Measurement and determinants of catastrophic health expenditures among the elderly in China using longitudinal data from the CHARLS

Shiai Liu  
   Center for Social Security Studies of Wuhan University

Peter Christopher Coyte  
   Institute of health Policy, Management and Evaluation, University of Toronto

Mingqi Fu  
   Center for Social Security Studies of Wuhan University

Qilin Zhang  (qilinzhang@whu.edu.cn)  
   Wuhan University  https://orcid.org/0000-0002-2636-9338

Research

Keywords: Catastrophic health expenditure, determinants, elderly, China

DOI: https://doi.org/10.21203/rs.3.rs-53346/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License
Abstract

Introduction: Catastrophic health expenditures (CHE) among Chinese elderly is an issue worthy of attention. However, the incidence, intensity and determinants of CHE have not been fully investigated by previous studies. This study explores the incidence, intensity and determinants of CHE among elderly Chinese citizens, i.e. those aged 60 years or older.

Methods: Data were obtained from three waves of the China Health and Retirement Longitudinal Study (CHARLS): 2011, 2013 and 2015. Cutoff points used in this study for catastrophic health expenditures were 10% of the total expenditures and 40% of non-food expenditures. Under the guidance of the Andersen model of health services utilization, this study used the logistic regression analysis to explore the determinants of catastrophic health expenditures.

Results: The incidence of catastrophic health expenditures rose over the study period, 2011-2015, from 20.86% (95% CI: 19.35% to 22.37%) to 31.00% (95% CI: 29.28% to 32.72%) with 40% non-food expenditure. The intensity of CHE had also increased. The Overshoot(O) rose from from 3.12% (95% CI: 2.71% to 3.53%) to 8.75% (95% CI: 8.14% to 9.36%) with 40% non-food expenditure, while the mean positive overshoot (MPO) rose from 14.96% (95% CI: 12.99% to 16.92%) to 28.23% (95% CI: 26.26% to 30.19%), which means that the problem of catastrophic health expenditures was even more serious in 2015 than in 2011. Logistic regression revealed that households were more likely to face CHE if they: had a spouse as a household member, reported an inpatient event in the last year, reported an outpatient visit in the last month, are disabled; are members of a poor expenditure quartile, are located in the middle and western zones and reside in an Urban area. In contrast, catastrophic health expenditures were not significantly affected by age above 75 years, household size, having a chronic health condition or insurance type.

Conclusion: Key policy recommendations include efforts to gradually improve medical assistance and to expand the use of health insurance to reduce household liability exposure for health expenditures.

Introduction

Health disorders are associated with large economic burdens on individuals as well as households. For individuals with demanding health conditions and limited financial resources, exposure to large medical expenses that may move the household into debt[1]. On occasions, this debt may be a burden over the remaining course of their life. Among the world, about 150 million individuals are reported to live with severe financial difficulties due to large health expenditures, with over 60% residing in low-middle income countries[2]. As the largest low-middle income country in the world, China faces serious challenges in dealing with catastrophic health expenditures. In 2015, the prevalence of poverty associated with onerous health expenditures was high at 44.1%[3]. Therefore, it is necessary to further deepen the research on this topic to effectively resolve and respond to the poverty problem brought about by the economic risk of diseases.
China officially launched the New Health Care Reform (NHCR) in 2009 with an overarching aim to reduce the financial burden of health expenditures on households. Under the NHCR, universal health insurance was expanded to cover both urban and rural residents. By 2017, two separate health insurance arrangements ensured universal coverage for all the Chinese residents: first, the UEBMI (the Urban Employee Basic Medical Insurance) scheme, which was designed for those employed in (and retired from) the formal sectors; and second, the UBMI (Unified Basic Medical Insurance) scheme, which was available for all rural residents as well as for those urban residents without formal employment. With the implementation of these insurance arrangements, the demand for medical services has grown dramatically but the consequences for CHE has yet to be explored in detail. This is the purpose of our study.

Of all groups in society, the elderly aged 60 years and older are at the greatest risk of incurring high health care expenses. In 2011, the elderly aged 60 and over accounted for approximately 13.7% of the total population. The fifth National Health Service Survey (NHSS) report of China in 2013 demonstrated that the outpatient visit ratio over two weeks among elderly people was 56.9%, the prevalence rate of chronic diseases was as high as 71.8%, and the annual rate of inpatient was 17.9%[4]. These figures were much higher than those recorded for other groups. Compared with a high demand for health care services, elderly income was limited, leading to a rise in exposure to high health care expenses. International evidence has shown that people of lower economic status are more likely to suffer from serious illness and become impoverishment due to health care expenses[5]. Of even greater concern is the rapid ageing of the population that will have a major impact on future health care costs of the elderly and their households and society. According to the “National Population Ageing Development Trend Forecast Research Report” issued by the National Committee on Aging in 2015, elderly Chinese residents will reach 437 million by 2051 at which time this group will account for 30% of the total population.

Indeed, an inquiry into catastrophic health expenditures (CHE) has become a hot issue in health studies in China. From the current research literature, CHE in rural areas has been discussed extensively in the literature [3, 6, 7]. Some scholars studied CHE among patients with chronic diseases[8, 9], and migrants [10, 11]. Though several studies have examined the prevalence of CHE in China, no consensus has been reached to date as each study has used different databases and methodologies. One study with data from the fourth NHSS suggested that the prevalence rate of CHE was 13.0%[12], while another study found that among elderly rural residents was 25.6%[13]. Existing studies have analyzed CHE for different age groups and found that CHE varied by age. Generally speaking, households with members over 65 years of age and under 5 years of age are more vulnerable to CHE[14], the proportion of CHE in elderly households is 3.71 times that for non-elderly households[15]. Additionally, the determinants of CHE have been extensively explored by previous studies. Household economic status, the inpatient rate, presence of an elderly or disabled household member, and the presence of a household member with chronic illness were commonly associated with CHE[16–18]. While it was thought that health insurance would help to alleviate some of the economic burden brought about by disease, the evidence has remained unclear. Some scholars believed that health insurance was helpful in reducing the prevalence of CHE[19], while
others declared either no\([20–22]\)or limited effects\([7, 18, 23]\). A recent study has analyzed the mechanism behind the multi-level medical security that reduce CHE\([24]\).

While earlier studies highlight the importance of CHE in China, those studies have several limitations. First, there has been very little focus, to date, on the elderly in China. To our knowledge, only one paper focused on rural elderly Chinese individuals\([21]\), but the data used in that paper was quite dated (i.e. before 2011) and was not longitudinal data, and there was the possibility that the study suffered from potential heterogeneity bias. Second, the impact of the various health insurance schemes in China on CHE remains unclear. Third, previous studies have varied in their choice of influencing factors and have not been guided by an explicit conceptual framework that would assist in variable identification and in the specification of the data generating process to be estimated.

The purposes of this study are threefold: to measure trends in the incidence and intensity of CHE among elderly Chinese aged 60 years or older from 2011 to 2015 using three waves of the CHARLS; to identify the factors that account for variations in the incidence of CHE with use of Andersen model of health service utilization, with special attention to the role played by different health insurance schemes on CHE; and finally, to describe more precise and evidence-based measures that reduce the prevalence of CHE among the elderly in China.

**Methods**

**Data sources**

The study sample was drawn from three waves (2011, 2013 and 2015) of the China Health and Retirement Longitudinal Study (CHARLS). It was implemented by the National Development Research Institute of Peking University. It collected information on a range of variables, including demographic background, family structure, work status, retirement and pension status, household expenditures, and health information, such as health status, insurance coverage, and health service utilization.

The baseline survey was conducted between June 2011 and March 2012. Households members aged 45 years or older were invited to participate in this survey and his/her spouse becomes the respondent automatically. A total of 12740 households participated in the survey, with a response rate of 80.51%. Data for 10257 households were eventually formed (Fig. 1). These households were re-surveyed for every 2 years, however, for many reasons like migration or death, there were only 3371 households to all three survey waves for all individuals aged 60 years or above, we deleted 581 households with inconsistent insurance. Finally, a total of 2790 households were included in our data for analysis in this study.

**Dependent Variable**

CHE is defined as household health care expenditures which exceed certain fractions of household total income or non-food expenditure\([5, 25]\). However, in low and middle-income countries, income information is frequently unavailable or of poor quality\([26]\). Consumption expenditures are often preferred to income
as a measure of socioeconomic status due to more accurate reporting[27]. As yet, there is not any consensus on the threshold value to apply to define CHE. Generally, two thresholds are widely used to define CHE: i) out-of-pocket healthcare payments (OOP) that comprise more than 10% of total expenditures[28, 29]; or ii) out-of-pocket healthcare payments that comprise more than 40% of non-food expenditures[25, 30]. The health expenses of the surveyed households only include the respondent and his/her spouse. The total household expenses and food expenses are extracted from the questionnaire.

CHE is usually assessed in terms of incidence and intensity, Headcount ($Hc$) is used to measure incidence, while overshoot ($O$) and mean positive overshoot ($MPO$) are used to measure intensity. HC means the percentage of households whose OOP payments as a proportion of their total income or non-food expenditure, equal or exceed a certain threshold. Overshoot($O$) means the average amount by which payments equal or exceed certain fractions for all the sample households, while mean positive overshoot ($MPO$) means the average amount of those whose household occurred CHE[28].

In this study, where CHE = 1 if health expenditures were compared with total expenditures ($\geq 10\%$) or with a net of non-food expenditures ($\geq 40\%$) and CHE = 0 otherwise.

**Independent variables**

The independent variables were associated with the Andersen model of health services utilization. In this model, the variables that determine utilization were categorized into predisposing factors (age, sex, ethnicity, and marital status etc); enabling factors (zone, area, health insurance type, household size and household socio-economic status etc); and needs-based factors (perceived severity of illness, presence of physician diagnosing chronic diseases etc)[31].

Based on the CHARLS survey questionnaire, we chose age and marital status as predisposing factors. For our unit of analysis is household, we use whether household having member greater than 75 years old and whether the household having spouse lives together or not as the predisposing factors according to the survey questionnaire.

For the enabling factors, we chose zone, area, health insurance type, household size and household socio-economic status. The zone was categories as eastern, middle and western. The area was grouped into urban and rural. The urban area was household living in towns and urban neighborhoods of cities while the rural area was household living in villages and suburban areas of cities. Health insurance was divided into four types. While UEBMI and UBMI covered almost all citizens, we included a category for other insurance (OI) that comprised those without either UEBMI or UBMI but with commercial medical insurance and/or other types of medical insurance, and finally, we included a category for those without any medical insurance (NI). The household socio-economic status was divided into five economic status categories according to household aggregate expenditures (excluding health expenditures), from low to high, indicating the poorest, poorer, medium, richer, and richest.

For the needs-based factors, we chose whether household member with chronic diseases diagnosed by a physician, whether the household member with disabled, whether the household member using
outpatient service in the last month and impatient service in the last year or not.

**Specification of the Empirical Model**

There are three main types of Binary Selection Models which including a pooled, random effects and a fixed-effects logit model for use with panel data\[32\]. Based on the results of the Hausman specification test, we selected the fixed-effect logit method for our baseline results. All data analyses were performed using STATA 15.0 (StataCorp LP, College Station, Texas)

**Results**

**Descriptive statistics**

Table 1 presents the descriptive statistics for each of the three waves of the CHARLS. the percent of household member age above 75 was 16% in 2011, 23% in 2013 and 30% in 2015 and nearly 65–70% of the household members were living with a spouse. By 2015, 1.15% of respondents had no insurance, with UEBMI and UBMI accounting for 13.69% and 84.91% of the respondents, respectively. Over half (67%) of the households were in the rural area. The household located in Eastern, Middle and Western Zone was 25.59%, 34.87% and 39.53% respectively. For the needs-based factors, the inpatient rate of the sample was 15%, 22% and 26% in 2011, 2013 and 2015 respectively. Over the study period, the overwhelming majority of households (83%) reported having a chronic condition and at least 30% of households with a disabled member. These summary data are consistent with the results of the fifth NHSS in 2013\[4\].
### Table 1
Household descriptive statistics of variables \(^a\) (\(N = 2790\))

| Variables                          | Definition                      | 2011            | 2013            | 2015            |
|------------------------------------|---------------------------------|-----------------|-----------------|-----------------|
|                                    |                                 | Mean(SD\(^b\))  | Mean(SD)        | Mean(SD)        |
| Health expenditure per month       | Continuous variables            | 34 \(^c\) (109) | 62(273)         | 77(301)         |
| Total expenditure                  | Continuous variables            | 314(357)        | 404(693)        | 448(709)        |
| Non-food expenditure               | Continuous variables            | 144(219)        | 213(518)        | 250(593)        |
| **Predisposing factors**           |                                 |                 |                 |                 |
| Household member age above 75      |                                 | 0.16(0.36)      | 0.23(0.42)      | 0.30(0.46)      |
| Marriage                           | 0 = No spouse 1 = With spouse   | 0.70(0.46)      | 0.65(0.47)      | 0.65(0.48)      |
| **Enabling factors**               |                                 |                 |                 |                 |
| Household size                     | Continuous variables            | 2.54(1.83)      | 4.28(1.58)      | 2.38(1.20)      |
| Economic status                    | 1 = Poorest 2 = Poor 3 = Medium | 2.57(1.39)      | 2.50(1.36)      | 2.37(1.35)      |
| Insurance type\(^d\)              | 0 = NI 1 = UEBMI 2 = UBMI 3 = OI| 1.81(0.51)      | 1.80(0.49)      | 1.84(0.40)      |
| Area                               | 0 = Urban 1 = Rural             | 0.67(0.49)      | 0.67(0.47)      | 0.67(0.47)      |
| Zone                               | 0 = Eastern 1 = Middle 2 = Western| 1.14(0.80)    | 1.14(0.80)      | 1.14(0.80)      |
| **Need factors**                   |                                 |                 |                 |                 |
| Inpatient or not                   | 0 = No 1 = Yes                  | 0.15(0.36)      | 0.22(0.36)      | 0.26(0.44)      |
| Chronic disease or not             | 0 = No 1 = Yes                  | 0.83(0.37)      | 0.83(0.38)      | 0.87(0.34)      |
| Disability or not                  | 0 = No 1 = Yes                  | 0.30(0.46)      | 0.45(0.50)      | 0.46(0.50)      |
| Outpatient or not                  | 0 = No 1 = Yes                  | 0.30(0.46)      | 0.32(0.47)      | 0.30(0.46)      |

Note: (a) The author sorts according to the CHARLS survey data; (b) In the brackets is the standard deviation (c) US$1 \approx 6.3 yuan (RMB) during 2011-2015  (d) Abbreviations: NI, no insurance; UEBMI, Urban Employee Basic Medical Insurance; UBMI, the Unified Basic Medical Insurance for urban residents without formal employment and rural residents; OI, Other Insurance.

### Incidence and intensity of Catastrophic Health Expenditures (CHE)

Table 2 summarized the incidence \((H_0)\) and intensity \((O \text{ and } MPO)\) of catastrophic healthcare expenditures for the 3 survey years. Results were calculated using the commonly recommended cut-off
points of 10% and 40%, associated with total and non-food expenditures, respectively.

Table 2
Incidence and intensity of catastrophic health expenditures among elderly household in China, defined to total and non-food expenditure, over various years\(^a\)

| Year | 2011        | 2013        | 2015        |
|------|-------------|-------------|-------------|
|      | Out-of-pocket health spending as a share of total expenditures (cut-off point = 10%) | | |
|      | Head count(SE) | 29.92(0.008) | 36.52(0.007) | 39.42(0.009) |
|      | p-value\(^b\)    | < 0.001     | < 0.001     |             |
|      | Overshoot(SE)  | 6.85(0.003) | 9.87(0.004) | 11.45(0.003) |
|      | p-value\(^b\)    | < 0.001     | < 0.001     |             |
|      | Mean positive overshoot | 22.89 | 27.03 | 31.25 |
|      | Out-of-pocket health spending as a share of non-food expenditures (cut-off point = 40%) | | |
|      | Head count(SE) | 20.86(0.007) | 27.63(0.008) | 31.00(0.009) |
|      | p-value\(^b\)    | < 0.001     | < 0.001     |             |
|      | Overshoot(SE)  | 3.12(0.002) | 5.06(0.002) | 8.75(0.003) |
|      | p-value\(^b\)    | < 0.001     | < 0.001     |             |
|      | Mean positive overshoot | 14.96 | 18.31 | 28.23 |

Note: (a) Presented as % unless otherwise indicated; (b) Statistical testing was conducted by comparing the year-specific “head count” with the equivalent value in 2011.

The incidence of CHE (accounting for >10% of total expenditures) continued to rise during the study period, 2011-2015, from 29.92% (95% CI: 28.23% to 31.63%) in 2011 to 39.43% (95% CI: 37.61% to 41.24%) in 2015. In contrast, when the incidence of CHE was defined as health expenditures exceeding >40% of non-food expenditures, the incidence of CHE also continued to rise during the whole study period, from 20.86% (95% CI: 19.35% to 22.37%) in 2011 to 31.00% (95% CI: 29.28% to 32.72%) in 2015.

In the case of the intensity of CHE as assessed by the value of the overshoot, no matter which measurement method was adopted, we found that the intensity of CHE had also increased. Based on household total expenditures for the whole study period, the overshoot (\(O\)) increased from 6.85% (95% CI: 6.27% to 7.45%) in 2011 to 11.45% (95% CI: 10.67% to 12.23%) in 2015. Based on the household non-food expenditure, the overshoot (\(O\)) also increased, from 3.12% (95% CI: 2.71% to 3.53%) in 2011 to 8.75% (95% CI: 8.14% to 9.36%) in 2015.

In the case of the mean positive overshoot (\(MPO\)), it was interesting to notice that in 2011, those spending more than 10% of total expenditures on healthcare, spent on average 32.89% (10%+22.89%) of
their total expenditure on healthcare. This proportion grew over the study period and reached 41.25% (10%+31.25%) by 2015. When healthcare expenditures were considered as a share of non-food expenditures, the level of this mean positive overshoot was very similar. In 2011, those spending more than 40% of non-food expenditures on healthcare, spent on average 54.96% (40%+14.96%) of their non-food expenditure on healthcare and this grew to 68.23% (40%+28.23%) by 2015. Consequently, the intensity of CHE grew over the study period.

**Determinants of CHE**

Table 3 presents the results of the logistic regression analysis for two alternative denominators with longitudinal data and the cross-section data of CHARLS in 2015: first, the determinants of CHE at 10% of total expenditures; and second, the determinants of CHE at 40% of non-food expenditures. For the fixed-effects model was used, variables like gender and region were automatically deleted as they did not change over the survey time. We use the cross-section data of CHARLS in 2015 to analyze the impact of zone and area separately at last.
Table 3
Determinants of the prevalence of catastrophic health expenditure using panel logistic regression model

| Variables | (1) Odds Ratio | (2) Odds Ratio | (3) Odds Ratio |
|-----------|---------------|---------------|---------------|
| **Predisposing factors** |               |               |               |
| Household having member greater than 75 years old (compare with less than 75) | 1.370<sup>a</sup> | 1.162 | 1.061 |
| | (0.107)<sup>e</sup> | (0.438) | (0.552) |
| Marriage (compare with without spouse) |               |               |               |
| With spouse | 1.731*** | 1.776*** | 1.767*** |
| | (0.004) | (0.003) | (< 0.001) |
| **Enabling factors** |               |               |               |
| Zone (compare with Eastern area) |               |               |               |
| Middle area | 1.363*** | | |
| | (0.008) | | |
| Western area | 1.317** | | |
| | (0.017) | | |
| Area (compare with Urban) |               |               |               |
| Rural | 0.825* | | |
| | (0.078) | | |
| Insurance Status (compare with No Insurance<sup>b</sup>) |               |               |               |
| UEBMI | 1.010 | 1.955 | 0.791 |
| | (0.982) | (0.106) | (0.592) |
| UBMI | 1.305 | 1.503 | 0.664 |
| | (0.353) | (0.166) | (0.323) |
| OI | 2.498 | 2.199 | 0.249 |
| | (0.214) | (0.270) | (0.216) |
| Economic Status (compare with poorest) |               |               |               |
|                  | (1) | (2) | (3) |
|------------------|-----|-----|-----|
| Poor             | 0.502*** | 0.583*** | 0.527*** |
|                  | (< 0.001) | (< 0.001) | (< 0.001) |
| Medium           | 0.345*** | 0.449*** | 0.351*** |
|                  | (< 0.001) | (< 0.001) | (< 0.001) |
| Richer           | 0.198**  | 0.327*** | 0.310*** |
|                  | (< 0.001) | (< 0.001) | (< 0.001) |
| Richest          | 0.079*** | 0.188*** | 0.116*** |
|                  | (< 0.001) | (< 0.001) | (< 0.001) |
| Household size (compare with less than 4 members) |     |     |     |
| Household size more than 4 | 0.970 | 0.871 | 0.899 |
| Need factors     | (0.763) | (0.179) | (0.596) |
| Impatient compare with not impatient |     |     |     |
| Inpatient        | 1.793*** | 1.763*** | 2.641*** |
|                  | (< 0.001) | (< 0.001) | (< 0.001) |
| Chronic diseases compare with not have chronic diseases |     |     |     |
| Chronic diseases | 1.043 | 1.191 | 2.056*** |
|                  | (0.910) | (0.626) | (< 0.001) |
| Disability compare with not disability |     |     |     |
| Disability       | 1.926*** | 2.424*** | 1.127 |
|                  | (0.005) | (< 0.001) | (0.189) |
| Outpatient compare with not outpatient |     |     |     |
| Outpatient       | 2.706*** | 2.424*** | 3.294*** |
|                  | (< 0.001) | (< 0.001) | (< 0.001) |

Note: (a) * p < 0.1, ** p < 0.05, *** p < 0.01; (b) Abbreviations: UEBMI, Urban Employee Basic Medical Insurance; NI, no insurance; UBMI, the Unified Basic Medical Insurance for urban residents without formal employment and rural residents; OI, Other Insurance; (c) CHE was defined as 10% of total expenditure; (d) CHE was defined based on 40% of non-food expenditure; (e) P-value in parentheses. (e) the cross-section of CHARLS in 2015 for logistic regression and CHE was defined as 40% of total expenditure.

In column (1), where CHE was defined as 10% of total expenditure, age and household size were not significant determinants of CHE. Household member with a spouse increased the prevalence of CHE,
about 1.73 times (p=0.004) than those without a spouse. Compared with those with NI, which mean they
should pay the whole cost of health care services by out-of-pocket, those with UBMI, UBMI and OI were
estimated to have a higher prevalence of CHE with 1.01 (95% CI: 0.42 to 2.41; p=0.982), 1.31 (95% CI:
0.74 to 2.29; p=0.353) and 2.49 (95% CI: 0.59 to 10.57; p=0.214) times respectively, all of them were not
statistically significant. This means that the various types of health insurance were not significant in
reducing CHE. The socio-economic status of households was another key driver of CHE. Compared with
the poorest, the richest was 0.08 (95% CI: 0.04 to 0.13; p<0.001) times than that of the poorest, while the
medium and the richer were 0.35(95% CI: 0.25 to 0.47; p<0.001) and 0.20 times (95% CI: 0.14 to 0.28;
p<0.001) respectively. The poor were 0.50 times (95% CI: 0.39 to 0.64; p<0.001) than that of the poorest.
In need factors, those who used inpatient services in the last review year and those who used outpatient
services in the last review month was 1.79 (95% CI: 1.42 to 2.27; p<0.001) and 2.25 (95% CI: 2.19 to 3.34;
p<0.001) times than those without such services. Those whose household with disability member(s) face
1.93 (95% CI: 1.22 to 3.04; p=0.005) times than those households without disability member(s). Lastly,
those household with chronic disease member was not significantly associated with a higher prevalence
of CHE, about 1.04 (95% CI: 0.51 to 2.15; p=0.91) times compare with those households without chronic
diseases member(s).

In column (2) where CHE was defined based on 40% of non-food expenditure, most of the results were
similar, with the socio-economic status was slightly larger than Column 1. For example, the CHE of the
richest was 0.19 times (95% CI: 0.12 to 0.30; p < 0.001) than that of the poorest, while the medium and the
richer were 0.45 (95% CI: 0.33 to 0.61; p < 0.001) and 0.33 (95% CI: 0.23 to 0.47; p < 0.001) times
respectively. The poor were 0.58 (95% CI: 0.45 to 0.75; p < 0.001) times than that of the poorest.

In column (3) we use the 2015 CHARLS cross-section data to further examine the impact of zone and
area on CHE. Here we select the standard of 40% of non-food expenditure as the standard of CHE. The
result reveals that household in Middle and Western zone face a higher prevalence of CHE, about 1.36
(95% CI: 1.08 to 1.71; p = 0.008) and 1.32 (95% CI: 1.05 to 1.65; p = 0.017) times than those households in
Eastern zone in respectively. Household in Rural area faces a lower prevalence of CHE, about 0.83(95% CI:
0.67 to 1.02; p = 0.078) times than those in the Urban area. Other variables were very similar.

Discussion

In this study, we estimated the overall incidence and intensity of CHE over five years among the elderly in
China with longitudinal data from CHARLS. We also explored the determinants associated with CHE. Our
study has three important findings.

First, we observed the incidence and intensity of CHE rose over the study period with two measurement
standards. The previous study had reported that the possibility of CHE could be higher than 50% of low-
income rural households in China[18]. This was unexpected because many policies were adopted in this
period for reducing the level of CHE. For instance, in 2012, China’s central government launched a
catastrophic medical insurance (CMI) program to prevent people from being reduced to poverty by health-
care costs[33]. The financial subsidy for health insurance for UBMI had increased from 200 to 380 yuan (RMB). It is therefore difficult to explain why the incidence and intensity of CHE continued to rise. One potential explanation is that in this period the health care expenditure increased significantly (our findings indicate that both the mean and median costs tripled in this period). In China, the main payment method for hospital charges was fee-for-service. In the absence of effective expenditure controls and with limited risk-sharing by the hospital, financial risk has been shifted to patients[34]. Hospitals have few incentives to cost control under a profit-seeking environment.

Second, the study showed that social health insurance programs have neither reduced the risk of catastrophic spending nor relieved the financial burden of the elderly in China. A study in China showed that health insurance increase health care usage, and as a consequence, the risk of CHE may also increase[35]. We also found there were similar CHE levels between UEBMI and UBMI groups. When OOP payments for health care were high, those who had UBMI may choose not to seek medical care instead of becoming impoverished from health expenditures for the reimbursement of UBMI was lower than UEBMI. In contrast, those who had UEBMI had few financial concerns for access to medical care, used a lot of medical services, but could end up with CHE. This finding indicates that the skill of management of health insurance in controlling health expenses should be further improved.

Third, our logistical results show that healthcare needs and service utilization are key determinants of catastrophic health expenditure. These results were agreed with previous studies[14, 36–38]. Our study found household member(s) with chronic conditions. Our data showed that at least 83% of households having member(s) with chronic disease. Our study also found that the risk of CHE was closely linked with economic status. Overall, there was a pro-poor effect among the elderly. The poorer the elderly, the more likely it was to suffer CHE.

Our research has important documentary value for recognizing the current medical security status of the elderly in China. At present, there are few studies on the current situation and influencing variables of Chinese elderly CHE especially using panel data. Besides, the introduction of Anderson's model on health care utilization in the framework of research has more comprehensively reflected the influencing variables of CHE.

However, some limitations of this study should be acknowledged. First, Our estimation of the proportion considered only those incurred health expenditure, the adverse impact of health-care cost on those households with member(s) did not seek treatment because they could not afford it was not examined, taking these omissions into account, the actual rate of physician use may be higher. Second, estimates of CHE in our study were influenced by the structure of the questionnaire, mode of data collection, recall bias. However, these limitations do not invalidate our work, the nature of large samples can reduce estimation bias to some extent, so do panel data we used.

Conclusion
China’s health sector reform has achieved unprecedented progress especially in terms of coverage of medical insurance, but protecting the elderly from health-care-related impoverishment remains a challenge. By examining the incidence and intensity of CHE and by identifying the main variables associated with CHE, several policy implications emerge from our study: (i) For poor households, there may be an abandonment of treatment, the government can issue free medical vouchers for their use and promote their basic medical needs. Many countries are using this approach to narrow the health gap between different income groups[39, 40]. (ii) For households that have already had CHE, it is necessary to gradually improve medical assistance and ensure that their normal life is not affected by health expenditures. (iii) the function of health insurance to control the price of medical services needs to be completely utilized. The international study has also proved that the investment in health insurance alone will not directly reduce out-of-pocket payments but also needs to strengthen measures such as reform of payment methods to control the rapid growth of medical expenses.[41]

Declarations

Ethics approval and consent to participate

Data used in this study were retrieved from CHARLS. This survey was endorsed by the Biomedical Ethics Committee of Peking University (NO. IRB00001052-11015). All participants of the survey signed or marked (if illiterate) the informed consent forms.

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and analysed during the current study are available in the CHARLS repository, [http://charls.pku.edu.cn/en]

Competing interests

The authors declare that they have no competing interests

Funding

This study was funded by Humanities and Social Science Funds from the Ministry of Education, China (Title: Research and Reform of China's Social Assistance System, No. 15JJD630009).

Author contributions

Qilin-Zhang and Shiai-Liu contributed to the conception and the design of the study and drafted the manuscript. Shiai-Liu acquisition of the data, Qilin-Zhang, Shiai-Liu and Mingqi-Fu contributed to the
analysis and the interpretation of the data. Peter C. Coyte contributed to the critical revision of the manuscript for important intellectual content.

Acknowledgements

Not applicable

Abbreviations

Catastrophic health expenditures, CHE;
China Health and Retirement Longitudinal Study, CHARLS;
Overshoot, O;
Mean positive overshoot, MPO;
New Health Care Reform, NHCR;
Urban Employee Basic Medical Insurance, UEBMI;
Unified Basic Medical Insurance, UBMI;
National Health Service Survey, NHSS;
Out-of-pocket healthcare payments, OOP;
Headcount, Hc.

References

1. Girard MP, Katz J, Pervikov Y, Palkonyay L, Kieny MP. Report of the 6th meeting on the evaluation of pandemic influenza vaccines in clinical trials World Health Organization, Geneva, Switzerland, 17–18 February 2010. Vaccine. 2010;28(42):6811–20. doi: 10.1016/j.vaccine.2010.07.034. PubMed PMID: 20659520.

2. WHO. The world health report 2010: health systems financing: the path to universal coverage. Geneva: WHO Press; 2010.

3. Manqie C, Yumei L. Suggestions on Solving Poverty Alleviation Caused by Poverty Caused by Rural Diseases. China Statistics. 2017;08:22–4.

4. Center for Health Statistics and Information. The fifth national health service survey report. Beijing: Peking Union Medical College Press; 2015.

5. Ekman B. Catastrophic health payments and health insurance: some counterintuitive evidence from one low-income country. Health Policy. 2007;83(2–3):304–13. doi:10.1016/j.healthpol.2007.02.004.
PubMed PMID: 17379351. Epub 2007/03/24.

6. Sun X, Jackson S, Carmichael G, Sleigh AC. Catastrophic medical payment and financial protection in rural China: evidence from the New Cooperative Medical Scheme in Shandong Province. Health Economics. 2009;(1):103–19.

7. Li Y, Wu Q, Liu C, Kang Z, Xie X, Yin H, et al. Catastrophic health expenditure and rural household impoverishment in China: what role does the new cooperative health insurance scheme play? PLoS One. 2014;9(4):e93253. Epub 2014/04/10. doi:10.1371/journal.pone.0093253. PubMed PMID: 24714605; PubMed Central PMCID: PMCPMC3979676.

8. Wang Z, Li X, Chen M. Catastrophic health expenditures and its inequality in elderly households with chronic disease patients in China. Int J Equity Health. 2015. doi:10.1186/s12939-015-0134-6. PubMed PMID: 25599715; PubMed Central PMCID: PMCPMC4304672.;14:8. Epub 2015/01/21.

9. Xu Y, Ma J, Wu N, Fan X, Zhang T, Zhou Z, et al. Catastrophic health expenditure in households with chronic disease patients: A pre-post comparison of the New Health Care Reform in Shaanxi Province, China. PLoS One. 2018;13(3):e0194539. doi:10.1371/journal.pone.0194539. PubMed PMID: 29547654; PubMed Central PMCID: PMCPMC5856426. Epub 2018/03/17.

10. Zhu M, Shi X. The impact of medical insurance coverage on migrant population's catastrophic health expenditure. Chinese Journal of Population Science. 2016;(6):47–57.

11. 10.3390/ijerph16050738
    Liu L, Zhang X, Zhao L, Li N. Empirical Analysis of the Status and Influencing Factors of Catastrophic Health Expenditure of Migrant Workers in Western China. Int J Environ Res Public Health. 2019;16(5). Epub 2019/03/03. doi: 10.3390/ijerph16050738. PubMed PMID: 30823652; PubMed Central PMCID: PMCPMC6427712.

12. Li Y, Wu Q, Xu L, David L, Hao Y, Gao L, et al. Factors affecting catastrophic health expenditure and impoverishment from medical expenses in China: policy implications of universal health insurance. Bull World Health Organ. 2012;90(9):664–71. doi: 10.2471/BLT.12.102178. PubMed PMID: 22984311; PubMed Central PMCID: PMCPMC3442391.

13. Wang L, Wang A, Fang G, Si L, Jiang Q. Analysis of the impact of poverty-stricken people's cash health expenditure on poverty in Anhui Province and related factors. Chinese Health Economics. 2013;32(5):69–71.

14. Aregbeshola BS, Khan SM. Determinants of catastrophic health expenditure in Nigeria. European Journal of Health Economics. 2018;19(4):521–32. doi:10.1007/s10198-017-0899-1. PubMed PMID: 28555372. Epub 2017/05/31.

15. Yang H, Nie M, Li F. Is universal health insurance effective against the economic risks of the disease? Statistics Decision. 2018;34(14):59–63.

16. Azzani M, Roslani AC, Su TT. Determinants of Household Catastrophic Health Expenditure: A Systematic Review. Malays J Med Sci. 2019;26(1):15–43. doi:10.21315/mjms2019.26.1.3. PubMed PMID: 30914891; PubMed Central PMCID: PMCPMC6419871. Epub 2019/03/28.
17. Choi JW, Choi JW, Kim JH, Yoo KB, Park EC. Association between chronic disease and catastrophic health expenditure in Korea. BMC Health Services Research. 2015;15:26. doi:10.1186/s12913-014-0675-1. PubMed PMID: 25608983; PubMed Central PMCID: PMCPMC4307618. Epub 2015/01/23.

18. Wu D, Yu F, Nie W. Improvement of the reduction in catastrophic health expenditure in China's public health insurance. PLoS One. 2018;13(4):e0194915. doi:10.1371/journal.pone.0194915. PubMed PMID: 29634779; PubMed Central PMCID: PMCPMC5892907. Epub 2018/04/11.

19. Wang X, Wang H. Evaluation of the effect of basic medical security system on improving catastrophic health expenditure. Chinese Public Health. 2017;33(6):901–4.

20. Dorjdagva J, Batbaatar E, Svensson M, Dorjsuren B, Kauhanen J. Catastrophic health expenditure and impoverishment in Mongolia. International Journal for Equity in Health. 2016;15(1):105. doi:10.1186/s12939-016-0395-8. PubMed PMID: 27401464; PubMed Central PMCID: PMCPMC4939814. Epub 2016/07/13.

21. Chen Z, Li W, Jiang Y. Impaction catastrophic health expenditure of rural elderly Journal of South China Agricultural University (Social Science Edition). 2017:45–53.

22. Wang Y, Xu D. Can basic medical insurance reduce catastrophic medical expenses for residents: An empirical analysis based on CHARLS data. Financial theory and practice. 2019;(2):87–94.

23. Guo N, Tor I, Lu M, Wang J, Luwen S. Does the new cooperative medical scheme reduce inequality in catastrophic health expenditure in rural China? BMC Health Services Research. 2016;16(1):653. doi:10.1186/s12913-016-1883-7. PubMed PMID: 28052775; PubMed Central PMCID: PMCPMC5214924. Epub 2017/01/06.

24. Zhu M, Yu X, Wang M, Xiong X. Evaluation of China's household catastrophic health expenditure and reimbursement modes of critical illness insurance. Economic Research Journal. 2017;(9):133–48.

25. Meng Q, Xu L, Zhang Y, Qian J, Cai M, Xin Y, et al. Trends in access to health services and financial protection in China between 2003 and 2011: a cross-sectional study. The Lancet. 2012;379(9818):805–14. doi:10.1016/s0140-6736(12)60278-5.

26. Deaton A. The analysis of household surveys: a microeconometric approach to development policy. Washington, DC: The World Bank; 2010.

27. O'Donnell O, Doorslaer Ev, Wagstaff A, Lindelow M. Analyzing Health Equity Using Household Survey Data: A Guide to Techniques and Their Implementation. Washington, D.C.: World Bank; 2008.

28. Wagstaff A, van Doorslaer E. Catastrophe and impoverishment in paying for health care: with applications to Vietnam 1993–1998. Health Econ. 2003;12(11):921–34. doi:10.1002/hec.776. PubMed PMID: 14601155. Epub 2003/11/06.

29. van Doorslaer E, O'Donnell O, Rannan-Eliya RP, Somanathan A, Adhikari SR, Garg CC, et al. Catastrophic payments for health care in Asia. Health Econ. 2007;16(11):1159–84. doi:10.1002/hec.1209. PubMed PMID: 17311356. Epub 2007/02/22.

30. Xu K, Evans DB, Kawabata K, Zeramdni R, Klavus J, L.Murray CJ. Household catastrophic health expenditure: a multicountry analysis. The Lancet. 2003;362(9378):111–7. doi:10.1016/s0140-6736(03)13861-5.
31. Andersen R, F.Newman J. Individual Determinants of Medical Care Utilization in the United States. The Milbank Memorial Fund quarterly Health society. 2010;51(1):95–124.

32. Chen Q. Advanced Econometrics and Stata Applications. Second. Beijing: Higher education press; 2014.

33. Zhao S, Zhang X, Dai W, Ding Y, Chen J, Fang P. Effect of the catastrophic medical insurance on household catastrophic health expenditure: evidence from China. Gac Sanit. 2019. Epub 2019/02/02. doi:10.1016/j.gaceta.2018.10.005. PubMed PMID: 30704817.

34. Xu Y, Gao J, Zhou Z, Xue Q, Yang J, Luo H, et al. Measurement and explanation of socioeconomic inequality in catastrophic health care expenditure: evidence from the rural areas of Shaanxi Province. BMC Health Serv Res. 2015;15:256. Epub 2015/07/04. doi:10.1186/s12913-015-0892-2. PubMed PMID: 26138738; PubMed Central PMCID: PMCPMC4490607.

35. Wagstaff A, Lindelow M. Can insurance increase financial risk? The curious case of health insurance in China. Journal of Health Economics. 2008;27(4):990–1005. doi:10.1016/j.jhealeco.2008.02.002. PubMed PMID: 18342963. Epub 2008/03/18.

36. Abolhallaje M, Hasani S, Bastani P, Ramezanian M, Kazemian M. Determinants of Catastrophic Health Expenditure in Iran Iranian. J Public Health. 2013;42:155–60.

37. Ashour M. Determinants of and changes in catastrophic health expenditure in the occupied Palestinian territory: an analysis of ten rounds of the Palestinian Households Expenditure and Consumptions Survey (1996–2011). The Lancet. 2018;391. doi:10.1016/s0140-6736(18)30343-x.

38. Sun X, Bernabe E, Liu X, Gallagher JE, Zheng S. Determinants of Catastrophic Dental Health Expenditure in China. PLoS One. 2016;11(12):e0168341. doi:10.1371/journal.pone.0168341. PubMed PMID: 27977756; PubMed Central PMCID: PMCPMC5158048. Epub 2016/12/16.

39. Pieper D, Kotte N, Ober P. The effect of a voucher incentive on a survey response rate in the clinical setting: a quasi-randomized controlled trial. BMC Med Res Methodol. 2018;18(1):86. doi:10.1186/s12874-018-0544-4. PubMed PMID: 30115037; PubMed Central PMCID: PMCPMC6097316. Epub 2018/08/18.

40. Jung J, Tran C. Health Care Financing over the Life Cycle, Universal Medical Vouchers and Welfare Social Science Electronic Publishig. 2010.

41. Yip W, Hsiao W. China's health care reform: A tentative assessment. China Econ Rev. 2009;20(4):613–9. doi:10.1016/j.chieco.2009.08.003.
Figure 1

Data flow diagram

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.
• Thomasdofilesofthepaper.do
• WideDataAnalysisEdition.dta
• LongDataAnalysisEdition.dta
• Longdata2015analysis.dta