

BMJ Open Effect of critical illness insurance on the medical expenditures of rural patients in China: an interrupted time series study for universal health insurance coverage

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ABSTRACT

Objective The objective of this study is to determine if critical illness insurance (CII) promotes the universal health coverage to reduce out-of-pocket (OOP) medical expenditures and improve the effective reimbursement rate (ERR) in rural China.

Study design The 5-year monthly hospitalisation data, starting 2 years before the CII (ie, the ‘intervention’) began, were collected. Interrupted time series analysis models were used to evaluate the immediate and gradual effects of CII on OOP payment and ERR.

Setting The study was conducted in Xiantao County, Hubei Province, China.

Participants A total of 511 221 inpatients within 5 years were included in the analysis.

Results In 2016, 100 288 patients received in-patient services, among which 4137 benefited from CII. After the implementation of CII, OOP expenses increased 32.2% (95% CI 24.8% to 39.5%, $p < 0.001$). Compared with the preintervention periods, the trend changes decline at a rate of 0.7% per month after the implementation of CII. Similarly, a significant decrease was observed in log ERR after the intervention started. The rate of level change is 16% change (95% CI -20.0% to -12.1% , $p < 0.001$).

Conclusion CII did not decrease the OOP payments of rural inpatients in 2011–2016 periods. The limited extents of population coverage and financing resources can be attributed to these results. Therefore, the Chinese government must urgently raise the funds of CII and improve the CII policy reimbursement rate.

BACKGROUND

Since the publication of *The world health report 2010*, universal health coverage (UHC) has received increasing attention from researchers in relevant fields. UHC is defined as financing systems that are specifically designed to provide people access to necessary health services with sufficient quality. These services must ensure that the user will not encounter financial hardship.¹ In many low-income and middle-income countries, these conditions are not satisfied, and

Strengths and limitations of this study

- This study determines the effect of critical illness insurance (CII) on the reduction of pocket medical expenditures in rural China.
- The study identifies the abovementioned effects by using interrupted time series analysis model with 5-year data.
- The study took Prais-Winsten regression to solve the autocorrelation.
- The study performed seasonal correction in accordance with periodic functions.
- The study was unable to identify a neighbouring county that did not implement CII with a similar level of economic status as a control group.

affordable and effective health services are not accessible to the entire population.

The lack of capacity to offer effective financial protection is the primary issue that hinders the achievement of UHC. In many countries, health financing relies on out-of-pocket (OOP) payments for services.² These costs prevent people from seeking or continuing care; those who seek care incur catastrophic financial burdens that push them to poverty.^{3 4} People who lack health insurance coverage or another form of financial protection hardly access health services, especially in-patient care, or experience delay in doing so. Therefore, providing financial protection to patients is necessary.

The Chinese government conformed rapidly and launched a series of rural health reforms. The first step in China’s reforms involves the expansion of the social health insurance coverage.⁵ In 2003, China adopted the New Cooperative Medical Scheme (NCMS), a new health insurance system for rural areas where 80% of people do not have any kind of health insurance.⁶ In 2011, the

NCMS expanded its coverage to include more counties, and 97% of the Chinese rural population was insured. This rate is higher compared with that in 2004, in which only 310 out of China's 2861 rural counties are covered by the scheme.^{7,8} However, a high coverage of health insurance does not necessarily provide a guarantee of UHC. Literatures indicated that the NCMS has no effect on reducing the OOP payment^{9,10} and even expands the gap of income-related inequity in rural China.¹¹

In 30 August 2012, to further reduce the financial burden of rural patients, China established a supplementary insurance called critical illness insurance (CII), which aims to provide reimbursements of high medical expenses. In the early 1980s, CII is known as 'Dread Disease Insurance' in South Africa and began to flourish in USA, Canada and Australia.¹² In USA and the UK, CII provides a single lump sum payment to the insured individuals, which includes medical and non-medical costs, such as mortgages and credits.¹³ In 2017, patients with critical illness get US\$10 000 or US\$20 000 as initial benefits from insurance companies in the USA.¹⁴ Today, CII covers have a considerable market share in Asian insurance markets.¹⁵

Many researches on CII were performed. A series of studies found that the extra premiums under the CII policies are extremely high, and the possible costs of adverse selection are related to the use of genetic test.^{16–18} Ozkok¹⁹ used a Burr distribution to conduct the Bayesian modelling of the delay between the dates of diagnosis and settlement of claims in CII. Jindrová and VJRAiMMiAS used the same model to assess the event probability of CII.²⁰ Recent studies reported the existence of healthcare disparities within CII. For instance, rich people receive more benefits from this policy than their counterparts.²¹ However, few studies evaluated the effect of CII, especially on health expenditures.

Unlike in other countries, the CII in China is an additional reimbursement for patients with higher payouts in NCMS. In other words, after claiming the CII via health insurance, all patients whose OOP payment still exceeds the premium, which is usually equal to the annual net income per capita of the rural residents, can obtain additional reimbursement.²² The average reimbursement rate is approximately 50%–70%. The funding comes from NCMS, which means that roughly 5% of NCMS's total capital pool should be allotted to CII compensation. Given that the health system reform process aims to improve the UHC, policy-makers expect this scheme to reduce the OOP payments. The objective of the present study is to determine whether the CII relieves the individuals of the financial burden of healthcare by reducing such expenditures in rural China.

METHODS

Setting

Meng *et al.*²³ reported that the lowest average in-patient reimbursement rates can be found in China's central

region (41.2%). Households in the central region suffer from high rates of catastrophic health spending. The rates of catastrophic health expenditure of households with members who were hospitalised are also high.²⁴ In this study, we focus on the rural in-patient health expenditures in Xiantao County (XT), Hubei Province, which is one of the counties in the central region.

Hubei Province is located in central China and the middle reaches of Yangtze River. The gross domestic product (GDP) per capita of this province in 2016 was CNY55 665 (US\$8383), which ranks 11th among the 32 provinces (municipalities and autonomous regions) in China. XT is a city in Southwest Hubei that has a total area of 2538 km². This county has jurisdiction in three streets and 15 towns. The total population of XT in 2016 was 1 563 500, and the GDP per capita is CNY56 065 (US\$8438).

Intervention

The local government of Xiantao initiated a policy in May 2013 to improve the patients' financial access to medical care. The policy states that CII financing should allocate a certain percentage of funds from the NCMS. In 2013, NCMS financing included the contribution of individual rural residents (CNY60) and financial assistance of the government (CNY280) and the local government extracted CNY15 as the fund pool of CII.

We collected and compiled the local NCMS and CII policies from 2011 to 2016. Table 1 denotes the policy changes in XT which was discussed in methods. Table 2 presents the percentage of population enrolled in the CII programme. Before the CII implementation, the deductible amounts for medical institutions inside and outside the county set by NCMS are CNY200 and CNY500, respectively. Therefore, the reimbursement rate of hospitals inside and outside Xiantao increased in varying degrees. However, because the limited pool of funds does not provide sufficient support, the local government reduced the reimbursement rate of NCMS while implementing CII. The reimbursement rate of the NCMS of hospitals in the county decreased from 80% to 60% after May 2013. The deductible amount of CII in 2014 was CNY8000, which increased to CNY12 000 in 2016.

The rule of insurance reimbursement is to conduct NCMS before implementing CII. The government pays part of the reimbursement ratio prescribed by the policy, and the rest is paid by the patient. For example, consider a patient hospitalised in a county hospital in June 2013 with a total medical expense of CNY60 000. Assuming that all medical expenses are included in the benefit package, the NCMS can cover CNY35 880 ((60 000–200)×60%). This amount is higher than the deductible amount in 2013 (CNY8000). Therefore, the patient will be further insured by CII. The CII will cover CNY12 060 ((60 000–35 880–8000)×50%), and the patient's OOP expenses will be CNY20 060 (60 000–35 880–12 060).

Table 1 Reimbursement policy for inpatient care in 2011–2016

Policy	2011	2012–2013 April	2013 May–2015 December	2016 January–2016 December
Insurance coverage	Only NCMS		NCMS+CII	
NCMS:				
Deductible (CN¥)				
In county*	200	200	200	500
Out county	500	500	800	1200
Policy reimbursement rate (%)				
In county†	75	80	60	70
Out county	50	60	50	50
CII:				
Deductible (CN¥)	Not available	Not available	80 000	12 000
Reimbursement rate (%)	Not available	Not available	CN¥80 000–CN¥30 000: 50%	CN¥12 000–CN¥30 000: 55%
			CN¥ 30 000–CN¥50 000: 60%	CN¥ 30 000–CN¥100 000: 65%
			over CN¥50 000: 70%	over CN¥100 000: 70%

*The local medical institutions contained primary hospitals and secondary hospitals, and none tertiary hospital. For primary hospitals, local NCMS did not set deductible (means 0), so the deductible in county was the deductible for local secondary hospitals.

†The reimbursement rate of local primary hospitals was 90%, and did not changed for years. At the same time, the beneficiaries of CII that we are concerned about are basically not using services in primary medical institutions, so the ERR in county mentioned here is also the local secondary hospitals.

CII, critical illness insurance; ERR, effective reimbursement rate; NCMS, New Cooperative Medical Scheme.

Data source

This study is based on the standardised administrative medical claims database of NCMS in XT, which includes all detailed medical treatments and insurance information of the rural residents in the jurisdiction. We collected all relevant data involving in patients from May 2011 to May 2016.

The OOP spending and effective reimbursement rate (ERR) are used to evaluate the effect of CII on the patients' financial burden. The OOP expenditures comprise the expenses below the deductible amount, expenses above the deductible amount copaid by the patients, and the non-reimbursable amount beyond the NCMS benefit packages.²⁵ ERR is defined as the reimbursement amount divided by the total medical expenditure.²⁶ These definitions are consistently used by the

National Health and Family Planning Commission in China. The primary outcomes are the average OOP payment and ERR per month of all CII patients, whereas the secondary ones are the average OOP payment and ERR of patients who sought health utilisation insides and outside XT. For example, the OOP spending inside the county refers to the average health expenditures paid by the patients when they avail in-patient services in county hospitals.

Statistical analysis

In this study, we used interrupted time series analysis (ITSA) models, which are the strongest quasi-experimental method, to estimate the postpolicy changes in the level and trend of each outcome measure.²⁷ After Gillings *et al*²⁸ introduced ITSA to the research on health

Table 2 The percentage of population enrolled in CII programme

Variables	2011	2012	2013	2014	2015	2016
Population	1 560 800	1 549 900	1 561 200	1 553 700	1 551 400	1 541 600
NCMS insured no (1)	1 145 104	1 196 530	1 217 000	1 223 088	1 132 475	1 099 935
Hospitalisation no (2)	60 489	87 536	74 502	87 614	100 792	100 288
CII insured no (3)	–	–	–	5308	4726	4137
CII insured percentage A (%) = (3)/(1)	–	–	–	0.434	0.417	0.376
CII insured percentage B (%) = (3)/(2)	–	–	–	6.058	4.689	4.125

CII, critical illness insurance; NCMS, New Cooperative Medical Scheme.

services, this approach has been widely used in assessing the effects of health services and policy interventions.²⁹ Segmented regression analysis a powerful statistical method for estimating the intervention effects in interrupted time series studies. This method uses baseline trends and levels to project future monthly outcomes with the assumption that these values reflect what would have happened without the policy (ie, the counterfactual). The basic model includes terms that estimate the baseline level for each outcome (intercept), baseline trend (slope), change in the level of the outcome measured immediately after policy implementation and change in postpolicy trend.

Segmented regression (with methods to account for autocorrelation) is the most commonly used modelling technique in ITSAs. When only one group is under study (ie, no comparison groups), the regression model is expressed as

$$Y_t = \beta_0 + \beta_1 (T) + \beta_2 (X_t) + \beta_3 (XT_t)$$

where Y_t is the outcome variable during a time period, which changes on a monthly basis between May 2011 and May 2016, T is the time since the start of the study (May 2011=1, June 2011=2, ..., May 2016=61), and X_t is a dummy (indicator) variable that represents the intervention. Preintervention periods are denoted as 0; otherwise, the value is 1. In this study, the value of X_t before May 2013 is 0, whereas that after this period is 1. XT_t is an interaction term, which is 0 before May 2013, and then increases by 1 each month from May 2013 (1 = May 2013, 2 = June 2013, 3 = July 2013, ...). β_0 represents the intercept or starting level of the outcome variable before CII, β_1 is the slope or trajectory of the outcome variable until the introduction of CII, β_2 is the level change following the intervention, and β_3 indicates the slope change following the intervention. XT_t is the interaction between time and intervention). The CI of the p value was 95%.

For time series data, seasonality is an issue need be concerned. If there is an uneven distribution of months before and after the intervention, such as a higher proportion of winter months, this could bias the results, especially in the analysis of short series. We confirmed the existence of seasonality through the timing chart and performed seasonal correction in accordance with the periodic functions used in similar research.³⁰

Autocorrelation is another problem. Assumption of standard regression models is that observations are independent. This assumption is often violated in time series data because consecutive observations tend to be more similar to one another than those that are further apart, a phenomenon known as autocorrelation. Autocorrelation was assessed by examining the plot of residuals and the partial autocorrelation function and, where data are normally distributed, conducting tests such as Durbin-Watson (D-W) test. The D-W test suggested the existence of autocorrelations, which we corrected using the generalised least squares method (Prais-Winsten).³¹ We adopted the Dickey-Fuller statistic to determine the

stability, and the results showed that the data constitute a stationary time series. The results of the Kolmogorov-Smirnov test indicated that the distribution of OOP payments is non-normal. Therefore, the logarithm of this value was used. According to Beard *et al*³² when the input and output time series have been log-transformed using a natural log-transformation and the data made stationary we can interpret the coefficients in terms of elasticity, that is, a change of 1% from the overall mean value in the input series leads to a $\beta\%$ change from the overall mean in the output series. Log transforming the ERR outcomes was taken for coherence across the research. Given the large reimbursement differences between the hospitals inside and outside the county, the trend of the medical expenditure costs in these two subgroups were further analysed to examine the effects of CII. The raw data and stata command are provided in online supplemental files 1 and 2, and the CHEERS checklist is added in online supplemental file 3).

Wagner *et al*³³ stated that the extreme values that do not fit in the series, which are referred to as wild data points, might occur in the time series. The result showed a decline in the OOP expenses in the county starting from January 2013, few months prior to the introduction of CII. The data points of the ERR in the same subgroup demonstrated a sharp increase after January 2013. The extreme change in both cases returned to relatively normal values after CII was introduced. The possible reason for this phenomenon is that the CII policy was issued at the beginning of the year, but the policy was implemented on May 2013. Therefore, the medical expenses incurred in the first 4 months of 2013 were not included. The lag between the periods when CII was announced and implemented may suggest people to visit primary hospitals and delay expensive procedures until they have coverage. To illustrate this modification, we represented the excluded points as hollow points to establish a contrast against the solid ones.

Patient involvement

Patients or the public were not involved in the conceptualisation or execution of this research.

RESULTS

In 2014, 87614 patients received in-patient services, among which 5308 (6.058%) benefited from CII. This percentage decreased to 4.125% in 2016.

Figure 1 and table 3 show that after the implementation of CII, OOP expenses increased 32.2% (95% CI 24.8% to 39.5%, $p < 0.001$). Compared with the preintervention periods, the trend changes decline at a rate of 0.7%/month after the implementation of CII (95% CI -1.1% to -0.2%, $p < 0.001$). The OOP spending of patients who were hospitalised in the county shows the same trend (figure 2). There is significant change of ERR in the regression slope is observed after the intervention started. The rate of level change is 16% change (95% CI -20.0%

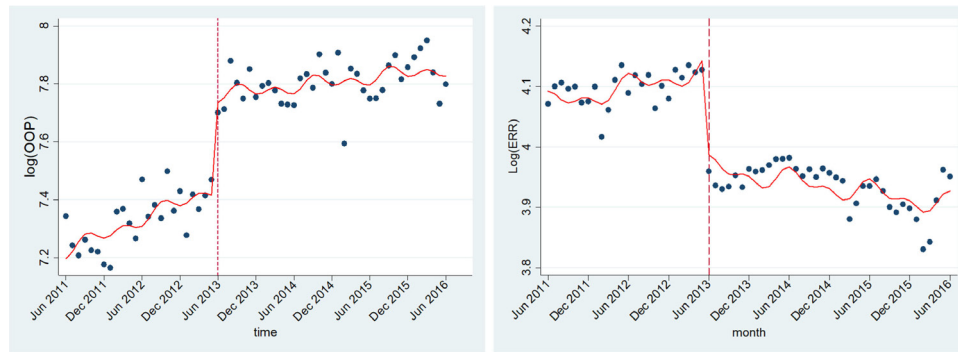


Figure 1 Segmented regression model showing OOP and ERR, May 2011–May 2016. ERR, effective reimbursement rate; OOP, out of pocket.

to -12.1%, $p < 0.001$). The ERRs in the two subgroups decline after the implementation of the CII, but the ERR of the patients who sought healthcare in the county is more obvious at the time of intervention with 9.3% change (95% CI -14.2% to -4.4%, $p < 0.001$). **Figure 2** also shows that the trend changes of ERR of the patients hospitalised in the county declines after the announcement of CII. The adjusted R squared of segmented regression model of log OOP was 0.935, which shows the fitness of this model was acceptable. The adjusted R squared, autocorrelation and partial autocorrelation plots of the model are presented in online supplemental file 4.

The financing and use of CII funds in XT in 2014 and 2015 denote that the expenses exceed the amount raised in 2014 (CII funds=255.2million, CII expenses=292.1million). In 2015, the CII funds and expenses decrease.

DISCUSSION

The CII was designed to reduced OOP expenses and increase the ERR. Not only did it not do this, it may have had the opposite effect: a 32% increase in the OOP and a 16% reduction in the ERR. For the decline of ERR, local insurance policy probably should take primary responsibility. The increased ERR before the implementation of CII is due to the government’s increasing investment on NCMS. The budget of the government for NCMS from May 2011 to May 2013 increased from CNY200 to

CNY280,³⁴ which might attribute to the lower deductible amount and higher policy reimbursement rate. As a result, the ERR during this period increased. However, CII does not raise funds separately, but withdraws funds from the existing pool of NCMS total funds. The implementation of CII poses overspending risks towards NCMS funds. In 2014, CII used funds excessively and overpaid roughly ¥40 million. In consideration of the overspending risk, the local government lowered the policy reimbursement rate of NCMS after May 2013, thereby resulting in a significant reduction in the ERR of all local patients after the implementation of CII. The purpose of basic health insurance is to protect all patients from the financial risks of diseases. CII aims to protect the economic risks of expensive treatments and vulnerable people and therefore should not crowd out the funds of NCMS to avoid decreasing the benefits of the patients, especially fragile ones.

The decreased ERR directly engage with the increase in OOP. For CII patients, lower reimbursement rate means they would get less benefit from insurance, and they had to pay more by themselves. Besides, this phenomenon can be attributed to two another reasons. First is the small number of rural patients who benefited from CII, which implies that the new insurance only reduces parts of the financial burden of the patients and does not affect the average OOP payments of all rural patients. The second reason is the limited average beneficiary of

Table 3 Interrupted time series analysis of outcome variables		
Outcome variables	β_2 , level change after CII, (95% CI)	β_3 , trend/slope change after CII, (95% CI)
Log (out-of-pocket payments)	0.322*** (0.248 to 0.395)	-0.007** (-0.011 to to 0.002)
In county	0.170** (0.056 to 0.283)	0.004 (-0.004 to 0.104)
Out county	-0.037 (-0.270 to 0.196)	-0.019* (-0.033 to to 0.004)
Log (effective reimbursement rate)	-0.161*** (-0.200 to to 0.121)	-0.004** (-0.007 to to 0.001)
In county	-0.093*** (-0.142 to to 0.044)	-0.005** (-0.008 to to 0.002)
Out county	0.018 (-0.031 to 0.066)	-0.001 (-0.004 to 0.002)

% changes results are multiplied by 100.
 * $P < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
 CII, critical illness insurance.

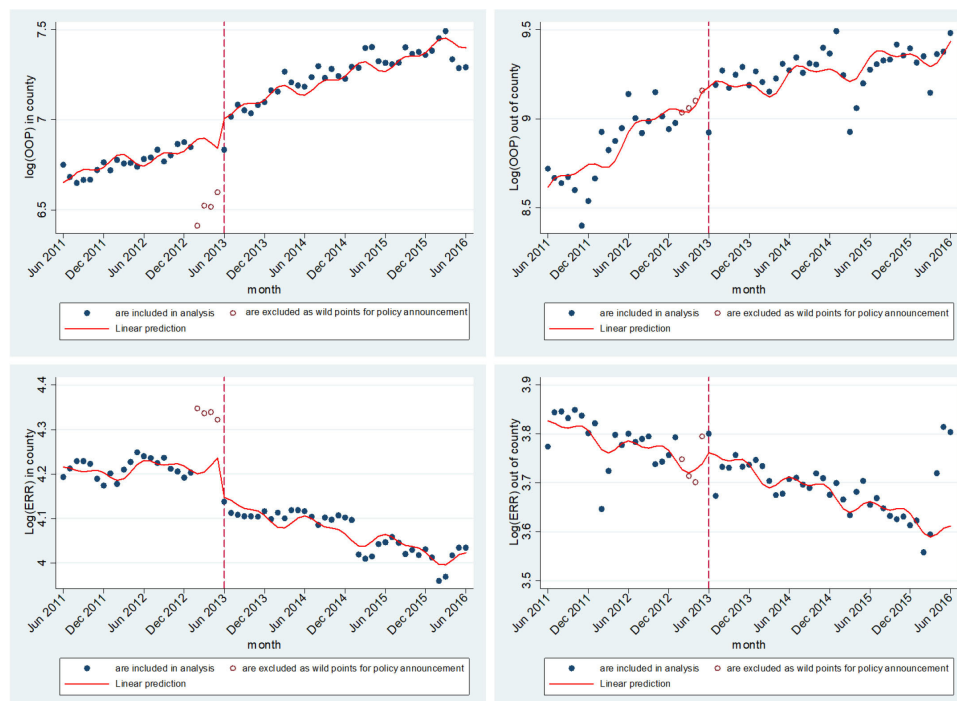


Figure 2 Segmented regression model showing OOP and ERR in and out of county, May 2011–May 2016. ERR, effective reimbursement rate; OOP, out of pocket.

the patients insured with CII. Nearly 10% of the total medical expenditure are paid by CII for the patients. The excessive deductible amount and limited reimbursement rate restrict the benefits of CII. In Xiantao, there were only 55% reimbursement ratio for medical expenditure during CNY12 000–CNY30 000. Only the patients who pay more than CNY100 000 can enjoy a 70% reimbursement rate. However, few patients reach this high level. The results clearly illustrate the drawback of CII when the OOP expenses rapidly increase.

These results are consistent with the findings of other studies. In a recent commentary, Yip and Hsiao claimed that the financial protection function of the current Chinese health system remains insufficient. According to the global health expenditure database of the WHO, the OOP payments in China account for 32% of the total health expenditure in 2014, which is higher than the level (15%–20%) recommended by the WHO.³⁵ Empirical evidences show that the high level of OOP payments in China results in severe health expenditure and medical impoverishment of the poor and disadvantaged.³⁶

The trend of OOP payments inside and outside XT shows several differences. For patients who were hospitalised in county hospitals, the CII dramatically increases the OOP expenses at the intervention moment, which can be ascribed to the low policy reimbursement rate of NCMS. The average OOP expenses do not meet the deductible amount, and the economic burden reduction is dependent on the role of basic health insurance. Once the NCMS reimbursement rate decreases, the OOP spending increases. However, because hospitals outside the county have better and more expensive medical technology than

county hospitals, the OOP expenditures of the patients who availed healthcare outside XT is relatively high^{37 38} (almost over CNY10000), and they are highly likely to benefit from CII. The increased reimbursement rate of CII neutralises the role of NCMS in reducing the reimbursement ratio, and thus slightly changes the trend of OOP payments. As a result, people who seek medical care outside the county benefit more from CII than patients in the county.

To expand the population coverage of CII and decrease the households' direct payments or co-payments for services, the government must improve the CII policy. The deductible amount should be settled not only in consideration of local medical expense distribution and disease characteristics, but also of the local average income. As presented in the annual government work report, the unified CII deductible line will be reduced, and the reimbursement rate will increase from 50% to 60%.³⁹ The funds of CII, however, should be increased separately. The highest government announced that it will increase the per capita financial subsidy by CNY30 and allot half of this amount to CII.

Strengths and limitations

This study has several limitations. First, we are unable to find a neighbouring county who does not implement CII with a similar level of economic status as a control group. Finding such country will eliminate the mixed effects of other external influences. However, because this policy is implemented throughout the province, no suitable control group is identified. Meanwhile, the implementation pattern of CII among the provinces is quite different,

and thus is not suitable as a control group. Second, because CII is an annual reimbursement, the amount is reimbursed once in the second half of the year in most cases. For the convenience of calculation, we disperse this amount in accordance with the proportion of medical expenses to each month, thereby disregarding the instantaneous effect of CII reimbursement. Lastly, because of the limitation of sample selection, the results of this study can only represent the regions with comparable sample GDP levels. The findings cannot reflect the results of economically developed eastern regions.

CONCLUSION

This study provides new evidence that CII did not effectively improve the UHC process in 2011–2016. The policy had limited extent of population and health service coverages and did not effectively decrease the OOP payments of inpatients. CII even decreased the ERR by spending the basic medical insurance fund pool. The results suggested that the Chinese government must urgently raise the funds of CII and improve the policy reimbursement rate.

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Contributors In this paper, ZZ served as the principal investigator who was involved in the study design and conception, manuscript preparation and editing. LX provided helpful technical support to the study design. JJ was involved in the manuscript preparation and editing. LL helped in the data collection. SC performed the data analysis. All authors have read and approved the final manuscript.

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