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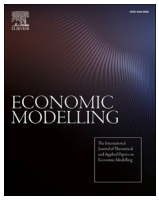

Examining the level and distribution of catastrophic health expenditure from 2013 to 2018: A province-level study in China☆

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ABSTRACT

Since 2018, 96.8% of China's population has received universal health coverage; however, changes in the general population's level and distribution of catastrophic health expenditure (CHE) remain unclear. This study aims to quantify the incidence and intensity of CHE by adopting a multistage stratified random sampling procedure that used a threshold of 25% of non-food household expenditures. We use the concentration index to measure the extent of inequality in CHE. Furthermore, logistic regression was applied to identify the socio-demographic and economic determinants of CHE, thereby revealing that the incidence and intensity of CHE increased between 2013 and 2018. A greater concentration of CHE was identified in low-income households. Our results imply that expanding the existing public health insurance benefit packages and introducing universal supplementary private insurance to more population segments is necessary.

1. Introduction

Out-of-pocket (OOP) health payments and inadequate prepayment systems for health care have been standard features in low- and middle-income countries for many years (Dalui et al., 2020; Hernández-Vásquez et al., 2020). Even in countries with full health insurance coverage, OOP payments have increased households' financial burdens while reducing their welfare (Zhang and Rahman, 2020). High levels of OOP expenditure have forced some households to cut back on non-medical goods and services and to sell assets, placing them at risk of being trapped in long-term debt and compromising their standard of living and economic prospects (Van Doorslaer et al., 2007). A cross-country analysis of 89 countries showed that 150 million people globally suffer from a financial catastrophe yearly related to healthcare costs (Xu et al., 2007). This figure is based on a criterion in which catastrophic health expenditure (CHE) is defined by a threshold level of OOP costs over annual disposal household income of 40%.

The World Health Organization (WHO) has called for universal health coverage (UHC), encouraging the removal of financial barriers to healthcare through the prepayment and pooling of funds earmarked for health (World Health Organization, 2010). Moreover, the United Nations Sustainable Development Goals noted that achieving UHC included financial risk protection, access to quality essential healthcare services, and safe, effective, quality, and affordable essential medicines and vaccines for all (United Nations, 2015).

Although China began establishing public health insurance in 1998, the first health insurance scheme—Urban Employee Basic Medical Insurance (UEBMI)—only covered formal workers and retirees in the

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urban public sector, such as government departments and state and collectively owned enterprises. Those not working in urban areas and residents of rural areas were generally not covered by any health insurance; thus, coupled with the adoption of advanced medical technologies and economic inflation, most of China's population had no protection against the high and growing costs of health care. The 2000 World Health Report pointed out that, compared to other WHO member countries, China had very high per capita healthcare expenditure (World Health Organization, 2000). OOP payments, as a proportion of total expenditure on health (TEH), reached their peak in 2000 at 58.98% (National Health Development Research Center of China, 2013). China's government reported that 5.42 million households in 2003 and 13.41 million in 2008 fell into poverty due to the cost of medical care (China's Ministry of Health, 2004; 2009).

The first decade of the 21st century saw far-reaching reforms in China's health sector, particularly in the healthcare financing system. Rural health insurance organized at the prefecture level—the New Rural Cooperative Medical Scheme (NRCMS)—was piloted in 2003; NRCMS was officially implemented in 2005 to meet the needs of the rural population. In 2007, Urban Resident Basic Medical Insurance (URBMI) was piloted to provide coverage for unemployed urban residents who were ineligible for the UEBMI scheme. Target groups for the URBMI scheme included the elderly, children, people with disabilities, laid-off workers, and other non-working urban residents.

In 2009, to provide affordable and equitable healthcare for citizens, the Chinese government announced a healthcare reform plan to achieve UHC by expanding public health insurance schemes to provide coverage for the general population (Chen, 2009). Since then, the coverage of UEBMI has gradually expanded to all types of workers, including migrant, self-employed, and laid-off workers. Over the same period, URBMI and NRCMS also provided healthcare coverage to eligible individuals. In addition to public health insurance, private health insurance has increased since 2014. The State Council of China issued the Opinions on Accelerating Development of Private Health Insurance in October 2014. Additionally, China City Medicare—a private insurance plan that was made and implemented for urban citizens—was subsequently implemented for critical and catastrophic disease patients (China's State Council, 2014).

Since 2016, to remove disparities in such a segmented health insurance system, China has begun introducing Urban–Rural Resident Basic Medical Insurance (URRBMI) by integrating the URBMI and NRCMS. URRBMI has a unified funding pool, one reimbursement rate, and one basic medical insurance list (Pan et al., 2016).

Since 2018, UHC has ostensibly been achieved in China, with 96.8% of the population covered by public health insurance schemes (National Health Commission of China, 2018). In addition, OOP expenditure (as a percentage of TEH) decreased from 40.42% in 2008 to 28.61% in 2018. Furthermore, public health insurance spending (as a percentage of TEH) increased from 34.85% in 2008 to 43.66% in 2018 (National Bureau of Statistics of China, 2019).

The health care financing mechanism differed among health insurance schemes. UEBMI contributions were financed by the employer and the employee, representing about 6% and 2% of the employee's salary, respectively). For URBMI, NRCMS, and URRBMI, each enrollee was required to pay the same premium, augmented with a government subsidy. Significant disparities exist in terms of financial risk protection among health insurance schemes. UEBMI has premiums 10 times higher than those of NRCMS and URBMI; consequently, UEBMI has a higher reimbursement level than both (Yip et al., 2012). The OOP expenditure of UEBMI was the lowest (15% on average in 2015), indicating a stronger capacity for compensation. The reimbursement level of NRCMS (OOP expenditure of 25% on average in 2015) and URBMI (OOP expenditure of 30% on average in 2015) was inferior to that of UEBMI (Li et al., 2020). In addition, China's central government launched critical illness insurance in 2016 to protect urban and rural residents against excessive medical expenses. This critical illness insurance covered the enrollees of URBMI and NRCMS and reimbursed those with critical illnesses for very high medical costs after reimbursement from URBMI or NRCMS. The total reimbursement rate was no less than 50% when medical bills after reimbursement exceeded annual per capita income levels (Li et al., 2019).

Nonetheless, previous studies on the impact of health insurance on CHE in China found that health insurance schemes may play a limited role in protecting households from CHE. A longitudinal study conducted from 2003 to 2005 by China's Ministry of Health and the World Bank indicated that per capita hospitalization costs increased by 30% after people were insured (China's Ministry of Health, 2007). Wagstaff et al. (2008) suggested that people with health insurance in China tended to seek care in higher-level health institutions more frequently than the uninsured, which increased the risk of catastrophic spending (Wagstaff and Lindelow, 2008). Li et al. (2014) found that households with NRCMS had similar levels of CHE as those without health insurance (Li et al., 2014). Alongside the achievement of UHC and the reduction of OOP, an increasing concern remains over the catastrophic effects of OOP payments during the progression toward UHC in China.

Our study contributes to the literature in the following ways. First, we evaluate the overall CHE level and assess the impact of implementing UHC on OOP for China's general population. Although many recent studies have measured the prevalence of CHE in China, they focus on a specific vulnerable population rather than the general population. A subpopulation's CHE cannot reflect the accurate level in certain areas and the effect of alleviating the CHE incurred by specific social and economic policies because these policies target the general population. Additionally, the results regarding inequity in CHE are questionable because the specific vulnerable individuals were not socioeconomically equally distributed throughout the general population. Therefore, the measurement of concentration indices on a subpopulation may over- or underestimate inequality in CHE.

Second, we provide updated evidence of the latest trends in CHE. We conducted a literature review and found that CHE trends had not been adequately reported. Although some studies examined CHE trends before 2015, they only reflected changes in CHE concerning specific populations, such as households with chronic disease patients (Fu and Chen, 2022; Jing et al., 2019) or those with elderly members (Liu et al., 2021; Wang et al., 2015).

Finally, our study has significant policy relevance. Current public health insurance schemes cannot meet the needs of the most vulnerable groups and households with lower socioeconomic standings that face higher levels of CHE. However, China City Medicare, a universal private insurance provider with low premiums and an attractive benefits package, provides adequate financial protection against CHE. These findings help us understand the importance of establishing and expanding private health insurance during China's progression toward UHC.

The remainder of this paper is organized as follows. Section 2 includes a literature review of the Chinese CHE studies, Section 3 presents the data, sample, and variables, and Section 4 describes the methodology. Section 5 provides the results, Section 6 presents the discussion, and Section 7 concludes.

2. Related literature

Several Chinese studies on CHE focused on specific vulnerable groups, such as patients with breast cancer (CY Sun et al., 2021a), lung cancer (CY Sun et al., 2021b), pediatric leukemia (Sui et al., 2020), hypertension (Zhang et al., 2020), and tuberculosis (Zhou et al., 2016). These patients were examined irrespective of whether their diseases increased the CHE risk. Wang et al. (2015) found that elderly households with chronic disease patients are more likely to experience CHE than those without chronic disease patients. Furthermore, they determined that the risk of CHE increased when chronic disease patients went to any hospital for either outpatient or inpatient services in rural areas (Wang

et al., 2015). Jing et al. (2019) assessed the occurrence and intensity of CHE related to type 2 diabetes mellitus care in Shandong province, China, finding that patients with complications were more likely to incur CHE (Jing et al., 2019). Many CHE studies regarding chronic disease have focused on the relationship between multimorbidity and CHE. For example, Fu et al. (2022) investigated the association between multimorbidity and CHE among patients with diabetes and those with hypertension in 2013 (Fu and Chen, 2022; Fu et al., 2022). Zhao et al. (2020) found that the effect of multimorbidity on CHE persisted even among the higher socioeconomic groups and across all health insurance schemes in China (Zhao et al., 2020).

Some studies have focused on the relationship between health insurance and CHE. Liang et al. (2012) conducted a systemic review to analyze the effects of NRCMS on alleviating CHE (Liang et al., 2012); however, they presented no clear evidence that NRCMS decreased the risk of CHE in the rural population. Wang et al. (2022) measured the inequity of CHE during the integration of URBMI and NRCMS. They found that the integrated insurance scheme moderately reduced the inequity of CHE; however, it did not effectively reduce the level of CHE (Wang et al., 2020). Zhang et al. (2010) conducted a comparative analysis of the effect of NRCMS on relieving CHE between poor and non-poor individuals in 2005. They found that cost control measures and medical financial assistance helped to reduce the risk of CHE (Zhang et al., 2010).

Other studies have recorded the change in CHE during a specified period. Song et al. (2020) examined the long-run trends in CHE during the transition from the market-oriented to the government-led healthcare financing systems during 1986–2009. They found that income and regional inequality in CHE increased from 1986 to 2002; although this gap narrowed after 2002, it remained wide (Song et al., 2020). Xu et al. (2018) conducted a pre-post comparison of CHE in households with chronic disease patients between 2008 and 2013. They evaluated its effect on alleviating the CHE incurred by China's health sector reform in 2009 (Xu et al., 2018). Similarly, Liu et al. (2021) measured the prevalence of CHE in households with elderly members in 2011, 2013, and 2015 (Liu et al., 2021).

Although many studies have evaluated CHE in China, investigating the prevalence and inequality of CHE for the general population has drawn relatively little attention in recent years. Therefore, this study seeks to evaluate the trends in CHE and its inequality through household surveys conducted in 2013 and 2018. Our three main objectives are to (1) measure the incidence and intensity of CHE each year, (2) estimate the inequalities in the distribution of CHE, and (3) explore its demographic and socioeconomic determinants. This in-depth analysis will help decision-makers adjust UHC policies and formulate specific policy actions for poverty alleviation related to the healthcare financing system in China. To the best of the authors' knowledge, our work is the first to investigate the level, distribution, and trend of CHE during China's progression toward UHC and explore the related sociodemographic and economic factors of CHE.

3. Data

3.1. Study site

We conducted our study in China's Jiangsu province, located in the southeast of China, an economically developed province with more than 85 million people. In 2018, the per capita gross domestic product (GDP) was 16,699.61 US dollars (National Bureau of Statistics of China.), and Jiangsu province is characterized by its rich health resources and progression toward UHC (Chen et al., 2020). As one of the first provinces piloting UEBMI, national health insurance policies—including coverage, benefits packages, and integrating different insurance schemes—were strictly implemented under central government guidance.

3.2. Sampling and data sources

Two rounds of China's National Health Services Survey (NHSS) were conducted in Jiangsu province in 2013 and 2018, respectively. These surveys recorded basic household information, healthcare use, and household members' expenditures. NHSS used a multistage stratified random sampling procedure. The six cities and counties were selected from the north, middle, and south of Jiangsu province, respectively, representing relatively low, moderate, and high levels of economic development, respectively. Five communities or towns were selected in each city or county based on their economic status and geographic distribution. We then selected two neighborhoods or villages from each community or town. In each neighborhood or village, 60 households were selected. Overall, we collected data on 3600 households comprising 10,466 individuals in 2013 and 3660 households comprising 11,549 individuals in 2018. Tables 1 and 2 present the descriptive statistics and socioeconomic characteristics of the sampled households in urban and rural, respectively.

We collected extensive information about each household's demographic and socioeconomic characteristics, including household expenditure, rural/urban classification, number of family members, gender, age, educational attainment, work status of household members, and household goods. During an interview, data collectors acquired data regarding household expenditures on food, clothing, transport, communication, housing, water, electricity, fuel, education, travel, entertainment, OOP, and other expenses during the previous 12 months. OOP expense refers to the costs incurred on the diagnosis, prevention, parturition, prescription, and treatment of disease, illness, injury, and other mental impairments. Expenses reimbursed by insurance schemes were excluded.

Trained data collectors interviewed household heads and permanent household members. They obtained information regarding household affairs from the household head or another member familiar with them. Personal information was obtained from each household member. For disabled individuals and children, guardians provided information to

Table 1
Descriptive statistics and socioeconomic characteristics of the sampled households in urban areas.

	2013	2018
No. of household	1800	1860
Age group		
0–45 years	41.31%	49.03%
45–60 years	28.03%	21.25%
60+ years	30.66%	29.71%
Median of household expenditure[a]	US$ 6592.69	US$ 7555.84
Median of household OOP expenditure	US$ 334.99	US$ 604.47
Median of household catastrophic health expenditure	US$ 1004.98	US$ 1511.17
Public health insurance		
UEBMI	70.61%	68.33%
URBMI	27.39%	24.57%
URRBMI	N.A.[b]	0.00%
NRCMS	0.00%	4.78%
None	2.00%	2.31%
Private health insurance		
Any	4.44%	25.91%
None	95.56%	74.09%
Proportion of households with chronic disease patients	67.72%	65.54%
Proportion of households with older people aged 65 years and above	42.61%	41.40%

UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance; URRBMI, Urban–Rural Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme.

[a] All expenditures have been adjusted to real prices in year 2018 using China's Consumer Price Index.

[b] URRBMI was officially established in 2016.

Table 2
Descriptive statistics and socioeconomic characteristics of the sampled households in rural areas.

	2013	2018
No. of household	1800	1800
Age group		
0–45 years	49.02%	44.23%
45–60 years	28.97%	29.97%
60+ years	22.00%	25.80%
Median of household expenditure[a]	US$ 3847.97	US$ 4533.50
Median of household OOP expenditure	US$ 165.86	US$ 377.79
Median of household catastrophic health expenditure	US$ 1658.61	US$ 1057.82
Public health insurance		
UEBMI	0.00%	16.06%
URBMI	0.00%	1.11%
URRBMI	N.A.[b]	81.28%
NRCMS	97.56%	0.00%
None	2.44%	1.56%
Private health insurance		
Any	32.44%	26.61%
None	67.56%	73.39%
Proportion of households with chronic disease patients	50.22%	66.78%
Proportion of households with older people aged 65 years and above	32.33%	37.06%

UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance; URRBMI, Urban–Rural Resident Basic Medical Insurance; NRCMS, New Rural Cooperative Medical Scheme.

[a] All expenditures have been adjusted to real prices in year 2018 by using China's Consumer Price Index.

[b] URRBMI was officially established in 2016.

the data collectors.

4. Methods

4.1. Measuring CHE incidence and intensity

Two key variables underlying CHE were total household OOP expenditure and total household expenditure (Hailemichael et al., 2019; Rezaei and Hajizadeh, 2019). The incidence of CHE was calculated from the proportion of households with OOP healthcare expenditures as a proportion of total household expenditure over a defined threshold (Wagstaff and Van Doorslaer, 2003). We used two comparisons for these estimates: OOP expenditure compared to total household expenditure (Wagstaff and Van Doorslaer, 2003) and OOP expenditure compared to total non-food expenditure (Xu et al., 2003). This study used household expenditure net of food spending as the indicator of living standards following the World Bank's view that non-food expenditure may be better than total household expenditure to distinguish between rich and poor households (O'Donnell and Wagstaff, 2008).

We compared OOP expenditure with household expenditure to assess whether the household faced CHE at different thresholds. This study categorized households with 25% of non-food household expenditures on healthcare as households with CHE (Wagstaff and Van Doorslaer, 2003). The percentage of households that incurred CHE was termed the catastrophic head count. The CHE incidence did not reflect how much households exceeded the threshold, so the CHE intensity was estimated using an index of overshoot (O) and mean positive overshoot (MPO). O measured the degree by which average OOP expenditure exceeded the threshold, and MPO represented the degree by which the average OOP expenditure of a household exceeded the threshold.

4.2. Estimating inequality in CHE

Inequality in CHE was measured by the concentration index (C), widely used to measure inequalities in various variables of health and healthcare (O'Donnell and Wagstaff, 2008; Rezaei et al., 2019). C shows the degree of inequality of CHE across income levels. Computing C requires comparing covariance between variables and fractional household ranks according to the ability to pay (ATP). We used the total household expenditure as the measurement of ATP. An adjustment was made for the size and age structure of the household by applying an equivalence scale to ATP. Per capita household expenditure adjusted by adult equivalence was used as the measure of ATP in our study (O'Donnell and Wagstaff, 2008). The scale used was expressed by:

$$AE = (A + \alpha K)^{\beta}$$

where A was the number of adults in the household and K was the number of children (0–14 years). α was the cost of children, and the β was the degree of economies of scale. The α and β values were assumed to be 0.5 and 0.75, respectively (O'Donnell and Wagstaff, 2008).

C estimates were obtained using ordinary least squares (OLS) regression of the variables of ATP and the incidence and intensity of CHE on the fractional rank in the ATP distribution (O'Donnell and Wagstaff, 2008).

$$2\sigma_{\gamma}^{2}\left(\frac{h_i}{\mu}\right) = \alpha + \beta\gamma_i + \varepsilon_i$$

where γ_i is the fractional household rank according to the ATP distribution, and σ_{γ}^{2} is the variance. h_i is the headcount or O of CHE for household i, and μ is an estimate of its mean. The OLS estimate of β is an estimate of C (O'Donnell and Wagstaff, 2008). A positive C value indicates that poor households have a lower probability of incurring CHE; thus, the distribution here is "pro-poor" (Rezaei et al., 2020).

4.3. Dominance test

A dominance test was conducted to determine whether the concentration curve of CHE in one year lies entirely above that in another year in this study. For the dominance tests, the standard errors and differences between ordinates were computed to allow between-curve dependence where appropriate. We adopted a multiple comparison approach to testing, with the null hypothesis defined as a lack of distinguishable difference between curves, which was tested against the dominance and crossing of curves. The null hypothesis was rejected in favor of dominance in the presence of at least one significant difference between the ordinates of the two curves in one direction. There was no significant difference in the other direction across 19 equidistant quintile points (from 0.05 to 0.95). The null hypothesis was rejected in favor of crossing if there was at least one significant difference in each direction (O'Donnell and Wagstaff, 2008).

A dominance test was conducted to investigate whether CHE inequality fell during 2013–2018. Inequality can be visually demonstrated to have been reduced when the concentration curve in 2013 lies above that in 2018.

4.4. Determinants of CHE

Logistic regression analysis was conducted to estimate the association between outcomes (i.e., a case of CHE) and a range of sociodemographic and economic variables, including urban–rural classification, economic status, insurance type, household members under 14 years of age, household members over 65 years of age, household members with chronic diseases, household members having had surgery in the last 12 months, households with working-age female members, one or more smokers, one or more members having had annual health check-ups, one or more members exercising regularly, and household size (Rezaei et al., 2019; Wang et al., 2015). The outcome variable was constructed as a dichotomous variable where 1 and 0 denoted households facing and not facing CHE, respectively (Piroozi et al., 2019).

4.5. Sensitivity analyses

Sensitivity analyses were conducted using 10% and 40% CHE thresholds, and we evaluated the impact of using these thresholds on the incidence, intensity, and determinants of CHE.

5. Results

5.1. CHE incidence and intensity increased from 2013 to 2018

Table 3 presents the CHE incidence and intensity in 2013 and 2018 in urban and rural areas. Overall, CHE incidence and intensity increased from 2013 to 2018. In urban areas, CHE incidence was 27.50% in 2013 and 34.52% in 2018; CHE intensity was 7.06% in 2013 and 8.57% in 2018. These findings were similar for rural areas. In urban areas, MPO was 25.66% in 2013 and 24.83% in 2018, while in rural areas, MPO was 24.21% and 27.24% in 2013 and 2018, respectively. For each quintile, CHE incidence and intensity increased among all quintiles from 2013 to 2018 in urban and rural areas.

Table 3
Incidence and intensity of CHE in 2013 and 2018.

Catastrophic payments measures	Urban	Rural
Head count		
Year 2013		
1-poorest	35.28%	43.61%
2	30.56%	18.61%
3	23.33%	14.40%
	26.67%	11.42%
5-richest	21.67%	20.56%
Total	27.50%	21.72%
standard error	(1.05%)	(0.97%)
C	−0.0997***	−0.2148***
95% CI	(-0.1428, −0.0566)	(-0.2645, −0.1651)
Year 2018		
1-poorest	48.92%	50.00%
2	39.78%	42.29%
3	30.91%	29.76%
4	30.83%	28.17%
5-richest	22.10%	29.56%
Total	34.52%	35.89%
standard error	(1.10%)	(1.13%)
C	−0.1592***	−0.1266***
95% CI	(-0.1947, −0.1237)	(-0.1618, −0.0914)
Overshoot		
Year 2013		
1-poorest	8.47%	10.47%
2	6.64%	4.33%
3	6.53%	2.46%
4	6.33%	2.77%
5-richest	7.31%	6.26%
Total	7.06%	5.26%
standard error	(0.36%)	(0.32%)
MPO	25.66%	24.21%
standard error	(0.89%)	(0.97%)
C	−0.0358	−0.1635***
95% CI	(-0.0942,0.0226)	(-0.2312, −0.0959)
Year 2018		
1-poorest	12.35%	12.01%
2	9.35%	11.54%
3	7.53%	7.15%
4	8.13%	6.85%
5-richest	5.50%	11.43%
Total	8.57%	9.78%
standard error	(0.37%)	(0.41%)
MPO	24.83%	27.24%
standard error	(0.71%)	(0.75%)
C	−0.1498***	−0.0410
95% CI	(-0.1979, −0.1018)	(-0.0885, 0.0064)
Dominance test		
Head count	None	D+
Overshoot	D−	D+

C, concentration index.
*p < 0.05, **p < 0.01, ***p < 0.001.
D+/D− indicates that the concentration curve in 2013 dominates (is dominated by) the concentration curve in 2018. None indicate that non-dominance between the concentration curves cannot be rejected.

5.2. Poor households had a higher probability of incurring CHE than rich households

The CHE incidence and intensity Cs were negative in urban and rural areas. Those in urban areas (2013) and rural areas (2018) were not statistically significant. These results indicated that poor households have a higher probability of incurring CHE than rich households. Figs. 1–4 illustrate the concentration curves of CHE in 2013 and 2018 in urban and rural areas, respectively.

5.3. Rural poor households had a higher probability of facing CHE compared with urban poor households during 2013–2018

The Cs of CHE incidence and intensity decreased from 2013 to 2018 in urban areas, indicating that poor households had a higher probability of facing CHE during this period. In contrast, in urban areas, CHE incidence and intensity increased from 2013 to 2018, indicating that poor households had a lower probability of facing CHE during this period.

5.4. Dominance test

We conducted a dominance test to determine whether CHE inequality fell during 2013–2018 (Table 3). In rural areas, the concentration curves in 2013 dominated those in 2018 for CHE incidence and intensity, indicating that CHE inequality decreased over this period. Urban areas showed no statistically significant dominance for the concentration curve of CHE incidence between 2013 and 2018. The 2013 concentration curve of CHE intensity was dominated by that in 2018, indicating that CHE inequality increased over this period.

5.5. Determinants of CHE

Tables 4 and 5 show the regression results of related sociodemographic and economic factors of CHE in 2013 and 2018 in urban and rural areas, respectively. In general, households at higher economic levels had significantly reduced CHE. Household size reduced the probability of incurring CHE, indicating that CHE was more likely to occur in smaller households. Households with working-age female members had a lower probability of incurring CHE. The likelihood of facing CHE was higher for households with chronically ill patients and those with elderly members. Households with a member who had undergone surgery in the last 12 months had a significantly increased probability of incurring CHE. CHE was more likely to occur in rural households in 2018, while this rural–urban difference was not statistically significant in 2013. Households with children had an increased probability of incurring CHE in 2013; however, this factor was no longer statistically significant in 2018. For the factors positively correlated with CHE, their odds ratio (OR) values decreased from 2013 to 2018.

Households with private health insurance did not face CHE in either year. CHE was less likely to occur in households with URRBMI than in those with URBMI or NRCMS.

5.6. Sensitivity analysis

Sensitivity analysis at the 10% and 40% thresholds showed that the CHE incidence and intensity increased from 2013 to 2018. When 10% was chosen as the CHE threshold, all CHE incidence and intensity Cs were negative ($p < 0.05$). When 40% was chosen as the CHE threshold, the Cs of CHE intensity in urban areas (2013) and rural areas (2018) were positive ($p > 0.05$), and other Cs were negative ($p < 0.05$). The association between outcomes (i.e., a case of CHE) and a range of sociodemographic and economic factors were not changed when the

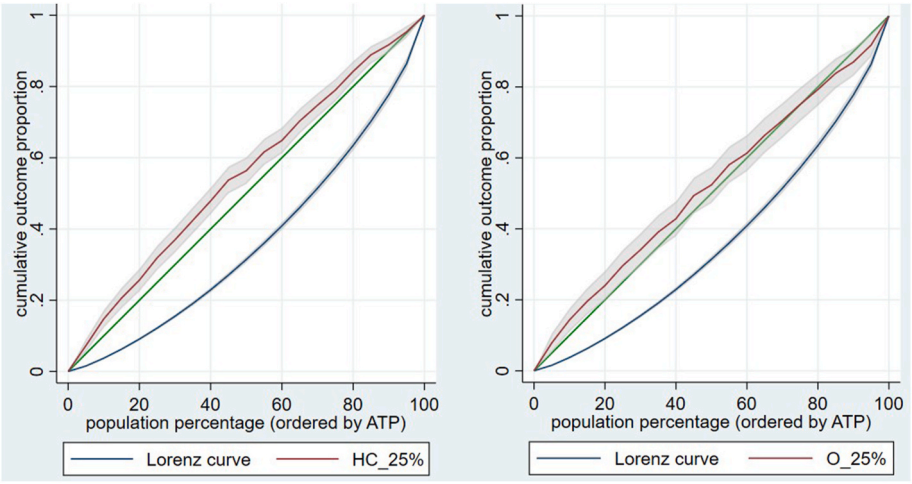

Fig. 1. Concentration curves for incidence and intensity of catastrophic healthcare and Lorenz curves (with 95% CIs) in urban areas in 2013.

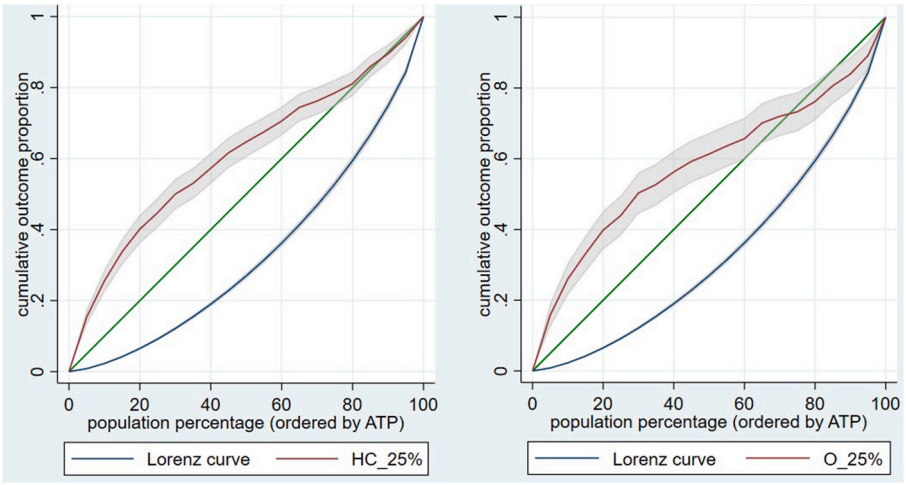

Fig. 2. Concentration curves for incidence and intensity of catastrophic healthcare and Lorenz curves (with 95% CIs) in rural areas in 2013.

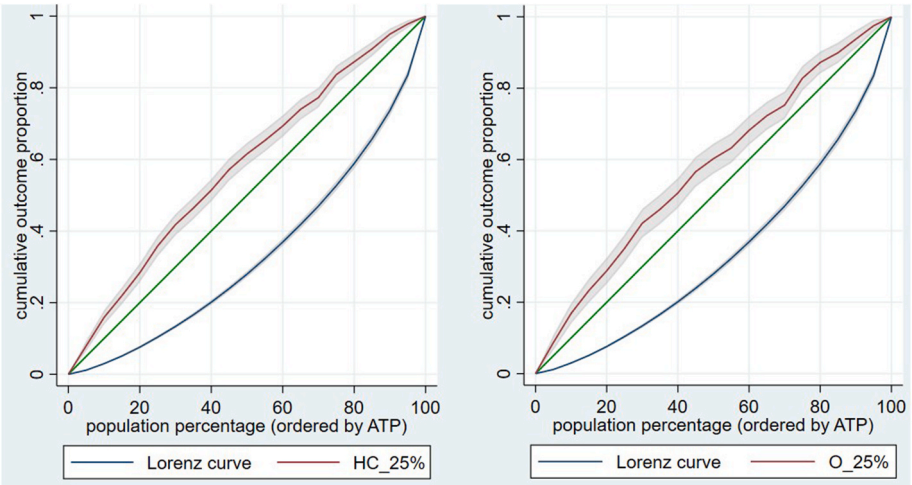

Fig. 3. Concentration curves for incidence and intensity of catastrophic healthcare and Lorenz curves (with 95% CIs) in urban areas in 2018.

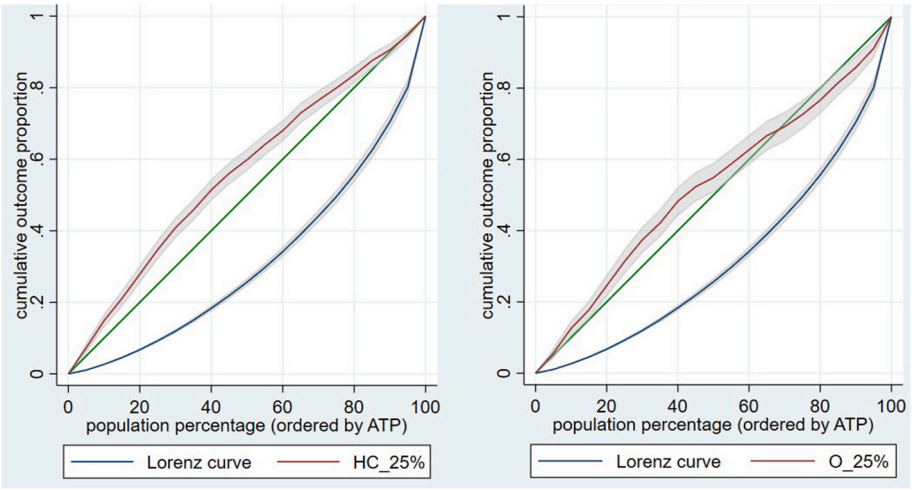

Fig. 4. Concentration curves for the incidence and intensity of catastrophic healthcare and Lorenz curves (with 95% CIs) in rural areas in 2018.

Table 4
Association between determinants and CHE in urban areas.

Variables	Description	2013		2018	
		OR	95% CI	OR	95% CI
SES quintile	2nd (Ref = Poorest)	0.9624	(0.6761, 1.3699)	0.7809	(0.5632, 1.0829)
	3rd (Ref = Poorest)	0.5929**	(0.4089, 0.8596)	0.5155***	(0.3667, 0.7248)
	4th (Ref = Poorest)	0.6768*	(0.4679, 0.9790)	0.5083***	(0.3583, 0.7211)
	Richest (Ref = Poorest)	0.5142***	(0.3473, 0.7613)	0.4051***	(0.2767, 0.5931)
Household with public health insurance	URBMI (Ref = UEBMI)	1.0390	(0.7843, 1.3764)	1.3177*	(1.0219, 1.6992)
Household with private health insurance	Ref = No private health insurance	0.8804	(0.5605, 1.3827)	0.6929*	(0.5207, 0.9220)
Household members with chronic diseases	Ref = No household member with chronic diseases	2.4081***	(1.7977, 3.2257)	2.5429***	(1.9205, 3.3672)
One or more household members aged 65 years and above	Ref = No household member aged 65 years and above	1.6540***	(1.2905, 2.1200)	1.0322	(0.8052, 1.3232)
Household with child under 14 years of age	Ref = Household without child under 14 years of age	1.2148	(0.8088, 1.8245)	0.9676	(0.6976, 1.3422)
Household with working age female member	Ref = Household without productive age female member	0.4023***	(0.2937, 0.5510)	0.5598***	(0.4159, 0.7536)
Household member has undergone surgery in the last 12 months	Ref = No household member has undergone surgery in the last 12 months	5.6849***	(3.8439, 8.4076)	3.6790***	(2.7009, 5.0113)
One or more household members are smokers	Ref = No household member is a smoker	0.8262	(0.6462, 1.0562)	0.7959*	(0.6351, 0.9974)
One or more household members has undergone annual health check-ups	Ref = No household member has undergone annual health check-ups	0.9728	(0.7356, 1.2866)	1.4486*	(1.0283, 2.0407)
One or more household members exercises regularly	Ref = No household member exercises regularly	1.5303**	(1.1543, 2.0287)	1.2846	(0.9956, 1.6574)
Household size	3–4 persons (Ref = 1–2 persons)	0.6596*	(0.4759, 0.9144)	0.8727	(0.6333, 1.2025)
	5 persons or more (Ref = 1–2 persons)	0.6189	(0.3539, 1.0826)	1.0337	(0.6467, 1.624)

*p < 0.05, **p < 0.01, ***p < 0.001. OR, odds ratio. Descriptive statistics and definitions of all variables are provided in Appendix Tables A1 and A3.

10% or 40% threshold was chosen as the CHE threshold; however, statistical significance was different for some factors (see Tables A4–A9).

6. Discussion

The incidence and intensity of CHE increased during 2013–2018 in urban and rural areas. This was largely unexpected because most of the population had been covered by public health insurance schemes by 2018. There has been a steady increase in population coverage since 2010, when the WHO highlighted this progress toward universal coverage (World Health Organization, 2010). One potential explanation for the rise in CHE is the inadequate compensation policies and benefits packages of public health insurance schemes leading to high co-payments and many services not being covered. For example, surgery was highly associated with CHE, suggesting incomplete coverage for associated costs. A study of health insurance in China found that while health insurance increased healthcare use, the risk of CHE also increased (JL Sun et al., 2021).

The increase in CHE may also be driven by low production efficiency, the increasing healthcare utilization rate, and new technology in China's healthcare sector (Wang and Chen, 2021; Yan et al., 2022). Based on Baumol's cost disease theory, the healthcare sector is a typical

Table 5
Association between determinants and CHE in rural areas.

Variables	Description	2013		2018	
		OR	95% CI	OR	95% CI
SES quintile	2nd (Ref = Poorest)	0.3727***	(0.2549, 0.5449)	0.8147	(0.5901, 1.1248)
	3rd (Ref = Poorest)	0.2824***	(0.1878, 0.4248)	0.4852***	(0.3479, 0.6766)
	4th (Ref = Poorest)	0.2245***	(0.1455, 0.3465)	0.4649***	(0.3301, 0.6547)
	Richest (Ref = Poorest)	0.4339***	(0.2934, 0.6416)	0.4170***	(0.2968, 0.5860)
Household with private health insurance	Ref = No private health insurance	0.9060	(0.6800, 1.2070)	0.9190	(0.7352, 1.1487)
Household members with chronic diseases	Ref = No household member with chronic diseases	3.8195***	(2.8806, 5.0644)	3.0878***	(2.4059, 3.9630)
One or more household members aged 65 years and above	Ref = No household member aged 65 years and above	1.8419***	(1.3842, 2.4508)	1.5292***	(1.2058, 1.9393)
Household with child under 14 years of age	Ref = Household without child under 14 years of age	1.9014**	(1.2093, 2.9895)	1.2434	(0.9033, 1.7115)
Household with working age female member	Ref = Household without productive age female member	0.6387**	(0.4573, 0.8921)	0.6831**	(0.5272, 0.8850)
Household member has undergone surgery in the last 12 months	Ref = No household member has undergone surgery in the last 12 months	3.7203***	(2.4576, 5.6318)	2.8783***	(2.0836, 3.9762)
One or more household members are smokers	Ref = No household member is a smoker	0.7726*	(0.5970, 0.9999)	1.1140	(0.8970, 1.3834)
One or more household members has undergone annual health check-ups	Ref = No household member has undergone annual health check-ups	0.8884	(0.6695, 1.1790)	1.2654	(0.9708, 1.6494)
One or more household members exercises regularly	Ref = No household member exercises regularly	1.1533	(0.6386, 2.0828)	0.9623	(0.6935, 1.3353)
Household size	3–4 persons (Ref = 1–2 persons)	0.3007***	(0.2055, 0.4400)	0.5299***	(0.3926, 0.7152)
	5 persons or more (Ref = 1–2 persons)	0.2124***	(0.1190, 0.3789)	0.4680***	(0.3102, 0.7061)

[a] URRBMI was officially established in 2016.
*p < 0.05, **p < 0.01, ***p < 0.001. OR, odds ratio. Descriptive statistics and definitions of all variables are provided in Appendix Tables A2 and A3.

non-progressive sector that is more labor-intensive than other sectors. Labor in high-income areas tends to have low efficiency in the health sector, leading to increased healthcare costs (Baumol, 1993). In the past few decades, the rate of wage growth outstripped that of healthcare output, reflecting the relatively low output efficiency but the increased cost of healthcare services. Consequently, the increase in healthcare utilization may also contribute to more CHE in households seeking healthcare services. Furthermore, innovative technology was an important driver of healthcare costs. With the advancement of new medical technologies, hospitals have continuously increased their investment in new high-tech equipment, resulting in increased medical costs. In addition, innovative technology was also an important driver of those costs (Wang and Chen, 2021).

One important explanation of these findings is that there may have previously been high levels of unmet needs. Furthermore, with programs to promote UHC, people who may not have otherwise sought care (due to cost or other access barriers) may have done so and incurred CHE. A study that quantified the increases in medical expenditure between 2008 and 2018 in China showed that service volume was associated with a 57.2% increase in TEH in outpatient services and 67.4% in inpatient services (Yan et al., 2022). The growth rate of TEH was generally faster than that of GDP during 2013–2018. The growth ratio of TEH to GDP was 1.31 in 2013 and 1.27 in 2018 (National Health Development Research Center of China, 2021).

In summary, on average, household health expenditure as a proportion of total household expenditure increased from 2013 to 2018, and excessive growth of household health expenditure has contributed to the increased likelihood of CHE. Previously, people may have abandoned medical care because of the prospect of high OOP expenditure; thus, they avoided CHE because they did not use health services. With the increased financial protection since 2018, people in the same situation may have elected to utilize health care and thus incurred CHE.

Many countries and regions have reported that CHE is more concentrated among households with a lower socioeconomic status (SES) (Khan et al., 2017; Tomini et al., 2013; Yazdi-Feyzabadi et al., 2019). Thailand is an exception that shows a greater concentration of CHE in high-income households due to the parallel public and private health services system and decreasing OOP expenditure on public health services (Somkotra and Lagrada, 2008). In our Chinese study, as in many other countries (Edmonds and Hajizadeh, 2019; Rezaei et al., 2019, 2020), we found that the concentration of CHE was greater in low-income households. The Cs of CHE incidence and CHE intensity were all negative, thus suggesting pro-poor inequality in CHE, although some CHE intensity Cs were not statistically significant. CHE intensity reflected the amount by which households exceeded the CHE threshold. Compared with CHE incidence, CHE intensity measures access to and the use of healthcare more precisely. Our results imply that CHE intensity tends to be proportionately distributed in all households, thus indicating that healthcare utilization is strongly associated with household economic level.

We found some essential sociodemographic and economic factors to be associated with CHE. Factors such as household economic level and households with working-age female members were correlated with a lower level of CHE in 2013 and 2018. Factors such as households with patients with chronic diseases and households with a member who had had surgery in the last 12 months correlated with higher CHE levels in both years.

Our findings have some important implications. During China's progression toward UHC, households with lower socioeconomic status still face a higher risk of CHE. Although OOP financing in proportion to TEH has decreased recently, the reduction has been too small to protect households against CHE effectively (National Bureau of Statistics of China, 2019). Our results imply that the current public health schemes are not meeting the needs of the most vulnerable population groups. Given the aim of primarily achieving high population coverage (Brown and Theoharides, 2009), benefits packages have not been expanded, and

patients have been faced with significant gaps in coverage and reimbursement levels. In contrast, private health insurance has emerged to protect households against CHE effectively. The experience of China City Medicare has successfully proved that private insurance contributes to the total coverage of UHC and significantly decreases the risk of facing a high health-related economic burden.

Per this study's results, previous studies have demonstrated that private health insurance significantly reduced exposure to CHE for households with gastrointestinal cancer patients (Piroozi et al., 2019). Since 2014, the central government has designed and implemented China City Medicare, a universal private insurance program characterized by its low premiums, attractive benefits, and high coverage. Senile people, catastrophic disease patients, and high-risk workers were allowed to enroll in China City Medicare. Our results show that private health insurance did not significantly affect CHE in either urban or rural areas in 2013. Still, it was correlated with a lower level of CHE in urban areas in 2018. Rural residents were encouraged to enroll in public health insurance schemes such as NRCMS and URRBMI. Although public insurance coverage has been improved in rural areas, it did not provide effective financial protection against CHE. This result implies that public health insurance should focus on basic health care needs. More importantly, it is urgent to establish a universal supplementary private insurance program similar to China City Medicare in rural areas that mirrors its premiums, benefits packages, and coverage. Both public and private health insurance should pay much more attention to chronic diseases. The proportion of households with chronic disease patients increased in rural areas and remained essentially unchanged in urban areas. This phenomenon may be attributed to rapid aging in rural areas and the universal two-child policy. The aging of society increased the proportion of elderly citizens in villages, while the two-child policy decreased their presence in cities. Due to the high prevalence of chronic disease in the aging population, there was an increasing proportion of households with chronic disease patients in rural areas. Although China's public health insurance schemes provided more than 50% reimbursement for ambulatory care for chronic disease patients, these patients were still associated with higher CHE. This result implies that benefit packages should be further expanded and tailored to the needs of chronic disease patients to guard against financial risks.

We note several limitations of this study. Our sample was from Jiangsu in China, one of the NHSS sampling provinces. The sampling method used in this study followed the NHSS; however, it might not capture the selected province's urban/rural and income distribution. Another limitation is that patients' diagnosis of chronic diseases was self-reported, which may underestimate the prevalence of chronic diseases and the number of households with chronic disease patients. Third, we calculate CHE using household OOP and total household expenditure; however, household expenditure includes OOP expenditure. Consequently, households with high OOP expenditure are classified as rich households, which underestimates the level and distribution of CHE for poor households. Fourth, income and expenditure details were gathered through self-reporting; thus, the information may not be accurate. In addition, although some studies have implied that the gender of the head of the household may affect whether it faces CHE (Hailemichael et al., 2019; Rezaei and Hajizadeh, 2019), we did not include this factor in exploring the determinants of CHE.

7. Conclusions

This paper examined the level and distribution of CHE and explored some essential sociodemographic and economic factors associated with CHE during China's progression toward UHC. We measured the incidence and intensity of CHE by using a threshold of 25% of non-food household expenditures, and sensitivity analyses were conducted using a 10% and 40% CHE threshold. In addition, we used the concentration index to measure the extent of inequality in CHE, and logistic regression was employed to identify the sociodemographic and economic determinants of CHE.

The main findings indicated that the incidence and intensity of CHE increased during the progression toward UHC in China. CHE was more concentrated in low-income households, which faced a higher risk of CHE than high-income households. Households with chronic disease patients or members who had had surgery in the last 12 months were associated with higher CHE. Our results imply that the current benefit packages and reimbursement levels of the public health insurance schemes do not effectively protect vulnerable households against CHE. Thus, a universal supplementary private insurance program with low premiums, attractive benefit packages, and high coverage is necessary to meet the diversified healthcare needs of the general population.

Ethical approval

Ethical approval was obtained from the Ethics Committee of Nanjing Medical University (study number 555).

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Declaration of competing interest

The authors declare that there are no competing interests.

Data availability

Data will be made available on request.

Appendix A

Table A1
Descriptive statistics of sociodemographic and economic factors of CHE in urban areas.

Variables	2013	2018
SES quintile		
1st quintile (Poorest)	20.00%	20.00%
2nd quintile	20.00%	20.00%
3rd quintile	20.00%	20.00%
4th quintile	20.00%	20.05%
5th quintile (Richest)	20.00%	19.95%
Households with public health insurance		
UEBMI	70.61%	68.33%
URBMI	27.39%	24.57%
NRCMS	0.00%	4.78%

(*continued on next page*)

Table A1 (*continued*)

Variables	2013	2018
URRBMI	N.A. [a]	0.00%
Uninsured	2.00%	2.31%
Households with private health insurance	9.78%	25.91%
Household members with chronic diseases	67.72%	65.54%
One or more household members aged 65 and above	42.61%	41.40%
Household with a child under 14	22.33%	33.12%
Households with working-age female members	49.89%	49.73%
Household members underwent surgery in the last 12 months	8.17%	14.46%
One or more household members are smokers	51.33%	49.46%
One or more household members undergone annual health check-ups	77.72%	87.15%
One or more household members exercise regularly	73.17%	68.92%
Household size		
1–2 persons	47.78%	41.34%
3–4 persons	37.78%	41.40%
5 persons or more	14.44%	17.26%

[a] URRBMI was officially established in 2016.

Table A2
Descriptive statistics of sociodemographic and economic factors of CHE in rural areas

Variables	2013	2018
SES quintile		
1st quintile (Poorest)	20.00%	20.00%
2nd quintile	20.00%	19.44%
3rd quintile	20.06%	20.72%
4th quintile	19.94%	19.72%
5th quintile (Richest)	20.00%	20.11%
Households with public health insurance		
UEBMI	0.00%	16.06%
URBMI	0.00%	1.11%
NRCMS	97.56%	0.00%
URRBMI	N.A. [a]	81.28%
Uninsured	2.44%	1.56%
Households with private health insurance	32.44%	38.00%
Household members with chronic diseases	50.22%	66.78%
One or more household members aged 65 and above	32.33%	37.06%
Households with a child under 14	31.17%	36.56%
Households with working-age female members	84.28%	74.33%
Household members underwent surgery in the last 12 months	8.00%	11.39%
One or more household members are smokers	52.78%	54.39%
One or more household members undergone annual health check-ups	65.67%	77.72%
One or more household members exercise regularly	95.44%	87.67%
Household size		
1–2 persons	48.28%	41.56%
3–4 persons	34.61%	35.11%
5 persons or more	17.11%	23.33%

[a] URRBMI was officially established in 2016.

Table A3
Variable definitions

Variables	Definition
SES quintile	The households are equally divided into five groups, from the poorest to the richest, according to their equivalent household expenditure.
Households with public health insurance	The types of public health insurance that households enroll in include UEBMI, URBMI, NRCMS, and URRBMI.
Households with private health insurance	A household with private health insurance is a dummy taking value one if any member in a household enrolls in private health insurance and zero otherwise.
Household members with chronic diseases	A member of a household is a chronic disease patient, as diagnosed by doctors.
One or more household members aged 65 years and above	Any member in a household aged 65 years and above
Households with a child under 14 years of age	Any member in a household aged 14 years and under
Households with a working-age female member	Any female member in a household currently has a job.
A household member has undergone surgery in the last 12 months	One or more household members have undergone surgery during the previous 12 months.
One or more household members are smokers	Any member of a household is a smoker.
One or more household members have undergone annual health check-ups	Any member of a household has undergone annual health check-ups.
One or more household members exercise regularly	One or more household members exercise no less than three times a week.
Household size	Household size is divided into three groups: 1–2 persons, 3–4 persons, and 5 persons or more.

Table A4
Incidence and intensity of catastrophic health expenditure in 2013 and 2018 (10% threshold)

Catastrophic payments measures	Urban	Rural
Headcount		
Year 2013		
1: poorest	63.33%	70.56%
2	54.44%	45.56%
3	53.61%	40.17%
4	48.89%	40.17%
5: richest	39.72%	36.67%
Total	52.00%	45.61%
standard error	(1.18%)	(1.17%)
C	−0.0854***	−0.0145***
95% CI	(−0.1107, −0.0600)	(−0.1729, −0.1161)
Year 2018		
1: poorest	71.51%	78.61%
2	64.25%	67.43%
3	57.53%	56.30%
4	53.62%	55.21%
5: richest	41.51%	51.93%
Total	57.69%	61.83%
standard error	(1.15%)	(1.15%)
C	−0.1048***	−0.0894***
95% CI	(−0.1268, −0.0828)	(−0.1100, −0.0689)
Overshoot		
Year 2013		
1: poorest	15.75%	18.79%
2	12.89%	8.99%
3	11.93%	6.06%
4	11.60%	6.06%
5: richest	11.65%	10.24%
Total	12.77%	9.99%
standard error	(0.48%)	(0.43%)
MPO	24.55%	21.90%
standard error	0.74%	(0.75%)
C	−0.0658**	−0.1745***
95% CI	(−0.1083, −0.0234)	(−0.2222, −0.1268)
Year 2018		
1: poorest	21.28%	21.64%
2	16.90%	19.73%
3	13.73%	13.37%
4	14.25%	12.72%
5: richest	9.90%	17.32%
Total	15.21%	16.93%
standard error	(0.49%)	(0.53%)
MPO	26.37%	27.38%
standard error	(0.66%)	(0.69%)
C	−0.1431***	−0.0717***
95% CI	(−0.1787, −0.1074)	(−0.1069, −0.0365)
Dominance test		
Headcount	None	D+
Overshoot	None	D+

C: concentration index.
* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.
D+/D− indicates that the concentration curve in 2013 dominates (is dominated by) the concentration curve in 2018. None indicate that non-dominance between the concentration curves cannot be rejected.

Table A5
Incidence and intensity of catastrophic health expenditure in 2013 and 2018 (40% threshold)

Catastrophic payments measures	Urban	Rural
Headcount		
Year 2013		
1: poorest	21.39%	26.67%
2	17.78%	9.72%
3	15.28%	7.76%
4	14.17%	6.13%
5: richest	15.00%	13.89%
Total	16.72%	12.83%
standard error	(0.88%)	(0.79%)
C	−0.0883**	−0.1970***
95% CI	(−0.1478, −0.0288)	(−0.2660, −0.1280)
Year 2018		
1: poorest	30.91%	33.89%
2	24.46%	27.71%

(*continued on next page*)

Table A5 (*continued*)

Catastrophic payments measures	Urban	Rural
3	19.09%	16.89%
4	20.38%	16.90%
5: richest	12.40%	22.38%
Total	21.45%	23.50%
standard error	(0.95%)	(1.00%)
C	−0.1687***	−0.1184***
95% CI	(−0.2184, 0.1190)	(−0.1663, −0.0705)
Overshoot		
Year 2013		
1: poorest	4.18%	5.30%
2	2.96%	2.35%
3	3.71%	0.98%
4	3.30%	1.50%
5: richest	4.64%	3.77%
Total	3.76%	2.78%
standard error	(0.25%)	(0.21%)
MPO	22.47%	21.66%
standard error	(0.95%)	(1.01%)
C	0.0226	−0.1185**
95% CI	(−0.0538, 0.0989)	(−0.2056, −0.0314)
Year 2018		
1: poorest	6.39%	5.76%
2	4.62%	6.24%
3	3.87%	3.74%
4	4.25%	3.46%
5: richest	2.95%	7.59%
Total	4.42%	5.35%
standard error	(0.25%)	(0.29%)
MPO	20.59%	22.76%
standard error	(0.71%)	(0.73%)
C	−0.1394***	0.0279
95% CI	(−0.2026, −0.0761)	(−0.0325, 0.0883)
Dominance test		
Headcount	None	D+
Overshoot	D−	D+

C: concentration index.
*p = < 0.05, ** = p < 0.01, *** = p < 0.001.
D+/D− indicates that the concentration curve in 2013 dominates (is dominated by) the concentration curve in 2018. None indicate that non-dominance between the concentration curves cannot be rejected.

Table A6
Association between determinants and CHE in urban areas (10% threshold).

Variables	Description	2013		2018	
		OR	95% CI	OR	95% CI
SES quintile	2nd (Ref = Poorest)	0.7423	(0.5313, 1.0371)	0.7692	(0.5462, 1.0831)
	3rd (Ref = Poorest)	0.6944*	(0.4946, 0.9750)	0.5831**	(0.4137, 0.8218)
	4th (Ref = Poorest)	0.5169***	(0.3672, 0.7275)	0.4704***	(0.3318, 0.6667)
	Richest (Ref = Poorest)	0.3441***	(0.2410, 0.4911)	0.3322***	(0.2304, 0.4791)
Households with public health insurance	URBMI (Ref = UEBMI)	0.9216	(0.7156, 1.1868)	1.1796	(0.9134, 1.5235)
Households with private health insurance	Ref = No private health insurance	0.8950	(0.6218, 1.2881)	1.2544	(0.9682, 1.6253)
Household members with chronic diseases	Ref = No household member with chronic diseases	2.4641***	(1.9494, 3.1148)	2.1700***	(1.6988, 2.7720)
One or more household members aged 65 years and above	Ref = No household member aged 65 years and above	1.5058***	(1.2008, 1.8882)	1.3716*	(1.0733, 1.7527)
Household with a child under 14 years of age	Ref = Household without a child under 14 years of age	1.2689	(0.9100, 1.7692)	1.0885	(0.8016, 1.4781)
Household with a working-age female member	Ref = Household without productive age female member	0.4291***	(0.3266, 0.5639)	0.6311**	(0.4771, 0.8350)
A household member has undergone surgery in the last 12 months	Ref = No household member has undergone surgery during the previous 12 months	5.9954***	(3.7624, 9.5537)	3.1744***	(2.2656, 4.4476)
One or more household members are smokers	Ref = No household member is a smoker	0.9307	(0.7468, 1.1599)	0.9173	(0.7393, 1.1381)
One or more household members have undergone annual health check-ups	Ref = No household member has undergone annual health check-ups	1.0342	(0.8005, 1.3361)	1.2591	(0.9123, 1.7378)
One or more household members exercise regularly	Ref = No household member exercises regularly	1.3290*	(1.0271, 1.7196)	1.1929	(0.9394, 1.5149)

(*continued on next page*)

Table A6 (*continued*)

Variables	Description	2013		2018	
		OR	95% CI	OR	95% CI
Household size	3–4 persons (Ref = 1–2 persons)	0.8382	(0.6265, 1.1215)	0.9175	(0.6744, 1.2483)
	5 persons or more (Ref = 1–2 persons)	0.6203*	(0.3869, 0.9946)	1.1563	(0.7341, 1.8212)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001; OR = odds ratio.

Table A7
Association between determinants and CHE in rural areas (10% threshold)

Variables	Description	2013		2018	
		OR	95% CI	OR	95% CI
SES quintile	2nd (Ref = Poorest)	0.4087***	(0.2909, 0.5741)	0.5792**	(0.4043, 0.8297)
	3rd (Ref = Poorest)	0.3298***	(0.2334, 0.4659)	0.3772***	(0.2656, 0.5355)
	4th (Ref = Poorest)	0.2723***	(0.1915, 0.3871)	0.3713***	(0.2600, 0.5302)
	Richest (Ref = Poorest)	0.2818***	(0.1979, 0.4014)	0.2757***	(0.1930, 0.3937)
Households with private health insurance	Ref = No private health insurance	0.7809*	(0.6217, 0.9810)	0.9894	(0.7959, 1.2300)
Household members with chronic diseases	Ref = No household member with chronic diseases	3.7985***	(3.0486, 4.7329)	2.7410***	(2.1958, 3.4215)
One or more household members aged 65 years and above	Ref = No household member aged 65 years and above	1.5199***	(1.1902, 1.9408)	1.6213***	(1.2671, 2.0744)
Household with a child under 14 years of age	Ref = Household without a child under 14 years of age	1.6306**	(1.1809, 2.2515)	1.6891***	(1.2480, 2.2860)
Household with a working-age female member	Ref = Household without productive age female member	0.7811	(0.5719, 1.0670)	0.7026*	(0.5346, 0.9234)
A household member has undergone surgery in the last 12 months	Ref = No household member has undergone surgery during the previous 12 months	2.1959***	(1.4943, 3.2270)	3.0187***	(2.0766, 4.3883)
One or more household members are smokers	Ref = No household member is a smoker	1.0386	(0.8409, 1.2827)	1.1898	(0.9607, 1.4737)
One or more household members have undergone annual health check-ups	Ref = No household member has undergone annual health check-ups	0.9253	(0.7375, 1.1609)	1.2777	(0.9857, 1.6562)
One or more household members exercise regularly	Ref = No household member exercises regularly	1.3078	(0.7835, 2.1828)	0.9106	(0.6557, 1.2645)
Household size	3–4 persons (Ref = 1–2 persons)	0.4267***	(0.3209, 0.5674)	0.5252***	(0.3919, 0.7037)
	5 persons or more (Ref = 1–2 persons)	0.4139***	(0.2727, 0.6280)	0.4545***	(0.3035, 0.6805)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001; OR = odds ratio.
[a] URRBMI was officially established in 2016.

Table A8
Association between determinants and CHE in urban areas (40% threshold).

Variables	Description	2013		2018	
		OR	95% CI	OR	95% CI
SES quintile	2nd (Ref = Poorest)	1.1041	(0.7271, 1.6766)	0.8379	(0.5833, 1.2038)
	3rd (Ref = Poorest)	0.8248	(0.5339, 1.2743)	0.6008**	(0.4094, 0.8816)
	4th (Ref = Poorest)	0.6608	(0.4203, 1.0390)	0.6774	(0.4585, 1.0008)
	Richest (Ref = Poorest)	0.7341	(0.4642, 1.1612)	0.4793**	(0.3074, 0.7471)
Households with public health insurance	URBMI (Ref = UEBMI)	1.2056	(0.8625, 1.6853)	1.4511**	(1.0954, 1.9222)
Households with private health insurance	Ref = No private health insurance	0.6637	(0.3578, 1.2310)	0.7479	(0.5322, 1.0511)
Household members with chronic diseases	Ref = No household member with chronic diseases	1.7269**	(1.2148, 2.4548)	2.7530***	(1.9406, 3.9055)
One or more household members aged 65 years and above	Ref = No household member aged 65 years and above	1.8907***	(1.3991, 2.5550)	1.2128	(0.9167, 1.6045)
Household with a child under 14 years of age	Ref = Household without a child under 14 years of age	1.2247	(0.7297, 2.0555)	1.1911	(0.8113, 1.7487)
Household with a working-age female member	Ref = Household without productive age female member	0.3368***	(0.2279, 0.4979)	0.5668**	(0.3992, 0.8048)

(*continued on next page*)

Table A8 (*continued*)

Variables	Description	2013		2018	
		OR	95% CI	OR	95% CI
A household member has undergone surgery in the last 12 months	Ref = No household member has undergone surgery during the previous 12 months	6.7730***	(4.4674, 10.2685)	3.0026***	(2.1703, 4.1541)
One or more household members are smokers	Ref = No household member is a smoker	0.6668**	(0.4959, 0.8965)	0.8262	(0.6387, 1.0688)
One or more household members have undergone annual health check-ups	Ref = No household member has undergone annual health check-ups	0.7320	(0.5340, 1.0035)	1.1279	(0.7692, 1.6539)
One or more household members exercise regularly	Ref = No household member exercises regularly	1.5010*	(1.0821, 2.0821)	1.3635*	(1.0189, 1.8248)
Household size	3–4 persons (Ref = 1–2 persons)	0.6923	(0.4676, 1.0251)	0.6435*	(0.4444, 1.9318)
	5 persons or more (Ref = 1–2 persons)	0.4996	(0.2403, 1.0388)	0.9836	(0.5770, 1.6765)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001; OR = odds ratio.

Table A9
Association between determinants and CHE in rural areas (40% threshold)

Variables	Description	2013		2018	
		OR	95% CI	OR	95% CI
SES quintile	2nd (Ref = Poorest)	0.4355***	(0.2724, 0.6961)	0.8766	(0.6156, 1.2483)
	3rd (Ref = Poorest)	0.3624***	(0.2173, 0.6046)	0.4628***	(0.3151, 0.6796)
	4th (Ref = Poorest)	0.2781***	(0.1596, 0.4844)	0.4866***	(0.3280, 0.7220)
	Richest (Ref = Poorest)	0.6632	(0.4157, 1.0581)	0.5917**	(0.4075, 0.8592)
Households with private health insurance	Ref = No private health insurance	0.8839	(0.6178, 1.2645)	0.9775	(0.7567, 1.2626)
Household members with chronic diseases	Ref = No household member with chronic diseases	4.1116***	(2.8443, 5.9434)	3.2322***	(2.3784, 4.3927)
One or more household members aged 65 years and above	Ref = No household member aged 65 years and above	2.3153***	(1.6268, 3.2952)	1.7843***	(1.3640, 2.3342)
Household with a child under 14 years of age	Ref = Household without a child under 14 years of age	2.1129*	(1.1753, 3.7985)	1.5210*	(1.0382, 2.2283)
Household with a working-age female member	Ref = Household without productive age female member	0.5299**	(0.3621, 0.7756)	0.7710	(0.5786, 1.0275)
A household member has undergone surgery in the last 12 months	Ref = No household member has undergone surgery during the previous 12 months	6.1998***	(3.8489, 9.9867)	4.5531***	(3.2396, 6.3993)
One or more household members are smokers	Ref = No household member is a smoker	0.6859*	(0.4996, 0.9417)	1.1225	(0.8776, 1.4357)
One or more household members have undergone annual health check-ups	Ref = No household member has undergone annual health check-ups	1.0881	(0.7605, 1.5568)	1.1587	(0.8604, 1.5605)
One or more household members exercise regularly	Ref = No household member exercises regularly	1.5194	(0.7373, 3.1309)	1.4120	(0.9640, 2.0680)
Household size	3–4 persons (Ref = 1–2 persons)	0.3446***	(0.2136, 0.5560)	0.3619***	(0.2544, 0.5149)
	5 persons or more (Ref = 1–2 persons)	0.1047***	(0.0461, 0.2375)	0.2778***	(0.1712, 0.4508)

* = p < 0.05, ** = p < 0.01, *** = p < 0.001; OR = odds ratio.
[a] URRBMI was officially established in 2016.

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