 55.63    | 1896      | 52.68    |
| Chronic diseases                 | Yes       | 793      | 28.72     | 977      | 27.15     | 1053     | 38.14     | 1284     | 35.68   |
| Noa                             | 1968      | 71.28    | 2622      | 72.85    | 1708      | 61.86    | 2315      | 64.32    |
| Supplementary medical insurance  | Yes       | 71       | 2.57      | 47       | 1.31      | 125      | 4.53      | 50       | 1.39    |
| Noa                             | 2690      | 97.43    | 3552      | 98.69    | 2636      | 95.47    | 3549      | 98.61    |
| Geographic location              | Easta     | 1370     | 40.62     | 1260     | 35.01     | 1370     | 49.62     | 1260     | 35.01   |
| Central                         | 902       | 32.67    | 1058      | 29.40    | 902       | 32.67    | 1058      | 29.40    |
| West                            | 489       | 17.71    | 1281      | 35.59    | 489       | 17.71    | 1281      | 35.59    |
| Gender of household head         | Femalea   | 1450     | 52.52     | 1442     | 40.07     | 1482     | 53.68     | 1493     | 41.48   |
| Male                            | 1311      | 47.48    | 2157      | 59.93    | 1279      | 46.32    | 2106      | 58.52    |
| Age                             | 49.78     | 12.99    | 49.60     | 12.18    | 51.33     | 12.75    | 51.37     | 12.06    |
| Age square                      | 2647.14   | 1343.76  | 2608.19   | 1224.73  | 2797.86   | 1349.55  | 2783.98   | 1254.45  |
| Education of household head     | Illiteratea | 468      | 16.95     | 1227     | 34.09     | 467      | 16.91     | 1200     | 33.90   |
| Primary school                  | 523       | 18.94    | 1007      | 27.98    | 515       | 18.65    | 1030      | 28.62    |
| Middle school                   | 883       | 31.98    | 981       | 27.26    | 880       | 31.87    | 977       | 27.15    |
| High school and above           | 887       | 32.13    | 384       | 10.67    | 899       | 32.56    | 372       | 10.34    |
| Marriage of household head      | Married   | 2450     | 88.74     | 3281     | 91.16     | 2420     | 87.65     | 3262     | 90.64   |
| Unmarried                       | 311       | 11.26    | 318       | 8.84     | 341       | 12.35    | 337       | 9.36     |
| Employment status of household head | Employed | 1773     | 64.22     | 3115     | 86.55     | 1801     | 65.23     | 3136     | 87.14   |
| Unemployed                       | 988       | 35.78    | 484       | 13.45    | 960       | 34.77    | 463       | 12.86    |
| Self-assessed health status of household head | Healthy | 1663     | 60.23     | 2085     | 57.93     | 1865     | 67.55     | 2280     | 63.35   |
| Unhealthy                       | 1098      | 39.77    | 1514      | 42.07    | 896       | 32.45    | 1319      | 36.65    |
Table 2 Summary statistics of variables in urban and rural households (Continued)

| Variables | 2012 Urban households | 2012 Rural households | 2014 Urban households | 2014 Rural households |
|-----------|-----------------------|-----------------------|-----------------------|-----------------------|
| Smoking   |                       |                       |                       |                       |
| Yes       | 776 28.11             | 1472 40.90            | 738 26.73             | 1372 38.12            |
| No<sup>a</sup> | 1985 71.89         | 2127 59.10            | 2023 73.27            | 2227 61.88            |
| Drinking  |                       |                       |                       |                       |
| Yes       | 474 17.17             | 672 18.67             | 438 15.86             | 677 18.81             |
| No<sup>a</sup> | 2287 82.83        | 2927 81.33            | 2323 84.14            | 2922 81.19            |
| Variables | 2016 Urban households | 2016 Rural households | 2018 Urban households | 2018 Rural households |
| Sample size | 2761 100%               | 3599 100%             | 2761 100%             | 3599 100%             |
| Household expenditure (Yuan) | 65,048 106,127        | 36,853 44,010         | 63,918 63,518         | 37,587 40,074         |
| OOP medical expenditure (Yuan) | 5517 17,708          | 4912 17,525           | 5234 12,473           | 4901 11,932           |
| Food household expenditure (Yuan) | 21,873 19,667       | 10,674 11,175         | 23,003 17,268         | 11,166 12,336         |
| Income (Yuan) | 27,401 60,884       | 12,937 66,828         | 32,762 62,048         | 13,758 17,529         |
| Lnincome  | 9.72 0.95            | 8.97 0.93             | 9.96 0.93             | 9.12 0.94             |
| Household size | 3.59 1.65            | 4.16 1.93             | 3.51 1.72             | 3.97 1.92             |
| Inpatient |                       |                       |                       |                       |
| Yes       | 844 30.57             | 1107 30.76            | 878 31.80             | 1214 33.73            |
| No<sup>a</sup> | 1917 69.43        | 2492 69.24            | 1883 68.20            | 2385 66.27            |
| Elderly members |                       |                       |                       |                       |
| Yes       | 1330 48.17            | 1835 50.99            | 1451 52.55            | 2023 56.21            |
| No<sup>a</sup> | 1431 51.83        | 1764 49.01            | 1310 47.45            | 1576 43.79            |
| Chronic diseases |                       |                       |                       |                       |
| Yes       | 1026 37.16            | 1315 36.54            | 993 35.97             | 1369 38.04            |
| No<sup>a</sup> | 1735 62.84        | 2284 63.46            | 1768 64.03            | 2230 61.96            |
| Supplementary medical insurance |                       |                       |                       |                       |
| Yes       | 157 5.69              | 105 2.92              | 137 4.96              | 84 2.33               |
| No<sup>a</sup> | 2604 94.31        | 3494 97.08            | 2624 95.04            | 3515 97.67            |
| Geographic location |                       |                       |                       |                       |
| East<sup>a</sup> | 1369 49.58        | 1260 35.01            | 1372 49.69            | 1259 34.98            |
| Central   | 904 32.74             | 1058 29.40            | 902 32.67             | 1057 29.37            |
| West      | 488 17.67             | 1281 35.59            | 487 17.64             | 1283 35.65            |
| Gender of household head |                       |                       |                       |                       |
| Female<sup>a</sup> | 1499 54.29        | 1550 43.07            | 1456 52.73            | 1564 43.46            |
| Male      | 1262 45.71            | 2049 56.93            | 1305 47.27            | 2035 56.54            |
| Age       | 53.08 12.97           | 52.78 12.42           | 54.65 12.96           | 54.52 12.41           |
| Age square | 2986.08 1410.88      | 2940.31 1318.79       | 3154.92 1452.19       | 3126.48 1356.12       |
| Education of household head |                       |                       |                       |                       |
| Illiterate<sup>a</sup> | 451 16.33        | 1184 32.90            | 401 14.52             | 1132 31.45            |
| Primary school | 541 19.59        | 1041 28.92            | 508 18.40             | 1006 27.95            |
| Middle school | 854 30.93        | 971 26.98             | 881 31.91             | 1056 29.34            |
| High school and above | 915 33.14        | 403 11.20             | 971 35.17             | 405 11.25             |
| Marriage of household head |                       |                       |                       |                       |
to 2018, urban household showed an unstable increase in the absolute values of the CI for both the CHE incidence and overshoot. In contrast, the increase of rural households on the corresponding indicators was relatively stable over the same period. In addition, the CHE incidence and overshoot were greater in absolute terms for urban households than for rural households between 2012 and 2014, until the situation reversed in 2016.

**Associated factors of CHE incidence**

Table 4 presents the random effects panel probit regression results for CHE incidence.

As shown in Table 4, economic status and household size were negatively associated with the occurrence of exposure to CHE for both urban and rural households. Education at the middle school and above reduced CHE occurrence. The risk of CHE was also decreased among households with a healthy or employed head. Meanwhile, experiencing CHE 2 years ago, receiving inpatient services and having household members suffering from chronic diseases significantly increased the CHE incidence of urban and rural households. In addition, the likelihood of urban households experiencing CHE was significantly lower when household members were covered by supplementary medical insurance or when the household head had a drinking habit. CHE incidence significantly increased when there were elderly members in rural households.

**Decomposition of inequality in CHE incidence**

Table 5 displays the results of estimated absolute and relative contribution for each variable to the inequality of CHE incidence.

### Table 2 Summary statistics of variables in urban and rural households (Continued)

| Variables                      | 2012 Urban households | 2012 Rural households | 2014 Urban households | 2014 Rural households |
|--------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Married                        | 2389                  | 86.53                 | 3206                  | 89.08                 |
| Unmarried                      | 372                   | 13.47                 | 393                   | 10.92                 |
| Employment status of household head | 1747                 | 63.27                 | 3085                  | 85.72                 |
| Employed                       | 1710                  | 61.93                 | 3017                  | 83.83                 |
| Unemployed*                    | 1014                  | 36.73                 | 514                   | 14.28                 |
| Self-assessed health status of household head | 1694                 | 61.35                 | 2148                  | 59.68                 |
| Healthy                        | 1811                  | 65.59                 | 2225                  | 61.82                 |
| Unhealthy*                     | 1067                  | 38.65                 | 1451                  | 40.32                 |
| Smoking                        | 716                   | 25.93                 | 1280                  | 35.57                 |
| No*                            | 2045                  | 74.07                 | 2319                  | 64.43                 |
| Drinking                       | 445                   | 16.12                 | 645                   | 17.92                 |
| No*                            | 2316                  | 83.88                 | 2954                  | 82.08                 |

Note: * Reference group; OOP medical expenditure = out-of-pocket medical expenditure

### Table 3 CHE incidence, intensity and inequality for urban and rural households

| CHE incidence and intensity | 2012 Urban households | 2014 Urban households | CHE incidence, intensity | H* | Overshoot | O* | MPO | CIH | ClO |
|-----------------------------|-----------------------|-----------------------|--------------------------|----|-----------|----|-----|-----|-----|
| Incidence                   | 11.01%                | 11.99%                |                          |    |           |    |     |     |     |
| Overshoot                   | 2.15%                 | 2.51%                 |                          |    |           |    |     |     |     |
| MPO                         | 2.51%                 | 2.99%                 |                          |    |           |    |     |     |     |
| CIH                         | −0.1694               | −0.1062               |                          |    |           |    |     |     |     |
| ClO                         | −0.1373               | −0.1490               |                          |    |           |    |     |     |     |

Note: CHE Catastrophic health expenditure, H* rank-weighted catastrophic health expenditure incidence, O* rank-weighted overshoot, MPO Mean positive overshoot; CIH the concentration index of catastrophic health expenditure incidence; ClO the concentration index of overshoot
With regard to the inequality in CHE incidence among urban and rural households, the main contributing factors remained largely unchanged between 2012 to 2018. Specifically, the main contribution to the inequality in CHE incidence among urban households in 2018 was associated with lagged CHE (7.62%), economic status (78.02%), household size (−18.91%), receiving inpatient services (1.19%), education of household head (high school and above, 11.80%), and self-assessed health status of household head (5.02%). In rural households, the majority of the inequality of incurring CHE was associated with lagged CHE (15.01%), economic status
(50.49%), household size (−3.90%), receiving inpatient services (5.19%), having elderly members (3.21%), education of household head (middle school, 3.68%; high school and above, 2.46%), and self-assessed health status of household head (6.20%). Furthermore, residual variables contributed extensively to the increase in pro-poor inequality of incurring CHE (urban households: 18.33%; rural households: 8.64%). The same logic can be applied to the urban and rural households in 2012/2014/2016.
Discussion

By deeply analyzing the national representative data, the present study estimates the incidence, intensity and inequality of CHE for urban and rural households in China. Here, we identified that both urban and rural households suffered CHE, with varying incidence and intensity, and that situation did not improve dramatically from 2012 to 2018. We also examined that the rural households had higher probability and intensity of incurring CHE than those of the urban households, which implied that rural households had higher risk of incurring CHE and heavier economic burden of diseases. Xu
reported that the CHE incidence of rural areas of Shaanxi Province in 2013 was 15.83% [22]. As Si showed, the occurrence of exposure to CHE for urban households with hypertension in 2013 was 21.50% [43]. The differences between this study and previous researches in CHE incidence could be attributed to the diversities of research samples and areas.

In addition, we found a significant increase of the CHE incidence and overshoot by giving greater weights to the poorer households. It meant that the CHE
incidence and overshoot would increase if the opportunity cost difference was considered from the perspective of social welfare in both two groups. In other words, the issue of CHE was worse than it appeared simply by observing the proportion of the households exceeding the threshold (40%), since it ignored the fact that the poorer households were more likely to exceed the threshold [28].

Furthermore, this article identified several key determinants of CHE incidence and most of them were similar with prior studies [14, 43, 44]. As we expected, higher annual per capita household income and better self-rated health status of the household head were both significantly associated with lower CHE incidence. The greater household size was more likely to avoid CHE. The risk of CHE was decreased among urban and rural households if the household head had a high level of education, or if the household head was employed. Conversely, receiving inpatient services and having members suffering chronic diseases may increase the risk of incurring CHE. Moreover, these effects were more prominent in rural households rather than in urban households, which meant that the related policy interventions should give priority to the health needs of vulnerable households, especially in rural areas. The study also found that urban and rural households experiencing CHE 2 years ago were significantly more likely to be impoverished again due to illness. The comparative analysis of the marginal effects also showed that the problem of poverty due to illness was more persistent in rural households than in urban ones.

Supplementary medical insurance significantly reduced the CHE incidence among urban households, but did not significantly affect the CHE incidence among rural households. One of the potential reasons for this phenomenon is that rural households have lower coverage rate of supplementary medical insurance than urban households. The coverage rate of supplementary medical insurance for urban households increased from 2.57% in 2012 to 4.96% in 2018, while that for rural households rose from 1.31% in 2012 to 2.33% in 2018. It implied that the Chinese government should encourage the

### Table 4 Marginal effect of each variable associated with CHE incidence

| Variables                        | Urban households | Rural households |
|----------------------------------|------------------|------------------|
|                                  | dy/dxb          | Std. Err.       | dy/dxb          | Std. Err.       |
| Lagged CHE                       | 0.0567**        | 0.0119          | 0.1144*         | 0.0567          |
| Lnincome                         | −0.0270**       | 0.0033          | −0.0179*        | 0.0079          |
| Household size                   | −0.0142**       | 0.0022          | −0.0221*        | 0.0090          |
| Inpatient, yes                   | 0.1153**        | 0.0068          | 0.1458*         | 0.0607          |
| Elderly members, yes             | 0.0117          | 0.0087          | 0.0276*         | 0.0135          |
| Chronic diseases, yes            | 0.0241**        | 0.0070          | 0.0396*         | 0.0143          |
| Supplementary medical insurance, yes | −0.0547**   | 0.0187          | −0.0441         | 0.0315          |
| Geographic location              |                 |                 |                 |                 |
| East                             |                 |                 |                 |                 |
| Central                          | 0.0013          | 0.0078          | −0.0132         | 0.0099          |
| West                             | −0.0188         | 0.0097          | −0.0208         | 0.0120          |
| Gender of household head, male   | 0.0128          | 0.0084          | 0.0117          | 0.0098          |
| Age                              | 0.0001          | 0.0018          | −0.0023         | 0.0021          |
| Age square                       | 0.0000          | 0.0000          | 0.0001*         | 0.0001          |
| Education of household head      |                 |                 |                 |                 |
| Illiterate                       |                 |                 |                 |                 |
| Primary school                   | −0.0083         | 0.0103          | −0.0198         | 0.0116          |
| Middle school                    | −0.0290**       | 0.0100          | −0.0298*        | 0.0151          |
| High school and above            | −0.0343**       | 0.0109          | −0.0270         | 0.0163          |
| Marriage of household head, married | −0.0033       | 0.0097          | 0.0183          | 0.0130          |
| Employment status of household head, employed | −0.0167* | 0.0078          | −0.0344*        | 0.0166          |
| Self-assessed health status of household head, healthy | −0.0447** | 0.0069          | −0.0552*        | 0.0238          |
| Smoking, yes                     | −0.0082         | 0.0091          | 0.0004          | 0.0085          |
| Drinking, yes                    | −0.0209*        | 0.0102          | −0.0287         | 0.0150          |

Note: * Reference group; ** Marginal effect; * p < 0.05; ** p < 0.01
Table 5 The contribution of each independent variable to the inequality in CHE incidence

| Variables                                      | 2012 Urban households | 2012 Rural households | 2014 Urban households | 2014 Rural households |
|------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Lagged CHE                                     | Cont^b Per^c          | Cont^b Per^c          | Cont^b Per^c          | Cont^b Per^c          |
| Lnincome                                       | −0.0974              | 65.79%                | −0.0168              | 15.82%                | −0.1124              | 79.79%                | −0.0551              | 43.72%                |
| Household size                                 | 0.0315               | −21.28%               | −0.0037              | 3.45%                 | 0.0181               | −12.88%               | 0.0012               | −0.98%                |
| Inpatient, yes                                 | −0.0022              | 1.47%                 | −0.0095              | 8.91%                 | −0.0055              | 3.93%                 | −0.0072              | 5.71%                 |
| Elderly members, yes                           | −0.0001              | 0.08%                 | −0.0033              | 3.12%                 | 0.0001               | −0.04%                | −0.0079              | 6.26%                 |
| Chronic diseases, yes                          | 0.0057               | −3.86%                | 0.0016               | −1.54%                | 0.0019               | −1.38%                | −0.0001              | 0.09%                 |
| Supplementary medical insurance, yes           | −0.0014              | 0.98%                 | −0.0001              | 0.06%                 | −0.0021              | 1.51%                 | −0.0010              | 0.78%                 |
| Geographic location                            |                       |                       |                       |                       |
| East^a                                         |                       |                       |                       |                       |
| Central                                        | −0.0059              | 3.99%                 | 0.0005               | −0.45%                | 0.0001               | −0.04%                | −0.0013              | 0.99%                 |
| West                                           | −0.0012              | 0.79%                 | −0.0003              | 0.29%                 | 0.0074               | −5.22%                | 0.0060               | −4.73%                |
| Gender of household head, male                 | 0.0026               | −1.75%                | −0.0004              | 0.36%                 | 0.0001               | −0.10%                | −0.0008              | 0.65%                 |
| Age                                            | −0.0124              | 8.38%                 | 0.0157               | −14.82%               | −0.0001              | 0.04%                 | 0.0083               | −6.58%                |
| Age square                                     | 0.0148               | −9.98%                | −0.0302              | 28.48%                | 0.0124               | −8.78%                | −0.0184              | 14.55%                |
| Education of household head                    |                       |                       |                       |                       |
| Illiterate^a                                    |                       |                       |                       |                       |
| Primary school                                 | 0.0016               | −1.06%                | 0.0017               | −1.61%                | 0.0038               | −2.66%                | −0.0004              | 0.34%                 |
| Middle school                                  | 0.0015               | −1.04%                | −0.0079              | 7.43%                 | 0.0014               | −1.01%                | −0.0045              | 3.53%                 |
| High school and above                          | −0.0315              | 21.30%                | −0.0135              | 12.70%                | −0.0146              | 10.34%                | −0.0045              | 3.59%                 |
| Marriage of household head, married            | 0.0000               | 0.00%                 | −0.0001              | 0.04%                 | −0.0011              | 0.75%                 | −0.0003              | 0.27%                 |
| Employment status of household head, employed  | 0.0010               | −0.68%                | −0.0010              | 0.96%                 | 0.0044               | −3.10%                | 0.0001               | −0.10%                |
| Self-assessed health status of household head, healthy | −0.0093            | 6.25%                 | −0.0065              | 6.12%                 | −0.0079              | 5.64%                 | −0.0080              | 6.38%                 |
| Smoking, yes                                   | 0.0009               | −0.61%                | −0.0002              | 0.16%                 | 0.0009               | −0.61%                | −0.0001              | 0.03%                 |
| Drinking, yes                                  | −0.0004              | 0.29%                 | −0.0024              | 2.23%                 | −0.0007              | 0.52%                 | −0.0035              | 2.81%                 |
| Residual variables                             | −0.0458              | 30.94%                | −0.0298              | 28.29%                | −0.0356              | 25.11%                | −0.0129              | 10.21%                |
| Variables                                      | 2016                 |                       | 2018                 |                       |
| Urban households                               |                       |                       | Rural households     |                       |
| Cont^b Per^c                                    | −0.0088              | 7.65%                 | −0.0225              | 17.06%                | −0.0129              | 7.62%                 | −0.0225              | 15.01%                |
| Lnincome                                       | −0.0733              | 33.88%                | −0.0459              | 34.88%                | −0.1321              | 78.02%                | −0.0758              | 50.49%                |
| Household size                                 | 0.0259               | −22.58%               | 0.0106               | −8.03%                | 0.0320               | −18.91%               | 0.0058               | −3.90%                |
| Inpatient, yes                                 | −0.0174              | 15.17%                | −0.0154              | 11.71%                | −0.0020              | 1.19%                 | −0.0078              | 5.19%                 |
| Elderly members, yes                           | −0.0001              | 0.09%                 | −0.0137              | 10.38%                | −0.0025              | 1.46%                 | −0.0048              | 3.21%                 |
| Chronic diseases, yes                          | 0.0009               | −0.80%                | −0.0015              | 1.15%                 | 0.0027               | −1.60%                | −0.0025              | 1.66%                 |
| Supplementary medical insurance, yes           | −0.0032              | 2.77%                 | −0.0011              | 0.83%                 | −0.0029              | 1.72%                 | −0.0025              | 1.67%                 |
| Geographic location                            |                       |                       |                       |                       |
| East^a                                         |                       |                       |                       |                       |
| Central                                        | 0.0024               | −2.06%                | −0.0005              | 0.42%                 | −0.0022              | 1.30%                 | 0.0001               | −0.06%                |
| West                                           | −0.0013              | 1.09%                 | 0.0010               | −0.73%                | 0.0049               | −2.89%                | 0.0057               | −3.81%                |
| Gender of household head, male                 | 0.0011               | −0.96%                | −0.0011              | 0.86%                 | 0.0004               | −0.24%                | 0.0000               | 0.01%                 |
| Age                                            | 0.0006               | −0.52%                | 0.0149               | −11.36%               | 0.0024               | −1.40%                | 0.0155               | −10.32%               |
| Age square                                     | 0.0039               | −3.36%                | −0.0298              | 22.63%                | 0.0019               | −1.13%                | −0.0295              | 19.63%                |
development of supplementary medical insurance, especially in rural areas, which is conducive to the formation of a multi-dimensional medical insurance system to alleviate the financial burden of rural patients.

There were strong pro-poor inequalities in CHE incidence and overshoot among urban and rural households, and the inequitable situation worsened from 2012 to 2018. This finding was concordant with the result of Sun et al.'s study [45]. The comparative analysis also revealed that rural households showed a greater and more stable increase in the absolute value of CI regarding the CHE incidence and overshoot from 2012 to 2018 compared to urban households. These results indicated that the problem of poverty due to illness was more severe for rural low-income groups than for urban low-income groups.

By decomposing the CI of CHE incidence, this article explored the contribution of each determinant to the inequality in CHE incidence among urban and rural households in China. Economic status made the greatest contribution to the pro-poor inequality of CHE incidence in both two groups, which demonstrated that household size reduced the risk of incurring CHE in poor households. This could be explained by the fact that the low-income households in China were associated with greater household size [24, 47], which was beneficial to alleviate the risk of incurring CHE. From 2012 to 2018, the pro-rich contribution of household size to the inequality in CHE incidence did not fluctuate significantly, indicating that the financial protection effect of household size on poor households was relatively stable. The level of education of household head increased the risk of incurring CHE among poor households, especially in urban areas. It further demonstrated that human capital played an important role in household economic protection and the necessity of generally improving citizens' education level through policy interventions [43].

The contribution of receiving inpatient services to the inequality of experiencing CHE was in a pro-poor direction, increasing the probability of incurring CHE in poor households. It can be attributed to the purchasing power of inpatient services was weaker in poor households than in affluent ones. From 2012 to 2018, there was a small reduction in the pro-poor contribution of receiving inpatient services to the inequality in CHE incidence among urban and rural households, indicating that the current problem has lessened but it is still unsolved. The other factors such as having elderly members, and self-assessed health status of household head, were also the major reasons for the pro-poor inequality of CHE incidence, especially in rural households. In order to solve the above problems, the medical security department

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**Table 5** The contribution of each independent variable to the inequality in CHE incidence (Continued)

| Variables                                | 2012 Urban households | Rural households | 2014 Urban households | Rural households |
|-------------------------------------------|-----------------------|------------------|-----------------------|------------------|
| Cont<sup>b</sup>                           | Per<sup>c</sup>       | Cont<sup>b</sup> | Per<sup>c</sup>       | Cont<sup>b</sup> | Per<sup>c</sup> |
| Education of household head               |                       |                  |                       |                  |
| Illiterate<sup>a</sup>                    |                       |                  |                       |                  |
| Primary school                            | 0.0076                | −6.63%           | −0.0001               | 0.01%            | −0.0058         | 3.42%           | −0.0003         | 0.17%           |
| Middle school                             | 0.0010                | −0.86%           | −0.0020               | 1.57%            | 0.0026          | −1.56%          | −0.0055         | 3.68%           |
| High school and above                     | −0.0290               | 25.28%           | −0.0033               | 2.52%            | −0.0200         | 11.80%          | −0.0037         | 2.46%           |
| Marriage of household head, married       | 0.0002                | −0.15%           | 0.0019                | −1.43%           | 0.0006          | −0.35%          | 0.0030          | −1.99%          |
| Employment status of household head, employed | 0.0015            | −1.31%           | −0.0023               | 1.72%            | 0.0049          | −2.88%          | −0.0026         | 1.71%           |
| Self-assessed health status of household head, healthy | −0.0075        | 6.51%            | −0.0077               | 5.85%            | −0.0085         | 5.02%           | −0.0093         | 6.20%           |
| Smoking, yes                              | 0.0010                | −0.84%           | −0.0003               | 0.24%            | −0.0005         | 0.28%           | 0.0001          | −0.04%          |
| Drinking, yes                             | −0.0005               | 0.44%            | −0.0008               | 0.63%            | −0.0014         | 0.80%           | −0.0006         | 0.39%           |
| Residual variables                        | −0.0198               | 17.19%           | −0.0120               | 9.09%            | −0.0309         | 18.33%          | −0.0129         | 8.64%           |

Note: a Reference group; b Contribution to concentration index; c percentage of contribution to concentration index
should appropriately increase the reimbursement rate of the medical assistance system according to the medical needs of low-income groups, especially for hospitalization expenses.

Additionally, the presence of chronic diseases made a minor pro-poor contribution to the inequality of CHE incidence in both two groups. Given the current significant impact of chronic diseases on the economic burden of diseases, this result was lower than our expectations. Based on Eq. (9), the contribution of each variable is equal to the product of the elasticity of the corresponding variable and the CI of the corresponding variable. Therefore, the minor contribution of chronic diseases can be explained by a small elasticity of chronic diseases in both urban and rural households.

There are several limitations in this study. Firstly, the negative contributions of residual variables indicate that the omission of related variables (e.g., outpatient services utilization, distance to the nearest health facilities, the levels of medical facilities) leads to some unexplained contribution of pro-poor inequality owing to the data availability. Secondly, the present research uses a conservative method to estimate the OOP medical expenditure. The fact that indirect expenditure (e.g., transportation, food, lost productivity due to illness) were not included in OOP medical expenditure leads to an underestimated CHE incidence and intensity to some extent [32, 34, 43]. Thirdly, it is worth emphasizing that the analysis of the association between CHE incidence and annual per capita household income, or between CHE incidence and self-rated health status of household heads, is not a strictly causal inference, and thus the relevant descriptions in the discussion section should not be interpreted as causal associations.

Conclusion

In conclusion, the present study identified that a certain proportion of incurring CHE existed in both urban and rural households in China, and rural households had higher risk of incurring CHE than urban households. The strong pro-poor inequality for CHE incidence and overshoot could be found in both two groups. In contrast, the problem of poverty due to illness was more severe for rural low-income groups than for urban low-income groups. Therefore, relevant policy interventions should further focus on narrowing the income gap among different groups, generally improving citizens’ education level, encouraging the development of supplementary medical insurance, and increasing the reimbursement rate for hospitalization expenses in the medical assistance system.

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Author’s contributions

Xian-zhi Fu formulated the primary framework of the study, conducted the data analysis, and contributed to the final manuscript. The author has read and approved the final version of the manuscript.

Authors’ information

Xian-zhi Fu, School of Political Science and Public Administration, Wuhan University, Wuhan 430072, Hubei, China.

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Availability of data and materials

The data source of this study was a publicly available database, the China Family Panel Studies (CFPS), which was hosted by the Institute of Social Science Survey (ISSS) of Peking University every 2 years from 2010 to 2018.

Declarations

Ethics approval and consent to participate

The study is conducted in accordance with the ethical standards of the institutional and national research committees and with the 1964 Helsinki Declaration and its subsequent revisions or similar ethical standards. Each volunteer participant obtained a written informed consent based on inclusion criteria.

Consent for publication

The author gives consent for publication of this paper in Health Economic Review.

Competing interests

The authors declare that there are no competing interests.

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References

1. World Health Organization. World health report 2010: health systems financing: the path to universal coverage. 2010. https://www.ghwatch.org/node/72. [cited 2020 Jun 9].
2. Hogan DR, Stevens GA, Hosseinpoor AR, Boerma T. Monitoring universal health coverage within the sustainable development goals development and baseline data for an index of essential health services. Lancet Glob Health. 2018;6(2):e152–68. https://doi.org/10.1016/S2214-109X(17)30472-2.
3. World Health Organization-World Bank. Global Monitoring Report 2017: Tracking universal health coverage. 2019. http://www.who.int/health- systems-advocacy/materials/who-world-bank-tracking-universal-health-coverage-2017-global-monitoring-report.html. [cited 2020 Jun 9].
4. Reinahardt UE, Cheng TM. The world health report 2000 -- health systems: improving performance. Bull World Health Organ. 2000;78(8):1064.
5. Xu K, Evans DB, Kawabata K, Zeramdini R, Klavus J, Murray CJ. Household catastrophic health expenditure: a multicountry analysis. Lancet. 2003;362(9378):111–7. https://doi.org/10.1016/S0140-6736(03)13861-5.
6. Yazdi-Feyzabadi V, Mehrholz-Masani M, Davishi A. Measuring catastrophic health expenditures and its inequality: evidence from Iran’s health transformation program. Health Policy Plan. 2019;34(4):316–25. https://doi.org/10.1093/heapol/czz031.
7. Guo Y, Shibuya K, Cheng G, Rao K, Lee L, Tang S. Tracking China’s health reform. Lancet. 2010;375(9720):1056–8. https://doi.org/10.1016/S0140-6736(10)60397-2.
8. Yip WC, Hsiao WC, Chen W, Hu S, Ma J, Maynard A. Early appraisal of China’s huge and complex health-care reforms. Lancet. 2012;379(9818):833–42. https://doi.org/10.1016/S0140-6736(11)61880-1.
9. State Council. Decision of the State Council on Establishing a Basic Medical Insurance System for Urban Employees (in Chinese). Beijing: National Ministry of Health 1998. http://www.gov.cn/banshi/2005-08/04/content_8025.htm; 1998.
10. Meng Q, Xu K. Progress and challenges of the rural cooperative medical scheme in China. Bull World Health Organ. 2014;92(6):447–51. https://doi.org/10.2471/BLT.13.131532.
11. State Council. The Guidance of the State Council on the Pilot Project of the Urban Residen Basic Medical Insurance (in Chinese). Beijing: National Ministry of Health 2007. http://www.gov.cn/zwgk/2007-07/24/content_ 695118.htm; 2007.

12. Center for Health Statistics and Information of MOH. An analysis report of 2013 National Health Services Survey in China. Beijing: Union Medical University Press; 2015.

13. Li S-C. All covering medical insurance require systematic arrangement. China Health Insur. 2013;12:35–7.

14. Fu X, Sun Q, Sun CQ, Xu F, He JJ. Urban-rural differences in catastrophic health expenditure among households with chronic non-communicable disease patients: evidence from China family panel studies. BMC Public Health. 2021;21(1):874. https://doi.org/10.1186/s12889-021-10887-6.

15. Wang H-P, Wang Z-T, Ma P-C. Situation analysis and thinking about poverty caused by illness in rural areas: based on research data of 1214 families whose poverty is caused by illness in 9 provinces in West China. Economist. 2016;107:81.

16. Jia L-R, Liu Y-S, Liu J-L, Li J-T. Study on the poverty causes and aid demands of poor rural households in the concentrated poverty-stricken areas in China. Hum Geogr. 2018;33(1):85–94+151.

17. Zhao Y, Oldenburg B, Mahal A, Lin YQ, Tang SL, Liu YX. Trends and socio-economic disparities in catastrophic health expenditure and health impoverishment in China: 2010 to 2016. Trop Med Int Health. 2020;25(2): 236–247.

18. National Bureau of Statistics of China. China statistical Yearbook. Beijing: China Statistics Press; 2021. p. 2021.

19. Rahman MM, Gilmour S, Saito E, Sultan A, Shibuya K. Health-related financial catastrophe, inequality and chronic illness in Bangladesh. PLoS One. 2013;8(2):e56873. https://doi.org/10.1371/journal.pone.0056873.

20. Choi JW, Choi JW, Kim JH, Yoo KB, Park EC. Association between chronic disease and catastrophic health expenditure in Korea. BMC Health Serv Res. 2015;15(1):265. https://doi.org/10.1186/s12913-014-0675-1.

21. Bhogari U, Thivenin B, Devadasan R, Munegovda C, Devadasan N, Kolsteren P, et al. Out-of-pocket healthcare payments on chronic conditions impoverish urban poor in Bangalore, India. BMC Public Health. 2012;12(1): 990. https://doi.org/10.1186/1471-2458-12-990.

22. Xu Y, Gao J, Zhou Z, Xue Q, Yang J, Luo H, et al. Measurement and explanation of socioeconomic inequality in catastrophic health care expenditure: evidence from the rural areas of Shanxi Province. BMC Health Serv Res. 2015;15(1):256. https://doi.org/10.1186/s12913-015-0892-2.

23. Yang T, Chu J, Zhou C, Medina A, Li Q, Jiang S, et al. Catastrophic health expenditure: a comparative analysis of empty-nest and non-empty-nest households with seniors in Shandong, China. BMJ Open. 2016;6(7):e010992. https://doi.org/10.1136/bmjopen-2015-010992.

24. Guo N, Velsen T, Lu M, Wang J, Shi L. Does the new cooperative medical scheme reduce inequality in catastrophic health expenditure in rural China? BMC Health Serv Res. 2016;16(1):653. https://doi.org/10.1186/s12913-016-1883-7.

25. Li A, Shi Y, Yang X, Wang Z. Effect of critical illness insurance on household catastrophic health expenditure: the latest evidence from the National Health Service survey in China. Int J Environ Res Public Health. 2019;16(24) https://doi.org/10.3390/ijerph16245086.

26. Saksena P, Hsu J, Evans D. Financial risk protection and universal health coverage: evidence and measurement challenges. PLoS Med. 2014;11(9): e1001701. https://doi.org/10.1371/journal.pmed.1001701.

27. Wagstaff A, Flores G, Hsu J, Smitz MF, Chepynoga K, Buismann LR, et al. Progress on catastrophic health spending in 133 countries: a retrospective observational study. Lancet Glob Health. 2018;6(6):e169–79. https://doi.org/10.1016/S2214-109X(17)30429-9.

28. Wagstaff A, van Doorslaer E. Catastrophe and impoverishment in paying for health care: with applications to Vietnam 1993-1998. Health Econ. 2003; 12(11):921–34. https://doi.org/10.1002/hec.776.

29. O’Donnell O, Doorslaer E, Wagstaff A, Lindelow M. Analyzing health equity using household survey data: a guide to techniques and their implementation. 2008. https://doi.org/10.1142/978-981-27-6933-3.

30. Wagstaff A, Lindelow M. Can insurance increase financial risk? The curious case of health insurance in China. J Health Econ. 2008;27(4):990–1005. https://doi.org/10.1016/j.jhealeco.2008.02.002.

31. Wang Z, Li X, Chen M. Catastrophic health expenditures and its inequality in elderly households with chronic disease patients in China. Int J Equity Health. 2015;14(1):8. https://doi.org/10.1186/s12939-015-0134-6.