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Impact of long-term care insurance on medical expenditure and utilization and the comparison between different pilot schemes: evidence from China

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Abstract

Objective This study investigates the effect of long-term care insurance (LTCI) on medical expenditure and utilization in China and compares the effects between different pilot schemes.

Methods We used four-wave data from the China Health and Retirement Longitudinal Study (CHARLS) 2011–2018, covering 19 cities piloted by national government or local governments. We applied a staggered difference-in-differences (DID) strategy to identify the effect of LTCI. Heterogeneity tests were used to identify the effects of different pilot schemes.

Results We found that LTCI implementation significantly reduces inpatient expenditure, annual inpatient visits, and monthly outpatient visits by 13.4%, 0.033, and 0.072, respectively. The effects of LTCI become more pronounced in pilot cities with government subsidies in financing or higher reimbursement ceilings. Compared to pilot schemes covering UEBMI & URRBMI program, the schemes only covering UEBMI program could significantly reduce inpatient and outpatient frequency by 0.029 and 0.069. Pilot schemes with more service items had lower outpatient frequency ($\beta = -0.146$), and pilot schemes with fewer service items had lower inpatient expenditure and frequency ($\beta = -0.226$ and $\beta = -0.049$).

Conclusion In general, this study found that LTCI implementation could effectively reduce the expenditure and utilization of medical services. The effects of different pilot schemes vary significantly. The results of this study further supplement the existing empirical evidence on the effect of LTCI and provide important policy implications for the future development of LTCI in China and other developing countries.

Keywords Long-term care insurance, Medical expenditure, Medical utilization, Pilot schemes comparison, China

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Introduction

Aging populations has become a universal phenomenon in the world, according to the World Population Prospect 2022, the proportion of the global population aged 65 or above is projected to rise from 10% in 2022 to 16% in 2050 [1]. For China, the number of older people (aged 65 or above) will reach approximately 210 million by 2022, accounting for 14.9% of the total population, and is expected to reach 26.1% (366 million) by 2050 [2]. The issue of aging populations in China is more challenging. The United Nations General Assembly declared 2021 to 2030 as the Decade of Healthy Aging. The World Health Organization (WHO) led to the global implementation of the Healthy Aging Action Plan which aims to change the aging population from a challenge to an opportunity [3, 4]. One of the important actions is to provide long-term care (LTC) for older people who need it [3].

As the population ages, the number of disabled people will also increase. In 2020, China had approximately 42 million disabled people aged over 60, accounting for 16.6% of the elderly population. In this context, the demand for LTC of the elderly will grow substantially [5]. However, care for the elderly is now dominated by informal care provided by family members in China, a previous study found that 27-33% of Chinese aged over 45 who needed help in at least one ADL had unmet needs for care [6]. Most importantly, when older people's needs for care are not met, it can seriously affect their independence and quality of life, as well as increase the risk of disability. This leads to increased utilization and expenditure of medical services and increases the risk of death [7].

In order to guarantee that disabled people can obtain affordable formal care services and reduce their financial burden, China has begun to explore an LTC system for the elderly and initiated pilot programs for long-term care insurance (LTCI). Qingdao was the first city in China to implement LTCI in 2012, and the Chinese central government issued the policy in 2016 and officially launched the LTCI pilots in 15 cities in 2017. After the operation is stable, the LTCI system will be fully promoted and implemented nationwide. Due to the different levels of economic development and size of the elderly population in pilot cities, the guideline proposed to formulate local LTCI systems following the actual conditions of the pilot cities. So the schemes of LTCI are different in each pilot city.

How does LTCI affect the expenditure and utilization of medical services? Many studies have conducted empirical research on this issue, but the results were inconsistent. Many developed countries have taken the lead in implementing LTCI, such as Japan, South Korea, the United States, Germany, etc., and they have more experience and relevant research. Two studies conducted in South Korea found that the implementation of LTCI significantly reduced the total medical expenditure and inpatient expenditure [8, 9]. Another study from South Korea also found the burden of medical expenditure was significantly reduced among LTCI beneficiaries [10]. A panel study from Spain found LTC subsidization significantly reduced hospital admissions and utilization [11]. A study analyzed the effect of public LTCI on consumption, medical care demand, and welfare in the United States and found public LTCI mainly crowded medical spending among low-health individuals [12]. The results of the above studies verified that the LTCI implementation effectively reduced the expenditure and utilization of medical services. Few studies also found that providing LTC services may increase the medical expenditure and utilization. A national population-based observational study conducted in Norway found LTC services increase inpatient service utilization due to stimulating the demand for therapeutic and functional support [13]. The differences in these conclusions are mainly due to differences in countries, medical markets and health insurance markets.

Because the LTCI system in developing countries like China is still in its infancy, few studies evaluate the impact of LTCI. A panel study from the Chinese Longitudinal Healthy Longevity Survey found the implementation of LTCI reduced the amounts of ADL-related care expenditures and out-of-pocket medical expenditures [14]. Another study used data of CHARLS 2015 and 2018 to evaluate the relationship between LCT needs and hospitalization costs, it found that LTCI reduced hospitalization costs [15]. There was also a panel study that exploited the national pilot cities and found that LTCI implementation significantly reduced the inpatient and outpatient frequency and reduced the outpatient and inpatient expenditure by 23.9% and 19.8% [16]. Another study evaluated the effect of LTCI in Shanghai, they found that the introduction of LTCI significantly reduced the length of stay and inpatient expenditure in tertiary hospitals [17]. In conclusion, most of the existing studies found LTCI could reduce medical expenditure and utilization but these studies only covered part of the pilot cities or the empirical study of a single pilot city, and there is also a lack of comparison of different pilot schemes. Therefore, it is necessary to comprehensively analyze the relationship between LTCI and medical expenditure and utilization in China, and compare the effect of different pilot schemes.

This study used panel data from CHARLS 2011–2018, which covers the first batch of LTCI pilot cities. For more comprehensive and objective assessments of the impact of LTCI on the expenditure and utilization of medical services, this study included all LTCI pilot cities from 2011 to 2018, not only national pilot cities but also local

government pilot cities. According to the timing of the adoption of LTCI in pilot cities, we applied a staggered difference-in-differences (DID) strategy to evaluate the impact of LTCI on medical expenditure and utilization. Moreover, we applied heterogeneity analyses to further explore the effects of different LTCI pilot schemes, contributing to the literature and providing a theoretical and empirical basis for future policy-making. These findings also can be useful to other developing countries that are exploring the LTCI system.

Institutional background

As a result of aging populations, unmet need for care, socialization of elderly hospitalization, and increasing medical expenditure have become important issues to be solved in China [18]. To proactively deal with these issues, China began to explore establishing the LTCI system. Qingdao has learned from the LTCI system of other countries and took the lead in implementing the LTCI system in 2012. In July 2016, the Chinese central government released guidelines for implementing the LTCI system and announced 15 pilot cities. In addition to the national pilot cities, there were other pilot cities implemented by local governments, mainly in Jilin and Shandong. This study included all 19 LTCI pilot cities in the CHARLS database from 2011 to 2018.

In recent years, Universal Health Coverage (UHC) has become a hot topic in global health policy. The concept of UHC is similar to the objectives of LTCI. Based on the three measurement dimensions of UHC [19] and combined with the content of LTCI policies, this study sorted out the main characteristics of each pilot city's scheme. Table S2 presents the key features of different schemes in pilot cities. In terms of financing sources, LTCI is mainly financed by public health insurance funds. Most of the pilot cities chose multiple forms of financing, which is a combination of public health insurance funds, individual payment, and government subsidies. Each pilot city's scheme is different, from the description of financing sources, the main source of financing is public health insurance fund, and the individual payment part is also directly deducted through the public health insurance fund, without additional delivery. So as long as the pilot city stipulates which type of medical insurance participants are covered by the LTCI, this part of the population is forced to be included in the LTCI. To some extent, the participation mechanism of LTCI is mandatory. In some pilot cities with relatively good economic levels, government subsidies are part of the financing plan, partly to ease the pressure on public health insurance funds financing and to cover more people enrolled in LTCI. In the pilot phase, the LTCI system mainly covers the urban employees enrolled in the Urban Employee Basic Medical Insurance (UEBMI) in principle. Some pilot cities also cover urban and rural residents enrolled in the Urban-Rural Resident Basic Medical Insurance (URRBMI) (e.g. Jingmen, Shanghai). And the uncovered population of LTCI cannot get the corresponding services provided by LTCI.

LTCI service mode is usually divided into three categories: home care, hospital care, and institutional care. Home care includes visiting care services by care workers and community care services. Hospital care refers to beneficiaries staying in community health centers or rehabilitation hospitals. Institutional care services are provided by designed elderly care facilities or nursing homes. And the service items mainly include daily living care and medical care, and some pilot cities also provide additional services such as rehabilitation care, preventive care, and psychological counseling (e.g. Chengdu, Shanghai, Guangzhou).

There are two ways of LTCI reimbursement plan when the beneficiary has settled the expenditure after receiving the LTC service. The former is reimbursed on a pro-rata basis, and the reimbursement rate of LTCI should be controlled by about 70% of the service expenditure mentioned by the Chinese central government. The latter is reimbursed in fixed amounts based on specific LTCI services. In most cases, the reimbursement for home care will be higher than other institutional care and hospital care.

Although the LTCI system in China is still in its infancy, the overall operation of pilot cities has been stable, and initial results have been achieved since the LTCI implementation. In September 2020, the Chinese central government announced the expansion of 14 pilot cities. According to the latest data released by the National Healthcare Security Administration, as of the end of March 2022, the LTCI covered 49 pilot cities, 145 million people, and a total of 1.72 million beneficiaries with an average reimbursement per capita of about 16,000 RMB per year. So, what is the impact of LTCI on medical expenditure and utilization? This study will comprehensively analyze this problem, and the conclusions will be of important reference value for future policymaking.

Data and variables

Data collection and sample

The primary data source is the China Health and Retirement Longitudinal Study (CHARLS) for this study. CHARLS is a nationally representative survey conducted in China. The survey collected comprehensive data of Chinese individuals aged 45 and above. The survey collected data through face-to-face interviews conducted by trained interviewers, covering various domains such as demographics, socioeconomic, health status, and healthcare utilization factors. CHARLS employed a multistage, stratified, and probability proportional to size (PPS)

sampling design to ensure the sample was representative of the Chinese population aged 45 and above [20].

This study used four-wave data from CHARLS 2011–2018, which covers the LTCI implementation time of the first batch of pilot cities. We merged cross-sectional data from four-wave to create panel data, resulting in a total sample size of 77,233. Considering that the beneficiaries of LTCI are middle-aged and elderly people, and CHARLS is also a survey data specifically aimed at middle-aged and elderly people, we excluded samples below the age of 45 on the target population. We consider the lag effect of policy implementation, so all LTCI pilot cities involved in this study need to implement for at least 6 months prior to the CHARLS survey during 2011–2018. Weihai implemented the LTCI policy in July 2018, and the follow-up period of CHARLS 2018 was from July to September, so Weihai didn't meet the specific criteria and to avoid skewing the results, it was excluded in the study. In the subsequent data processing steps, individuals with missing values for age and the outcome variables were eliminated, as these missing values could potentially impact the research outcomes. Furthermore, we need panel data for empirical analyses, in which each individual needs to appear at least twice. Individuals that participated in only once in four waves of CHARLS were excluded. As a result of these procedures, we obtained a final sample size of 66,745. The full process of sample selection is specified in Fig. S1. For cases where covariates had missing values, the random forest imputation method was employed to supplement these missing values. By employing such a sample selection and processing procedure, the research aims to ensure the reliability and validity of the study and provides a representative sample for analysis and investigation.

Outcome variables

To examine the impact of LTCI on medical expenditure, two outcome variables were selected from CHARLS. These variables include annual total inpatient expenditure and monthly total outpatient expenditure. These variables were subjected to a natural log transformation to normalize their distribution. In addition, two outcome variables were chosen to assess the medical utilization, specifically the frequency of annual inpatient visits and the frequency of monthly outpatient visits. These outcome variables selected from CHARLS provide comprehensive data support for this study.

Independent variables

In this study, the independent variable is LTCI coverage, which is a binary choice variable indicating whether the individual is in the LTCI pilot cities and implemented for at least 6 months prior to the CHARLS survey. Based on the policy and database, the treatment group consists of samples from 19 cities, which were piloted by the national government or local governments (see Fig. 1). The control group consists of samples that were not in the LTCI pilot cities from the CHARLS.

Covariates

In consideration of the confounding factors, the covariates were added to the model. Based on the behavior model of health services use [21], combining the influencing factors of health service utilization [22] and research data, we chose the confounding factors. According to previous studies [14, 17], the covariates were divided into three aspects: individual demographics, socioeconomic status, and health level. Individual demographic variables include gender, age, area of residence, marital status, type of basic health insurance, region, and number of living children; Socioeconomic status covariates include household income per capita; health level variables include smoking status, drinking status, number of chronic diseases, and disability. The specific definitions of the variables are shown in Table S1. Although we scientifically selected covariates that may affect outcome variables, some covariates change less before and after the LTCI implementation, resulting in weak influence on the results.

Method

To evaluate the impact of the LTCI on medical expenditures and utilization, we used CHARLS wave1 to wave4 to form panel data and applied a staggered DID strategy with individual and time fixed effects (FE). Traditional DID estimates the effect of policy intervention by comparing the treatment group and control group. The staggered DID extends this approach to multiple treatment groups that differ according to the timing of the adoption of events, in this study marked by when cities became the

Fig. 1 LTCI pilot cities implemented for at least 6 months prior to the CHARLS survey during 2011–2018

LTCI pilot cities [23]. In our study, the treatment group consisted of respondents from LTCI pilot cites which were implemented for at least 6 months prior to the CHARLS survey during 2011–2018. The control group consisted of respondents from cities that were not covered by LTCI. The Staggered DID model was exploited as follows:

$$Y_{ict} = \beta_0 + \beta_1 LTCI_{ict} + \beta_2 X_{ict} + \tau_t + a_i + \epsilon_{ict} \quad (1)$$

where Y_{ict} denotes the outcome variable of individual i living in city c in year t, including inpatient frequency, outpatient frequency, and the natural log form of inpatient expenditure, outpatient expenditure. In staggered DID model, $LTCI_{ict}$ denotes dummy variable for the LTCI pilot cities, marked by when these cities became the LTCI pilot cities. X_{ict} is a set of covariates, including individual demographics, socioeconomic status, and health level variables τ_t is a set of year fixed effects, a_i is a set of individual fixed effects and ϵ_{it} is random error term. The coefficient β_1 is the core coefficient concerned in this study, which represents the difference between the pilot city sample and the non-pilot city sample in terms of outcome variables. So as to investigate the policy effect of LTCI, that is, whether the LTCI implementation affects the medical expenditure and medical utilization among middle-aged and elderly people.

In this study, we conducted four types of robustness checks to examine the reliability and sensitivity of our analytical results. First, the prerequisite for the correct application of DID is that the outcome variables of the treatment group and control group have a similar time trend before LTCI implementation. So, we applied an event study to check the common trend assumption. Second, some studies [24–26] pointed out that in staggered DID, the heterogeneity of the treatment effects at different time points may lead to potential bias in the estimation of the two-way fixed effect model. We further calculate the heterogeneity robust estimators for staggered treatment timing according to the method proposed by Borusyak [24], and verifies the robustness of main effect.

Third, since the medical expenditure can be divided into out-of-pocket expenditure and reimbursement, we included out-of-pocket medical expenditure and reimbursement to outcome variables for analysis, to test the robustness of the effect of LTCI implementation on medical expenditure.

Finally, in order to reduce the selection bias in the estimation of LTCI implementation effects on the observations [27], we learned from previous studies [28, 29] and combined the propensity score matching (PSM) method and DID to evaluate the robustness of the main effect of LTCI. It is necessary to make the individuals in the treatment group and the individuals in the control group to be similar and comparable in PSM-DID [30]. We chose the covariates as the matching variables to match the control group for the treatment group and applied logit regression. The coefficient of each matching variable was used as the weight to fit the value of the propensity score, which reflects the probability of a sample as the treatment group. With the value of propensity score, we used nearest-neighbors matching to get the control group. After matching, the distribution of propensity scores between the two groups was more similar, and the kernel density curves were closer (see Fig. S1). We then conducted the PSM-DID analyses with individuals in the common support to compare the results with the DID.

We also took the heterogeneity test from the perspective of LTCI policy design, combining the view of financing and three dimensions of UHC [19]. In order to compare the effects of different pilot schemes. Based on the LTCI policy published in the pilot cities, we divided the sample into different subgroups (government subsidies, health insurance coverage, reimbursement rules, and care services) according to the above dimensions. Based on the policy content and previous study [14], we defined "government subsidies" as LTCI programs that were partly financed by government subsidies. We defined high-ceiling programs if payment ceilings exceed 50 RMB/day for home care, 1900 RMB/month for institutional care, and 160 RMB/day for hospital care [14] or reimbursement rate exceeds 70%. We divided care services into more services and less services, with more services representing that the pilot cities provided services other than daily living care and medical care, such as rehabilitation care and psychological counseling, and less services representing that the pilot cities only provided daily living care and medical care. We divided health insurance coverage into two group, UEBMI and UEBMI & URRBMI. And to explore whether the relationship between LTCI implementation and outcome variables differs on these important dimensions.

Results

Descriptive statistics

Table 1 presents the summary statistics for pilot cities and non-pilot cities, which reports the mean values and standard deviations of outcome variables and covariates. We divided the sample of pilot cities into three parts, before and after the LTCI implementation and a full sample, to carry out a descriptive analysis. For non-pilot cities, we conducted descriptive analyses according to the year of the CHARLS wave. We can get simple variation trends of key variables in pilot and non-pilot cities through descriptive statistics.

Table 1 Summary statistics

Variables	Pilot cities			Non-pilot cities				
	Before	After	Overall	2011	2013	2015	2018	Overall
Outcome variables								
Inpatient frequency	0.161	0.215	0.177	0.121	0.194	0.197	0.276	0.199
	(0.625)	(0.743)	(0.664)	(0.567)	(0.667)	(0.621)	(0.869)	(0.695)
Outpatient frequency	0.428	0.281	0.383	0.384	0.472	0.394	0.343	0.398
	(1.476)	(1.030)	(1.357)	(1.260)	(1.547)	(1.317)	(1.337)	(1.371)
Ln (Inpatient expenditure + 1)	0.933	1.202	1.015	0.693	1.075	1.136	1.481	1.109
	(2.724)	(3.086)	(2.842)	(2.308)	(2.865)	(2.968)	(3.345)	(2.925)
Ln (outpatient expenditure + 1)	1.021	0.782	0.948	0.944	1.156	1.069	0.889	1.016
	(2.275)	(2.117)	(2.230)	(2.112)	(2.375)	(2.347)	(2.220)	(2.273)
Covariates								
Individual demographic variables								
Age	59.402	62.190	60.254	58.743	59.837	60.262	62.723	60.445
	(9.585)	(9.661)	(9.693)	(9.486)	(9.783)	(9.999)	(9.668)	(9.852)
Gender	0.490	0.482	0.488	0.485	0.486	0.489	0.483	0.486
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
Living Area	0.538	0.486	0.522	0.631	0.625	0.623	0.622	0.625
	(0.499)	(0.500)	(0.500)	(0.482)	(0.484)	(0.485)	(0.485)	(0.484)
Marriage	0.885	0.861	0.878	0.876	0.867	0.865	0.842	0.862
	(0.319)	(0.346)	(0.327)	(0.330)	(0.339)	(0.342)	(0.365)	(0.345)
Type of Insurance	2.378	2.728	2.485	2.478	2.529	2.091	2.643	2.428
	(1.142)	(1.090)	(1.138)	(1.021)	(0.960)	(1.293)	(1.006)	(1.104)
Region	1.341	1.277	1.512	1.941	1.946	1.956	1.958	1.951
	(0.596)	(0.553)	(0.500)	(0.762)	(0.763)	(0.767)	(0.763)	(0.764)
Number of living children	2.375	2.339	2.364	2.685	2.710	2.763	2.690	2.714
	(1.340)	(1.249)	(1.313)	(1.428)	(1.447)	(1.447)	(1.374)	(1.425)
Socioeconomic status variables								
Education	0.326	0.314	0.322	0.331	0.336	0.310	0.314	0.322
	(0.469)	(0.464)	(0.467)	(0.471)	(0.473)	(0.462)	(0.464)	(0.467)
Income	2.002	2.333	2.103	1.921	1.935	1.825	2.236	1.979
	(0.821)	(0.752)	(0.815)	(0.771)	(0.812)	(0.833)	(0.778)	(0.815)
Health level variables								
Drink	0.379	0.373	0.377	0.330	0.346	0.350	0.329	0.339
	(0.485)	(0.484)	(0.485)	(0.470)	(0.476)	(0.477)	(0.470)	(0.473)
Smoke	0.281	0.267	0.277	0.308	0.247	0.286	0.273	0.278
	(0.449)	(0.443)	(0.447)	(0.462)	(0.431)	(0.452)	(0.446)	(0.448)
Chronic diseases	0.702	0.778	0.725	0.684	0.720	0.791	0.814	0.755
	(0.458)	(0.415)	(0.447)	(0.465)	0.449	(0.407)	(0.389)	(0.430)
Disability	0.272	0.275	0.273	0.294	0.298	0.327	0.325	0.312
	(0.445)	(0.446)	(0.446)	(0.456)	(0.457)	(0.469)	(0.468)	(0.463)
N	7645	3362	11,007	12,613	13,775	15,046	14,304	55,738

Notes: Standard deviations are shown in parentheses

Main effect of LTCI

Table 2 presents the effects of LTCI on inpatient expenditure, outpatient expenditure, inpatient frequency, and outpatient frequency. The coefficient of LTCI indicates the LTCI implementation. The results of this study show that after LTCI implementation, compared with non-pilot cities, inpatient expenditure was significantly reduced by 13.4% in pilot cities. LTCI implementation is significantly associated with a decrease in medical utilization, a reduction in inpatient frequency by 0.033, and a decrease in outpatient frequency by 0.072. We also found a reduction in outpatient expenditure by 4.6%, but the negative effect was statistically insignificant. With the results, we can find that LTCI implementation can effectively reduce the medical utilization and expenditure for middle-aged and elderly people.

Robustness check

Figure 2 shows the results of the common trend test, on the X-axis, event time "0" represents the reform year and the benchmark category is the year prior to the LTCI implementation (denoted by -1), we excluded the benchmark category to avoid collinearity problems. In the Fig. 2, event time "-1" is used as a reference and

Table 2 Effect of LTCI on medical expenditures and utilization

	(1)	(2)	(3)	(4)
Variables	**Ln (Inpatient expenditure)**	**Ln (outpatient expenditure)**	**Inpatient frequency**	**Outpatient frequency**
LTCI	-0.134** (0.067)	-0.046 (0.047)	-0.033** (0.015)	-0.072*** (0.027)
Control variables	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES
Individual fixed effect	YES	YES	YES	YES
Observations	66,745	66,745	66,745	66,745
R-squared	0.431	0.420	0.444	0.409

Notes: Standard errors are shown in parentheses. The significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively

the coefficient is 0. The coefficient estimates for the pre-reform period were not significant among these three variables, inpatient expenditure, inpatient frequency and outpatient frequency, suggesting that these variables of pre-reform in the treatment group did not differ from those in the control group. In terms of outpatient expenditure, the result shows that in several periods before the reform, the results of treatment group were significantly lower than the control group, which may also be the reason why the difference between the two groups was not significant after the LTCI policy implementation.

Table S3 shows the results of heterogeneity robust estimators for staggered treatment timing. The results were basically consistent with the main effect results, indicating that the staggered DID analysis of this study, LTCI policy in different periods did not produce severe potential bias to the results, and the research results were relatively robust.

The results of the effect of LTCI on reimbursement and out-of-pocket expenditures are shown in Table 3. LTCI implementation is significantly associated with a decrease in out-of-pocket inpatient expenditure and inpatient reimbursement, which decreased by 10.8% and 11.8%, respectively. We also found a reduction in out-of-pocket outpatient expenditure by 3.5% and a reduction in outpatient reimbursement by 2.1%, but the negative

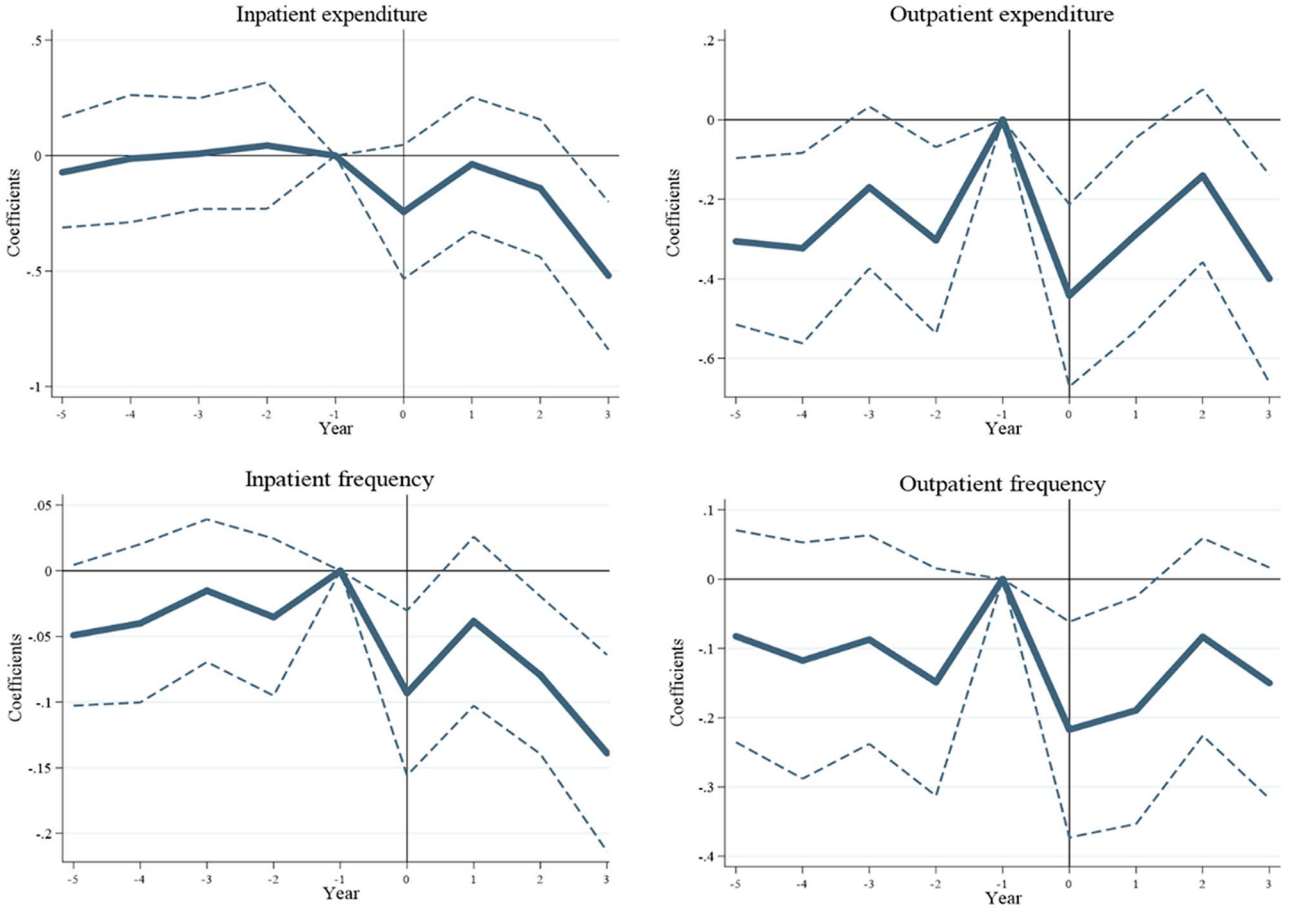

Fig. 2 Common trend test. The figure depicts coefficients and the 95% confidence intervals for an event study analysis. On the x-axis, number − 1 is the benchmark group and indicates the year before LTCI

Table 3 Robustness check: effect of LTCI on reimbursement and out-of-pocket expenditures

	(1)	(2)	(3)	(4)
Variables	**Ln (Out-of-pocket Inpatient expenditure)**	**Ln (Out-of-pocket Outpatient expenditure)**	**Ln (Inpatient reimbursement)**	**Ln (Outpatient reimbursement)**
DID	-0.108*	-0.035	-0.118**	-0.021
	(0.062)	(0.046)	(0.058)	(0.030)
Control variables	YES	YES	YES	YES
Time fixed effect	YES	YES	YES	YES
Individual fixed effect	YES	YES	YES	YES
Observations	66,745	66,745	66,745	66,745
R-squared	0.424	0.417	0.416	0.381

Notes: Standard errors are shown in parentheses. The significance levels of 1%, 5%, and 10% are denoted by ***, **, and *, respectively

effect was statistically insignificant. This finding is consistent with that of the results of medical expenditures, which proved the stability of the main effect.

Table S4 reports the results of PSM-DID, the effect of LTCI implementation on medical expenditure and utilization after matching is similar to the results before matching. As expected, the results show that inpatient expenditure was significantly reduced by 13.6% in pilot cities. LTCI implementation is significantly associated with a decrease in medical utilization, a reduction in inpatient frequency by 0.33, and a decrease in outpatient frequency by 0.71, respectively. We also found a reduction in outpatient expenditure by 4.4%, but the negative effect was statistically insignificant. It appears that the results of the robustness test suggested the reliability and sensitivity of the main analysis results.

Heterogeneity

The results of heterogeneity are shown in Fig. 3 and Table S5 in Additional file. From the perspective of LTCI financing resources, we found that pilot schemes with government subsidies significantly reduced the inpatient and outpatient expenditure, and inpatient and outpatient frequency by 17.3%, 10.1%, 0.048, and 0.098, respectively. Pilot schemes with no government subsidies had negative effects on inpatient expenditure, frequency, and outpatient frequency, but the results were not significant. As for the perspective of health insurance coverage, we found pilot schemes covering the UEBMI program could significantly reduce inpatient and outpatient frequency by 0.029 and 0.069. Pilot schemes covering UEBMI & URRBMI programs had more distinct effects on inpatient expenditure and frequency, and outpatient frequency, but with no significance. Compared to the low reimbursement level schemes, high reimbursement level schemes presented a more prominent and significant effect on inpatient expenditure and frequency, and outpatient frequency. From the perspective of providing service items, we found pilot schemes with fewer services had more distinct effects on inpatient expenditure and frequency, and pilot schemes with more services had more distinct effects on outpatient frequency.

Discussion

Whether the implementation of LTCI can alleviate the increasing burden of medical services brought about by the aging population, this study used follow-up data from CHARLS 2011–2018 to analyze the effect of LTCI on medical expenditure and utilization. The results revealed that the implementation of LTCI can significantly reduce the expenditure and utilization of medical services in pilot cities. We found the LTCI implementation significantly reduced the inpatient expenditure, by 13.4%. LTCI implementation is significantly associated with a decrease in medical utilization, a reduction in inpatient frequency by 0.033, and a decrease in outpatient frequency by 0.072.

The decreases in medical expenditure and utilization may reflect the substitutional effect that formal LTC from home care and institutional care instead of hospitalization [31, 32]. The substitutional effect refers to the subsidies of LTCI for home care or institutional care, which makes patients receiving care in hospitals switch to home or institutional care services, thereby reducing the expenditure and utilization of medical services. Many studies have shown similar results and indicated the existence of this substitution effect. One early study found that the implementation of a long-term home care program in Chicago significantly lowered the risk of long-term hospitalization [33]. Forder found that hospital and home care services were substituted among the elderly in the UK and the results indicated that for each 1 pound spent on home care would lead to a 0.35 pound fall in hospital expenditure [34]. Goda examined the impact of state tax subsidies for private LTCI in the United States and found that tax incentives could increase coverage of LTCI and reduce Medicaid spending [35]. Two studies also found that the implementation of LTCI in South Korea significantly reduced the total medical expenditure and inpatient expenditure [8, 9]. Gaughan et al. found that increasing the number of institutional care beds in the

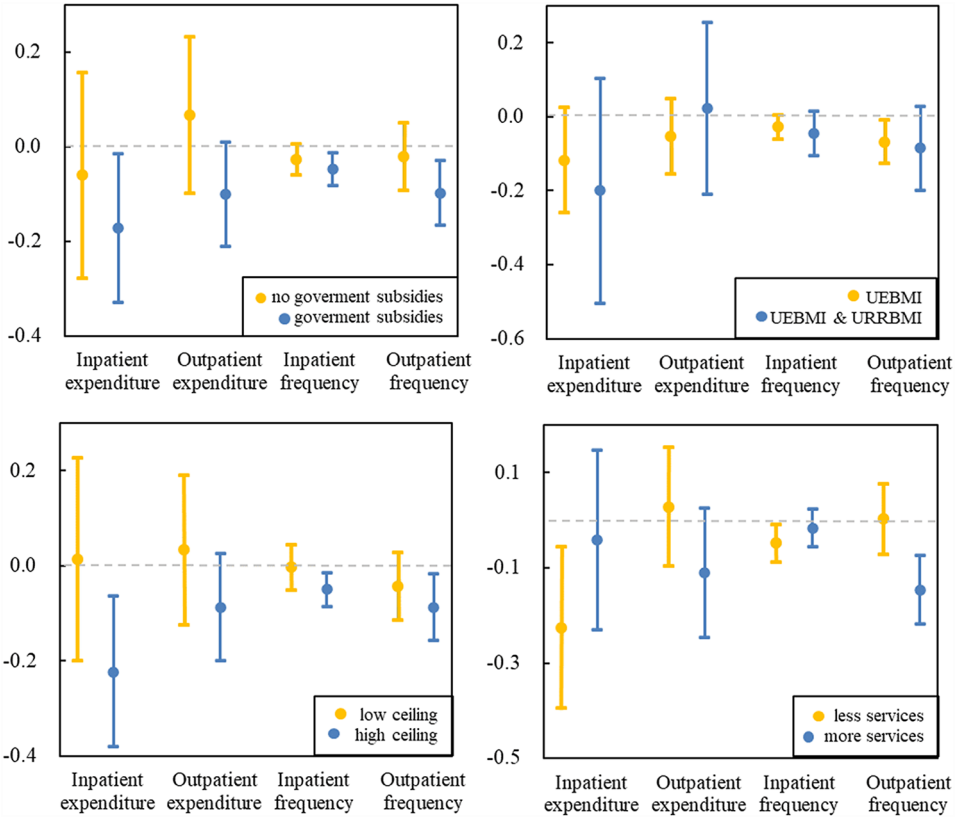

Fig. 3 Heterogeneous effects of LTCI. Notes: The figure shows the DID with matching estimates for the effect of LTCI on the medical expenditure and utilization by government subsidies, health insurance coverage, reimbursement level, and number of service items from the perspective of the policy designed. Each pair is based on a separate regression with interaction terms between LTCI and indicators for each subgroup. The dots mark the point estimates, and the lines indicate 95% confidence intervals

United Kingdom would lead to a decrease in the number of bed-blocking patients, and reduced the delayed hospital discharges [36].

According to the results of this study, the substitution effects of inpatient utilization and expenditure are both significant, but the substitution effect of inpatient expenditure is more distinct. This may be due to the fact that LTCI subsidizes hospital care, institutional care, and home care. Beneficiaries who chose home care and institutional care instead of hospital care would lead to reduce inpatient expenditure and even choosing hospital care will also get subsidies and save part of hospitalization cost. As for the outpatient medical behavior, the significant reduction in outpatient frequency may be due to the health effects of LTCI. The health effect is that LTC improves the health of the beneficiaries, thereby reducing the utilization of outpatient. There were studies that provided empirical evidence for the health effects of LTCI. Stabile et al. found that the increased availability of publicly financed of public home care programs in Canada increased the utilization of home care and improved the health of beneficiaries [37]. Rice et al. used data from the United States to find that Medicaid LTC policies could effectively improve activities of daily living/instrumental activities of daily living (ADL/IADL) assistance of beneficiaries and reduce unmet care needs [38]. And two empirical studies using the CHARLS database also found that LTCI has health effects on people who are covered by LTCI, the implementation of LTCI effectively improved the health status of them [39, 40]. However, we did not use empirical analysis to verify the health effects of LTCI, and the decrease in outpatient frequency may only be caused by the substitution effect of home visits and other LTC facility care. We also found a reduction in outpatient expenditure by 4.6%, but the negative effect was statistically insignificant. Perhaps LTCI did not provide subsidies for outpatient medical care, and outpatient expenditure are higher for the elderly, which may cause LTCI to fail to significantly reduce outpatient expenditure.

The results of heterogeneity showed the effect of LTCI became more pronounced in pilot cities with government subsidies in financing. The financing sources of LTCI in pilot cities were majorly from the public health insurance fund, the results from heterogeneity implied a multifaceted strategy would be more conducive to the

development of LTCI. Many OECD economies exploit general taxation or social insurance as the financing method of LTCI, in order to provide a wide range of LTCI services and to enable the stable development of LTCI [41–44]. China's healthcare spending is growing fast, with 12% a year rising between 2008 and 2017, which is 4% faster than GDP growth [45]. Moreover, the UEBMI and URRBMI funds were already in deficit and needed to dip into reserves in many places [46]. Therefore, if the financing source is mainly from the public health insurance funds, it is unfavorable to the development of LTCI, and it is necessary to explore a multifaceted financing mechanism, such as increasing government subsidies, to ensure the high-quality development of LTCI [47].

Furthermore, we found pilot schemes covering the UEBMI program could significantly reduce inpatient and outpatient frequency. At the beginning of the implementation of LTCI, the LTCI system mainly covered the urban employees enrolled in the UEBMI in principle, in order to achieve the efficient landing and stable operation of the LTCI system. From the results of this study, we can see that this scheme indeed achieved good effects. Pilot schemes covering UEBMI & URRBMI program had more distinct effects on inpatient expenditure and frequency, and outpatient frequency, but with no significance. This may be because there were fewer pilot cities implementing this scheme and the sample size is small, leading to insignificant results. However, this pilot scheme has already shown a trend towards a more pronounced effect of LTCI on medical expenditure and utilization. With the continuous improvement of the LTCI, the government should gradually consider including urban and rural residents enrolled in the URRBMI in the scope of security. Compared with urban employees, older urban and rural residents have lower income levels, and less access to medical services, and rural residents have more unmet LTC care needs [6]. Therefore, the LTCI system should gradually realize the comprehensive coverage of public health insurance enrollees and expand the scope of security, which not only reflects the social equity in the establishment of the LTCI but also better controls the expenditure and utilization of medical services.

From the perspective of reimbursement level, we also found the LTCI effects on medical expenditure and utilization were more distinct with a higher reimbursement ceiling. This may be due to providing a higher reimbursement ceiling for LTCI services will give more economic incentives to beneficiaries and lead to stronger substitution effects. The results showed that the effects on the outcome variables were both negative and significant in the presence of government subsidies and high levels of reimbursement, suggesting that the degree of coverage made the difference. Government subsidies may make it possible for more people to be included in the program, and the depth and breadth of services that can be funded is greater. Higher levels of reimbursement mean higher utilization of LTC facilities so there may be more alternative care. In summary, LTCI scheme needs significant government support in order to produce substitution effects.

We also found pilot schemes only providing daily living care and medical care had more distinct effects on inpatient expenditure and frequency, and pilot schemes with more services provided had more distinct effects on outpatient frequency. This may be due to the substitution effect of services that reduce the outpatient frequency, but some services require hospitalization in a hospital or institution, resulting in the possibility of increased inpatient expenditure and frequency. The above results and discussion of different pilot schemes' comparisons have important policy implications for China to establish a more appropriate and sustainable LTCI system in the future.

Despite the comprehensiveness and strengths of this study, there were some limitations. First, this study analyzed the effect of LTCI only through the policy documents issued by the pilot cities and did not conduct research on the pilot cities. The actual implementation of pilot cities may differ from that described in the policy document, which may lead to bias in the results. Second, we used the event study method to mainly test the trend before the LTCI policy implementation. Since most of the pilot cities implemented the LTCI policy in 2016-17, the post-trend of event study can only show the short-term effect of LTCI. The estimates for the third period after reform included only three pilot cities. The results of DID analyses also mainly reflect the short-term effects of LTCI policy. The long-term effects of LTCI policy should be analyzed in the future with additional data. Third, the sample size of each pilot is relatively small, so it is still necessary to further expand the scope of research objects to ensure the representativeness of results. Fourth, due to the data limitation, we could not analyze the substitution effect of home care and institutional care separately. And this result may have important implications for future policy directions. With the development of LTCI and the increase of data volume in the future, more high-quality empirical studies on LTCI can be conducted.

Conclusion

In general, this study found that LTCI implementation could effectively reduce the expenditure and utilization of medical services. The effects of LTCI become more pronounced in pilot cities with government subsidies in financing or higher reimbursement ceilings. Compared to pilot schemes covering UEBMI & URRBMI program, the schemes only covering UEBMI program had more prominent and significant effect on inpatient and

outpatient frequency. Pilot schemes with more service items had lower outpatient frequency, and pilot schemes with less service items had lower inpatient expenditure and frequency. The results of this study further supplemented the existing empirical evidence on the effect of LTCI and provided important policy implications for the future development of LTCI in China and other developing countries that are exploring the LTCI system.

Supplementary Information

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Supplementary Material 1

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Author contributions
Conception and design of study: L.X, Y.Y; Collating data: Y.Y, S.Y, W.C; Analysis and interpretation of data: Y.Y, S.Y, W.C, C.J; Drafting the manuscript: Y.Y, S.Y; Critical revision of the paper for important intellectual content: L.X, Q.Y, S.C, J.J, K.L, Z.Z, Y.X;

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethical approval and consent to participate
Ethical approval for CHARLS was granted from the Biomedical Ethics Review Committee of Peking University (IRB00001052-11015). All participants signed informed consent before interview.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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