# Impact of changing the maximum out-of-pocket amount on the health expenditure burden for low-income population in South Korea

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This certifies that the dissertation of ***Hyeon Ji Lee*** is approved.

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***Hyeon Ji Lee***

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# ABSTRACT

## Impact of changing the maximum out-of-pocket amount on the health expenditure burden for low-income population in South Korea

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**Background**: Since 2014, the maximum out-of-pocket (MOOP) amount has been improved to reduce the burden of health expenditure for the low-income population. Consequent to the subdivision from three sections to seven sections, based on the insurance premium income deciles, and the adjustment of the MOOP amount for each section, the MOOP amount for the low-income population was reduced. This study aims to analyze the changes in the burden of health expenditure and health utilization of the low-income population following the adjustment of the MOOP amount.

**Methods**: This study used the National Health Insurance Services sample cohort data to examine the adults in the first to fifth income deciles of insurance premium for each year from 2009 to 2015. Among the study participants, the first to third deciles with reduced MOOP were set as the treatment group, and the fourth to fifth deciles with no change in the MOOP were set as the control group.

The primary dependent variables were net-out-of-pocket expenses (net-OOPs), the estimated burden of catastrophic health expenditure (CHE), and total health expenditure for covered services. The study model used was segmented regression with difference-in-differences (DID), and it was investigated by focusing on the interaction terms of the treatment group and the control group before and after the implementation of the system. Analysis of secondary dependent variables, subgroup analysis, and sensitivity analysis with stabilized inverse probability treatment weight were also performed. The generalized estimation equation model was used as a statistical analysis method.

**Results**: The reduction of the MOOP amount was related to a decline in the burden of health expenditure of the low-income population. Consequently, the DID analysis results showed the reduction of the MOOP amount was associated with a decrease in the net-OOPs of the treatment group and a decrease in the expected burden of CHE (EXP(β)= 0.97, $p<.0001$; EXP(β)= 0.91, $p<.0001$, respectively).

The total health expenditure for covered services tended to decrease, but it was not statistically significant (EXP(β)=0.98, *p*=0.0976). Subsequent to the subgroup analysis, the estimated burden of CHE and total health expenditure for covered services in the group with high Charlson comorbidity index and cancer patients tended to increase immediately after the system implementation, and had a decreasing trend thereafter. The sensitivity analysis results were similar to the main analysis results.

**Conclusions**: The reduction of the MOOP amount reduced the burden of health expenditure without affecting the health utilization by the low-income population. Based on the results of this study, it can be stated that the downward adjustment of the MOOP amount worked for its purpose. However, there is a need to evaluate long-term effects on health expenditure for cancer patients and for those with severe illness. The results of this study may serve as a reference for system related to OOPs, including the MOOP. Furthermore, it is recommended that future evidence be presented to improve financial accessibility of health in low-income population.

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**Key words**: Maximum out-of-pocket, Cost-sharing, Health expenditure burden, Health utilization

# I. Introduction

## 1. Background

According to economic principles, various health services are bound to incur costs. However, owing to the socio-economic characteristics of healthcare different from common goods, many countries worldwide have established healthcare systems to ensure the health of people and find economic efficiency. They are implementing health policies based on the system. The healthcare system could traditionally be divided into National Health Service (NHS) and Social Health Insurance (SHI), and recently further subdivided into NHS, SHI, National Health Insurance (NHI), Private Health Insurance (PHI), and so on[1-3]. One of the key factors that distinguish these healthcare systems is financing, classified into taxation, insurance, and personal property[1-3].

In some systems, patients might be burdened with health expenditure depending on the health expenditure payment system. The greater the portion of the health expenditure that the patient pays in the total health expenditure, and the more increase the total health expenditure the patient has to pay, the more the patient could experience the burden of health expenditure.

According to the most recent health statistics data from the Organization for Economic Cooperation and Development (OECD), the OECD average of the proportion of out-of-pocket expenses (OOPs) paid in total health spending is 20.1%, whereas South Korea is 31.4%, which is higher than the OECD countries' average (a minimum is 9.3% in France, and a maximum is 41.4% in Mexico)[4] (Figure 1).

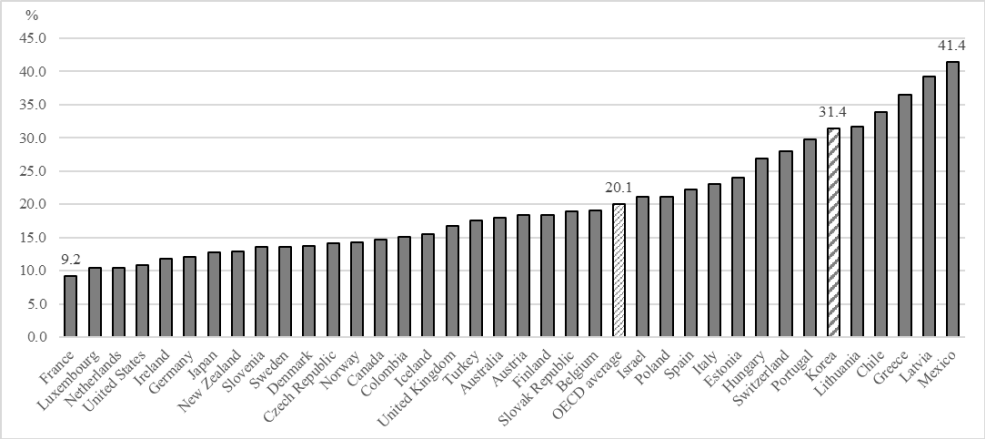


**Figure 1.** Out-of-pocket expenses (% of health spending)
Source: OECD health statistics, 2019 or latest value

Although there is a difference in the level of proportion by country, people's burden of health expenditure exists. As the burden and difficulty felt for health expenditure are relative to their income level or property, economic hardships caused by medical expenses and even medical bankruptcy are not unique to anyone country[5-8]. In South Korea, some people experience economic hardships owing to health expenditures. South Korea tried to realize universal health coverage through

NHI and realized the NHI in 12 years from 1977 to 1989[9]. However, to quickly apply health coverage to the entire population, started in the structure of low insurance premiums, low reimbursement, and low coverage, which has not been resolved about 40 years after the start of NHI[10,11].

Owing to the low coverage rate of NHI, OOPs have increased. In other words, the high burden of individual health expenditure is a problem owing to the structure of health insurance with low coverage. Patients are highly likely to experience financial hardship owing to the burden of health expenditure and physical difficulties caused by diseases[12-14]. In South Korea, as the burden of out-of-pocket payment increases[4], the proportion of people who experience catastrophic health expenditure (CHE) is also increasing[15,16]. In future, the number of patients facing difficulties and suffering from health cost will likely increase.

The South Korean government has implemented several policies to reduce the health expenditure burden by expanding insurance coverage. The maximum out-of-pocket (MOOP) amount is one of these policies, sets a maximum amount on the annual OOPs that patients have to pay, relieving the burden of spending more than the maximum amount. This is intended to prevent the experience of CHE caused by excessive OOPs and economic collapse[17].

This system was implemented in July 2004, and at the beginning of its introduction, the MOOP amount was uniform regardless of income decile. From

2009, the income deciles group on insurance premiums were divided into three sections, and the MOOP amount was set differently for each section, from 2014, to enhance health equity, the sections were further subdivided into seven sections, and the MOOP amount was adjusted for each section (Table 1).

In 2014, the MOOP amount of the income deciles 1st, 2nd, 3rd, 6th, and 7th groups based on insurance premium was reduced, the MOOP amount of the 4th, 5th, 8th, and 9th groups remained the same as before, and the MOOP amount of the tenth group was increased. Notably, the MOOP amount was reduced from the previous amount for the bottom 30 percent of income in accordance with the system change purpose of relieving the burden of health expenditure for the low-income population[17].

As there have been changes in the system, previous studies have evaluated the effect of the system. However, most studies did not apply quasi-experimental designs; the results might include the effects of other health policies.he MOOP amount has maintained seven sections by income decile, which began in 2014. As the main target group for system change was the low-income population, it is necessary to focus on investigating the effect of that change. Additionally, it is necessary to control the effects of other policies by applying a quasi-experimental methodology to evaluate only the effect of changing the MOOP amount.

**Table 1.** Change history of maximum out-of-pocket amount (unit: 10,000 KRW)

| Year | | group 1 | group 2 | group 3 | group 4 | group 5 | group 6 | group 7 |
|---|---|---|---|---|---|---|---|---|
| | | **1st income decile (low)** | **2nd-3rd income decile** | **4th-5th income decile** | **6th-7th income decile** | **8th income decile** | **9th income decile** | **10th income decile (high)** |
| 2004. 7. | | 300 by 6 months | | | | | | |
| 2007. 7. | | 200 by 6 months | | | | | | |
| **2009. 1.** | | **200 by 1 year (Low 50%)** | | | **300 by 1 year (Middle 30%)** | | **400 by 1 year (High 20%)** | |
| **2014. 1.** | | **120** | **150** | **200** | **250** | **300** | **400** | **500** |
| **2015. 1.** | | **121** | **151** | **202** | **253** | **303** | **405** | **506** |
| 2016. 1. | | 121 | 152 | 203 | 254 | 305 | 407 | 509 |
| 2017. 1. | | 122 | 153 | 205 | 256 | 308 | 411 | 514 |
| 2018. 1. | over 120 days admission in long-term hospitals | 124 | 155 | 208 | 260 | 313 | 418 | 523 |
| | others | 80 | 100 | 150 | | | | |
| 2019. 1. | over 120 days admission in long-term hospitals | 125 | 157 | 211 | 280 | 350 | 430 | 580 |
| | others | 81 | 101 | 152 | | | | |
| 2020. 1. | over 120 days admission in long-term hospitals | 125 | 157 | 211 | 281 | 351 | 431 | 582 |
| | others | 81 | 101 | 152 | | | | |
| 2021. 1. | over 120 days admission in long-term hospitals | 125 | 157 | 212 | 282 | 352 | 433 | 584 |
| | others | 81 | 101 | 152 | | | | |

Source: Revised Cho Yeal Park's dissertation table according to National Health Insurance

## 2. Study objectives

On January 1, 2014, the MOOP amount sections were subdivided into seven by income deciles based on insurance premiums, and the MOOP amount was changed for each section. The purpose of this study is to evaluate the effect of the changing MOOP amount conducted in 2014 on the low-income population by applying the experimental method. These results are intended to be provided as information that could suggest a better direction for the operation of OOPs-related systems, including MOOP amount, in the future. The detailed objectives of this study are as follows:

(1) To investigate whether the amount of net-OOPs and the burden of health expenditure have decreased in the low-income population, which was the aim of changing the system, owing to the effect of reducing the MOOP amount.

(2) To investigate whether reducing the burden of health expenditure by changing the MOOP amount has also changed health utilization in the low-income population.

# II. Literature Review

## 1. Health utilization model

There are various models proposed to explain health utilization[18-22]. Andersen's models are some of the behavior models that suggest the factors that affect health utilization. The models presented by Andersen regarding health utilization as an individual's behavior and explain the factors that influence this behavior.

The initial Andersen's model explains that an individual's health behavior is determined by the influence of predisposing characteristics, enabling resources, and individual’s need[23]. Expanding on the initial model, Andersen and Aday presented a health utilization model that encompasses health policy, health care system, and individual's determinants[24,25]. This model can be explained in terms of individual health utilization that are affected by the health care system, and that health policy can improve the health care system and individual behavior.

Further, extending on the previous model, Andersen and Davidson presented a behavioral model for health utilization that emphasizes contextual determinants and individual's determinants, including factors that promote or hinder

healthcare utilization (Figure 2)[26,27]. This model explains that health accessibility can be improved by focusing on individual determinants as well as contextual determinants. It is emphasized that contextual determinants could have a more direct effect on health behavior than the effects of individual determinants, and that health policies that consider not only individual determinants but also contextual determinants should be implemented to improve health accessibility.

Based on the Anderson's model, the types of cost-sharing in health services according to the national health system are determined by factors that could have a significant and direct impact on the public's health utilization.

Although Andersen's behavioral model ultimately focuses on individual health utilization, it has been widely used in studies focusing on health utilization in the healthcare field because it considers not only individual determinants but also contextual determinants.

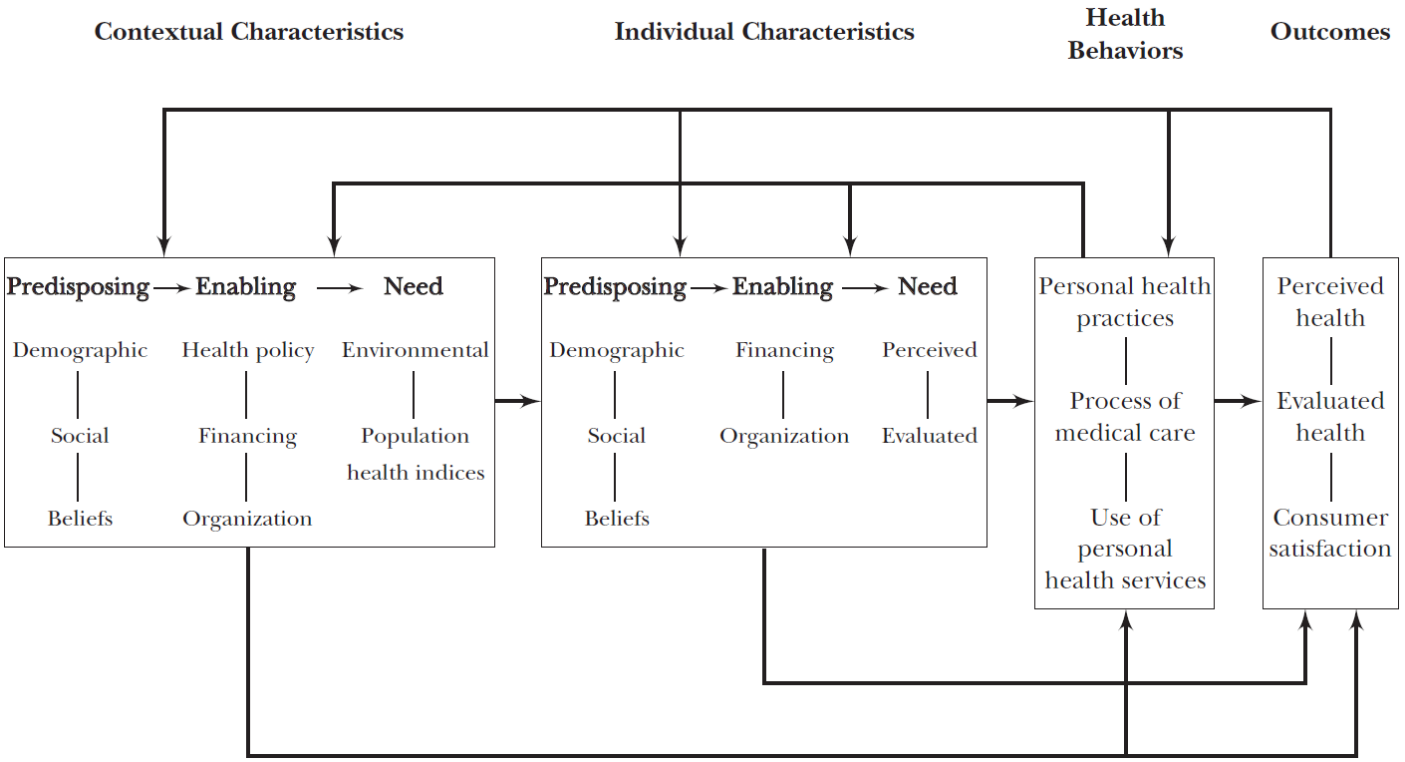


**Figure 2.** A behavioral model of health services use
Source: Andersen and Davidson (2007)

## 2. Cost-sharing in health services

Cost-sharing refers to sharing the burden of health expenditure incurred by the use of health services between the insurer and the patient and is mainly used to refer to the health expenditure that the patients have to pay; OOPs[28]. Therefore, the cost-sharing method, that is, the method of setting the amount of OOPs according to health services use, could be divided into the following three types; copayment, coinsurance, deductible[29]. Copayment is a way of paying a fixed amount of OOPs for each health service item. Coinsurance is a method in which paying OOPs according to a stated percentage rate per health service. Deductible is a way to pay OOPs before the insurer starts paying out for health services used.

South Korea's cost-sharing uses both copayment and coinsurance[30,31]. A coinsurance system is applied to most of inpatient and outpatient services and, a copayment is applied to some treatments at clinics, and health care centers or medical aid for particular population.

The reason for imposing a burden on patients for health expenditure through cost-sharing is to effectively use limited medical resources by preventing overuse or inappropriate health utilization[32-35]The cost-sharing was set to prevent moral hazard by imposing part of the burden of expenses to patients. However, if

the form or amount of cost-sharing is changed in the health system where cost-sharing existed, especially when the burden is reduced, moral hazard might occur.

Cost-sharing has also a negative aspect by which it might raise the financial threshold of health utilization and lowers the accessibility of health utilization[36,37]. Therefore, additional health expenditure assistance systems exist for patients who need health service but experience difficulties in using health service due to lack of money or who experience financial difficulties due to rapid increase of health expenditure[38,39].

The MOOP is one of the systems that support health expenditure, and it is also called the maximum contribution or safety net, which pays only up to the upper limit for a certain period of time[9]. In the United States, the MOOP is applied differently depending on the insurance plan under the yearly certain maximum amount specified by the Affordable Care. Although there are slight differences in the form of each country, the MOOP system is being implemented in France, Germany, Japan, Belgium, Taiwan, and so on, including South Korea.

## 3. Maximum out-of-pocket system

In South Korea, the MOOP system is implemented under the "Enforcement Decree of the National Health Insurance Act", Article 19, Paragraph 4[17]. Health expenditure applied to the MOOP system are based on all types of medicine, dental, pharmacy, and oriental health services covered by the NHIS, but exclude items that are not essential health services among covered services. This system also has other names, such as copayment ceiling, upper limit amount, cap of OOPs.

The MOOP system was introduced in July 2004 to reduce the burden of health expenditure for severely ill patients and to strengthen insurance coverage. Since 2009, the period of the system was changed from 6 months to 1 year, and different maximum amount has been applied by dividing three sections as the insurance premium decile which based on income: 2 million won for the lower 50% of income, 3 million won for the middle 30%, and 4 million won for the upper 20%. From 2014, the section was further subdivided into seven sections and the maximum amount for each section was adjusted for the purpose of reducing the health expenditure burden of the low-income population and enhancing health equity. And since 2015, the annual inflation rate has been reflected in the maximum amount for each section and adjusted accordingly. From 2018, the maximum

amount for the first to fifth insurance premium decile was further adjusted based on the hospitalization day (whether or not more than 120 days) (Table 1).

The MOOP system is divided into pre-paid and post-reimbursement by the NHIS, and is operated on a yearly basis (Figure 3). If the total OOPs for covered services received by a patient at the same medical institution exceeds the level corresponding to the maximum amount for tenth decile of the MOOP system, the health expenditure incurred from the moment it is exceeded is paid by NHIS. The pre-paid method could reduce the burden of health expenditure upon hospital discharge.

Post-reimbursement is operated in the form of a refund from the NHIS for the excess amount if the patient's total OOPs for all types of covered health services for one year exceeds the maximum amount corresponding to their insurance premium decile. In the case of post-reimbursement, the patient uses the health service for one year and then the health expenditure is retrospectively calculated for each patient in the next year, and if their OOPs' maximum amount is exceeded, the NHIS informs the patient that they are eligible for a reimbursement. If a patient applies for a refund to the NHIS, the amount corresponding to the excess could be refunded.

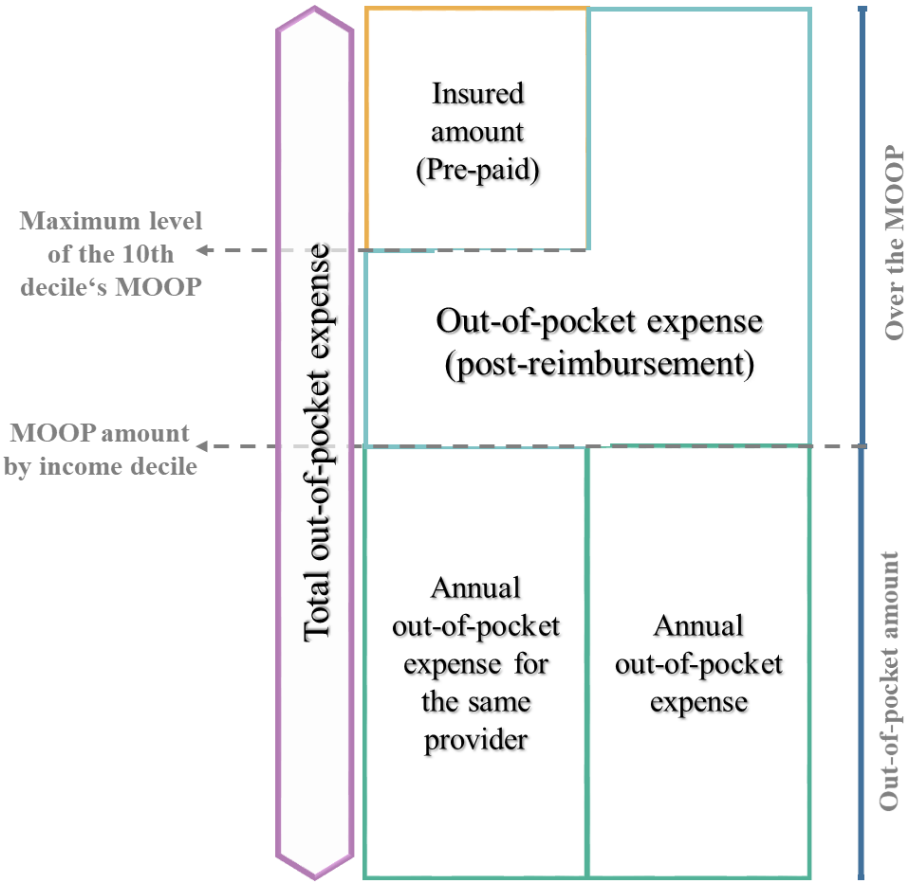


**Figure 3.** Operation of maximum out-of-pocket (MOOP) system
Note: All OOPs refer to the expenses for covered services by NHIS
Source: National Health Insurance Service

## 4. Previous studies on the maximum out-of-pocket system

There are several previous studies on the MOOP system in South Korea. Previous studies have focused on investigating health behavior before and after the system change based on the intervention point when the MOOP system was changed (ie, 2009 and 2014).

According to the results of previous studies that investigated changes in 2009[40,41], out-of-pocket expenses, health utilization, and number of patients who experienced CHE increased after the change compared to before the change. In addition, when only cancer patients were set as study participants, CHE experience rate showed a decreasing trend, but their health utilization increased[41]. According to the results of previous studies that studied changes in 2014[42-44], the number of MOOP beneficiaries increased significantly after further subdividing the system and adjustment of the maximum amount. In terms of health utilization, the use of inpatient services decreased and the use of outpatient services increased. In particular, according to the analysis by income level, the use of inpatient services for low-income groups decreased, the use of outpatient services increased, whereas for high-income groups, the use of inpatient increased and the use of outpatient decreased[43].

However, the results of these previous studies might have been influenced by external factors as well as the effect of changes in the MOOP system. The results for studies might reflect the trend of increasing health utilization as general interest and need in health services increases. Especially, the study results for changes in 2014 might have been influenced by external factors, including the policy of national health insurance coverage expansion, such as changing non-covered health services into covered services by NHIS. Therefore, it is necessary to evaluate only the effects of changes in the MOOP system through a quasi-experimental study design.

# III. Material and Methods

## 1. Framework of the Study Design

This study design was established based on the Anderson model. Through this model the change in MOOP amount were examined to see how its change affects the burden of health expenditure and health utilization in the low-income population. The framework of this study is given below (Figure 4).

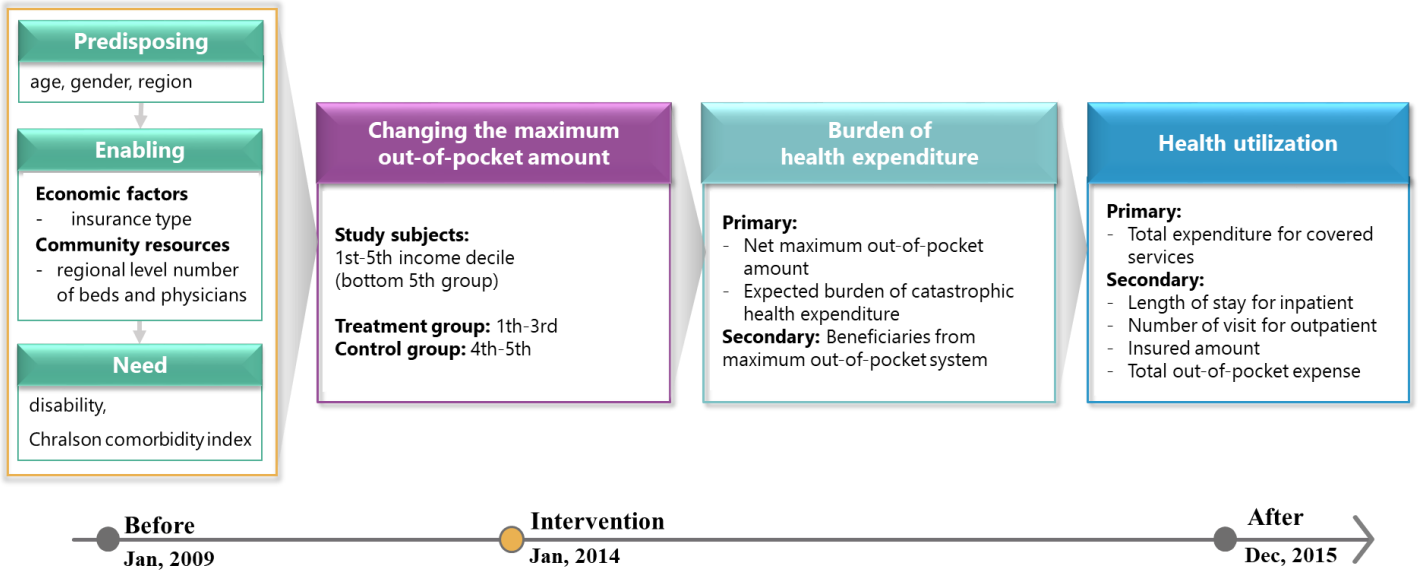


**Figure 4.** Conceptual framework of the study design

## 2. Data sources and study population

This study used the Korea National Health Insurance Service National Sample Cohort 2002 to 2015 (NHIS-NSC 2002–2015). The database was established by NHIS, a single insurer that provides universal healthcare coverage to all citizens living in South Korea[45,46]. The NHIS-NSC data is a population based cohort, represent the entire South Korea population, because 2.2% of the entire population in 2006 was sampled from the NHIS claim database. The baseline population of NHIS-NSC is 1,011,638 individuals in 2006, extracted from 48,222,537 individuals using stratified random sampling. A total of 2,142 strata, composed of age, sex, region and income, were used for the sampling process. The NHIS-NSC database contains all claim data from 2002 to 2015. The database also contains patient level variables; region, types of insured, birth date and death data, national health check-up information and hospital level variables; region, number of beds, number of physicians, number of medical equipment, types of hospital.

In this study, in order to examine the effects of system changes in 2014 for low-income beneficiaries from NHIS, the study period was set from 2009, the point of system changes before 2014, to 2015, the most recent year for which data is provided. The study target group is adults over the age of 19, which is the 1st-5th

decile based on the income decile of insurance premiums by year. Those born before 1921 whose exact age was unknown were excluded from the study. There were no missing values in the other variables. Among them, the 1st-3rd income decile for each year is the treatment group, and the 4th-5th income decile is the control group. Finally, treatment group (1st-3rd income decile) included 175,622 subjects in 2009, 174,262 subjects in 2010, 178,244 subjects in 2011, 183,210 subjects in 2012, 184,616 subjects in 2013, 191,471 subjects in 2014, 191,451 subjects in 2015. Control group (4th-5th income decile) included 136,671 in 2009, 139,977 in 2010, 140,856 in 2011, 139,391 in 2012, 143,315 in 2013, 143,230 in 2014, 145,358 in 2015 (Figure 5).

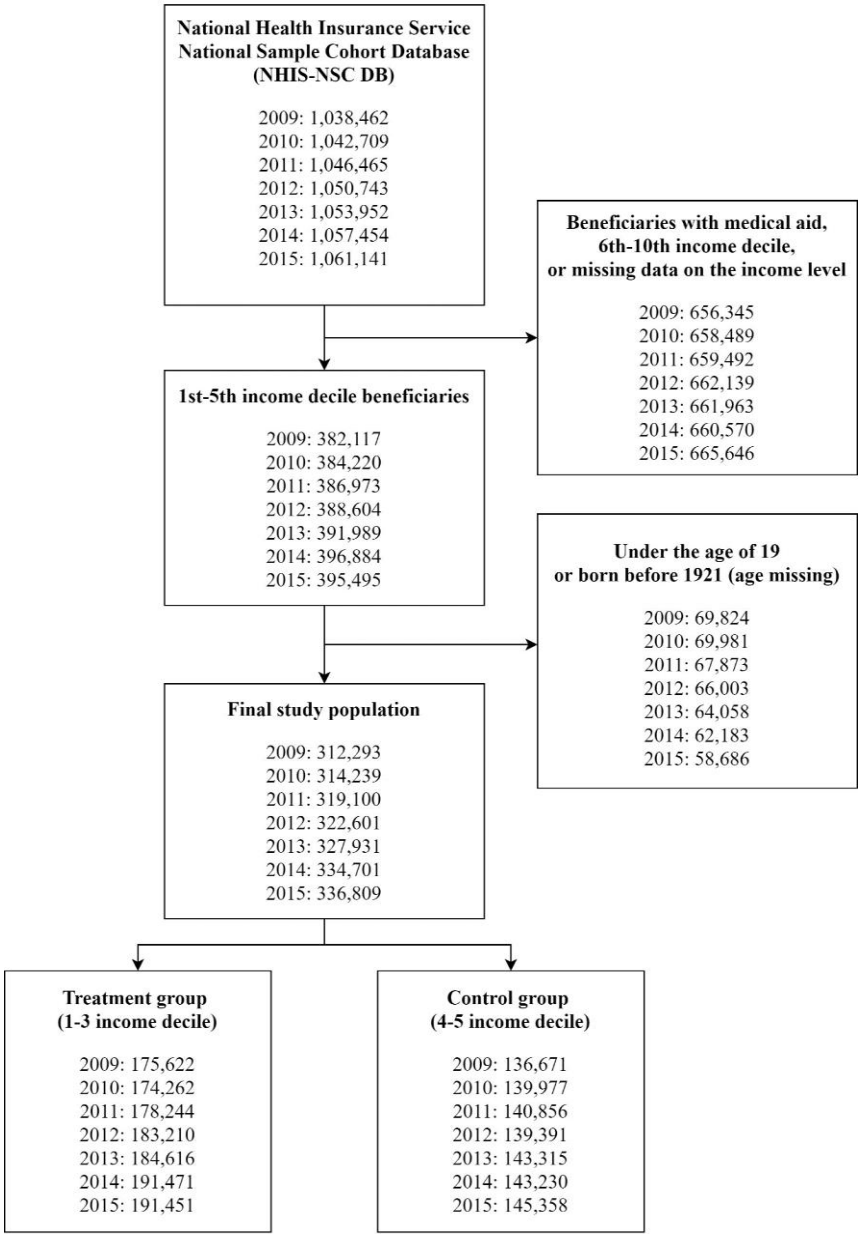


**Figure 5.** Flow chart of the study population

## 3. Definition of variables

### 1) Dependent variables

The primary dependent variables of this study were set as variables for investigating the burden of health expenditure (net-OOPs and expected burden of CHE) and variables for investigating health utilization (total health expenditure for covered services). In addition, MOOP beneficiaries and non-beneficiaries were set as secondary dependent variables to investigate the burden of health expenditure, and the length of stay for inpatient, the number of visits for outpatient, the insured amount, and the total OOPs were set as secondary dependent variables to investigate health utilization.

As for the health expenditure variable, to reflect the inflation, the conversion factor of relative value scale for each year was applied, and the value of 0 was adjusted by adding 1 to all observations to apply the log-link function in statistical analysis.

Net-OOPs were calculated as follows. If the annual total OOPs is over the MOOP amount, it is set as the MOOP amount, and if it is less than the MOOP amount, it is set as the actual OOPs.

The burden of CHE calculated in the following steps[47-49].

**1)** Estimation of out-of-pocket expenses for non-covered health services: The out-of-pocket for non-covered health services was inversely estimated using follow formula.

***Coverage rate by NHI*** *= (Insured amount ÷ Total health expenditure) × 100*

***Total health expenditure =*** *Insured amount + OOPs for covered services + OOPs for non-covered services*

The annual health insurance coverage rate by income decile each insurance type (employee and self-employed) are presented in the appendix (Appendix 1)[50]. If there was no observed expenditure for covered services at the NHIS, the non-covered out-of-pocket health expenditure will be 0.

2) Estimation of the capacity to pay: The capacity to pay amount is estimated through disposable income and food expenses by income decile each insurance type (Appendix 2-3)[51], the calculation is as follows.

***Capacity to pay =*** *disposal income – food expenses*

3) Estimation of the burden of CHE: The denominator is the capacity to pay, and the numerator is total health expenditure, which is the sum of total out-of-pocket amount (covered services amount and expected non-covered services amount) and insured amount. It is calculated according to the following formula:

***The burden of CHE =*** *(Total health expenditure ÷ Capacity to pay)* × *100*

**2) Interesting variable**

To evaluate the changing MOOP amount effect, this study included interaction term between the treatment variable and the intervention variable as the interesting variable. 1st-3rd income decile beneficiaries were indicated as the treatment group and defined “Treatment” variable as “1”. 4th-5th income decile beneficiaries were indicated as the control group and defined "Treatment" variables as "0".

Intervention variable was the implementation of changing MOOP amount. Since this intervention was implemented in January 1, 2014, the period between January 1, 2009 and December 31, 2013 was defined as the “Before” policy intervention period and indicated “Policy” variable as “0”. The period from January 1, 2014 to December 31, 2015 was defined as the “After” policy intervention period and indicated “Intervention” variable as “1” (Figure 6).

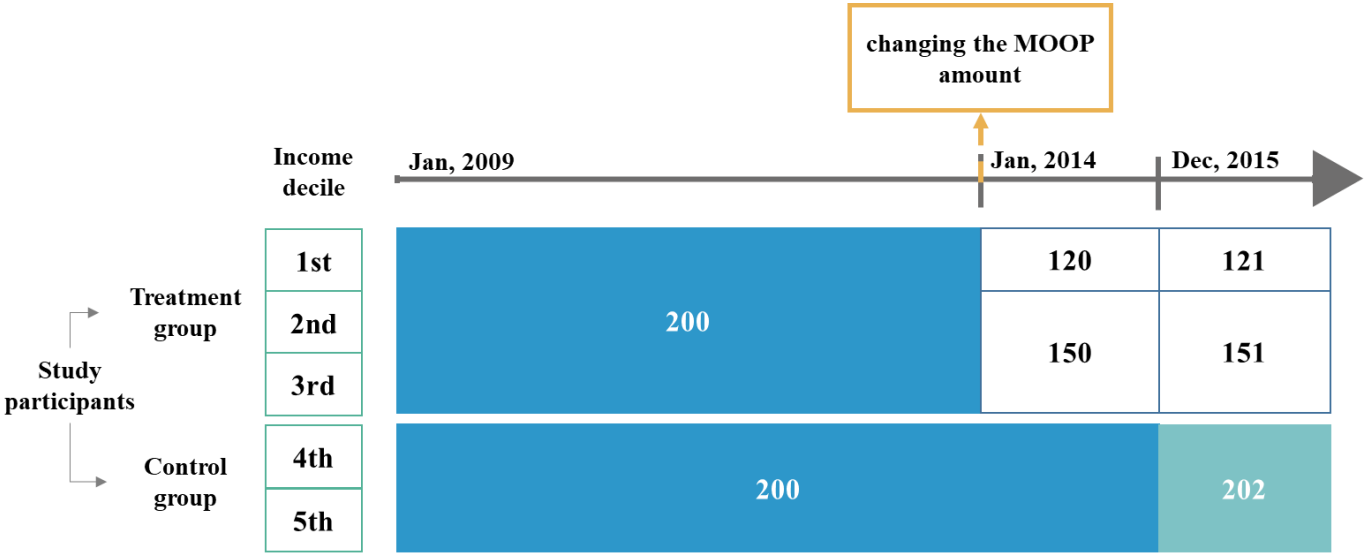


**Figure 6.** Changes of MOOP amount by income decile among low-income population

Note: Maximum out-of-pocket(MOOP) amount by income group (unit: 10,000 Korean won, yearly)

**3) Independent variables**

The independent variables of this study were age (19-29, 30-39, 40-49, 50-59, ≥60), sex (male or female), types of insurance (self-employed insured, employee insured), disability or not, Charlson comorbidity index (CCI: 0, 1, 2 or over)[52,53], and regional-level variables (Categorized the number of beds/physicians per 1,000 population in the region (by 17 Si-Do) as a third quartile by each study year). Regional-level variables were used by year data from Statistics Korea. This study also controlled for regional characteristics by including fixed effect for residential area in the regression.

**Table 2.** Composition of variables

| Variables | | | Description |
|---|---|---|---|
| **Dependent variables** | | | |
| Burden of health expenditure | Primary | Net-OOPs* | Health expenditure over the maximum: total OOPs - MOOP amount<br>Health expenditure under the maximum: total OOPs |
| | | Expected burden of CHE | Calculated according to yearly insurance type and income decile. |
| | Secondary | MOOP beneficiaries | Health expenditure exceeded the MOOP amount or not |
| Health utilization | Primary | Total expenditure for covered services* | Total health expenditure for all type of covered services by NHIS: medicine, dentistry, oriental medicine, pharmacy |
| | Secondary | Length of stay for inpatient | Treatment days for inpatient |
| | | No. of visits for outpatient | Number of visit for outpatient |
| | | Insured amount* | Expenses paid by insurer (NHIS) |
| | | Total OOPs* | Total out-of-pocket expense for covered services by NHIS |
| **Independent variable** | | | |
| Intervention | | | Before changing MOOP amount (2009 ~ 2013), After changing MOOP amount (2014 ~ 2015) |
| Treatment | | | Treatment: 1st-3rd income decile, Control: 4th-5th income decile |
| Interaction term | | | Treatment × Intervention |
| **Covariates** | | | |
| Age | | | 19-29, 30-39, 40-49, 50-59, 60-69, 70+ |
| sex | | | Male, Female |
| Types of insured | | | Self-employed, Employee |
| Disability | | | No, Yes |
| Charlson's comorbidity index | | | 0, 1, 2 or more |
| Regional level variables | | | Categorized the no. of beds/physicians per 1,000 population in the region (Si/Do) as a tertile by each year. |
| **Fixed effect** | | | Residential area (by 17 si-do administrative districts of Korea) |

*To apply the log-link function in statistical analysis, 1 won is added to all observations.
OOPs; out-of-pocket expenses, CHE; catastrophic health expenditure, MOOP; maximum out-of-pocket, NHIS; national health insurance service

## 5. Statistical methods

Chi-square tests, T-tests, and Standardized Mean Difference (SMD) were used to evaluate differences in proportion or mean between treatment group and control group for each factors. Then, this study summarized the general characteristics and dependent variables of treatment group and control group for the periods 2009-2013 (before changing MOOP amount) and 2014-2015 (after changing MOOP amount) by reporting frequencies and means using Chi-square tests and T-tests.

To investigate the effect of changing MOOP amount in low-income population, segmented regression with difference-in-differences (DID)[54-56] was used to examine any change in burden of health expenditure and health utilization among the treatment group (from 1st to 3rd decile income group) in the before (2009-2013) and after (2014-2015) intervention periods, relative to change in burden of healthcare expenditure and healthcare utilization for control group (from 4th to 5rh decile income group).

Segmented regression modelling is widely used for the analysis of interrupted time series data[54]. The DID method is generally used when evaluating policy effect in healthcare field[57], which reinforces the inference by adding a

concurrent control group to the interrupted time series model[54,55,58]. Therefore, this study used segmented regression with DID model to evaluate the effect of the change of MOOP amount implemented in 2014 by investigating the period from 2009 to 2015.

In this study, the following equation for Segmented Regression with DID analysis using Generalized Estimating Equation (GEE)[59,60] with fixed effect was used to investigate the effect of the changing MOOP amount in low-income population.

$$Y_{it}=\beta_0 + \beta_1(Time_t) + \beta_2(Intervention) + \beta_3(Time\ after\ Intervention)$$
$$+ \beta_4(Treatment_t) + \beta_5(Treatment_t \times Time_t) + \beta_6(Treatment_t \times Intervention)$$
$$+ \beta_7(Treatment_t \times Intervention \times Time\ after\ Intervention)$$
$$+ X_{it} + \varepsilon_{it}$$

***Y***: dependent variables

***i***: individual

***t***: time period

***Treatment***: dummy variable which assigns 1 if the treatment group

(1st to 3rd income decile after intervention, treatment = 1: treatment group, treatment = 0: control group)

***Intervention***: dummy variable which assigns 1 if time is after the changing MOOP amount intervention period

(policy = 1: after intervention, policy = 0: before intervention)

***Time***: yearly time variable started in 2009 (Continuous variable)

***Time after intervention***: yearly time variable started in 2014 (Continuous variable)

$\boldsymbol{X_{it}}$: covariates (sex, age, region, types of insured, disability, CCI, regional level number of bed and physician), and region fixed effect (by Si/Do)

$\boldsymbol{\varepsilon_{it}}$: residual variance

Subgroup analysis according to dependent variable, covariates, independent variable, and study participants was performed. In the subgroup analysis of the secondary dependent variable, the MOOP beneficiaries, the length of stay for inpatient, the number of visits for outpatient, the insured amount, and the total OOPs for covered services were analyzed as secondary dependent variables.

The covariates subgroup analysis analyzed the primary dependent variables according to the covariates. In particular, additional analysis was performed depending on the types of insured among the covariates.

The subgroup analysis of independent variables was analyzed by setting the period of study and the point of intervention; changing MOOP amount. First, the study period was set to be 1 year before and after the intervention (January 1, 2013 to December 31, 2014) and 2 years before and after the intervention (January 1, 2012 ~ December 31, 2015). Second, the period of study was the same as the main analysis, and the point of intervention was set differently to 2010, 2011, 2012, 2013, and 2015 instead of 2014.

The subgroup analysis according to the study participants was performed as follows. First, the analysis is performed on the 3rd and 4th income decile, which are classified into the treatment group and the control group even though the income decile are close and continuous. Second, even in the treatment group, there is a difference in the limits of copayment ceiling between the first and 2nd-3rd income

decile. Therefore, the 1st income decile versus 4th-5th income decile and 2nd-3rd income decile versus 4th-5th income decile are analyzed respectively. Third, the analysis was conducted on people whose OOPs for covered services in 2013 ranged from 1.2 million won to 2 million won, and those with 1.5 million won to 2 million won, the health expenditure range that could be affected by changes in the MOOP system. Additionally, patients with chronic kidney disease, rare disease, or cancer were analyzed.

Especially, chronic kidney disease is a disease that incurs more health expenditure compared to the number of patients. Chronic kidney disease patients are defined as those diagnosed with the main diagnosis code (Korean Classification of Disease [KCD] codes N18)[61]. Rare diseases were defined using the information provided by the database, and cancer patients were defined using the main diagnosis (KCD code: Cxx, D0x, D45, D46, D471, D474, D475)[62].

To investigate the health expenditure, GENMOD procedure with *log link, gamma distribution,* and *Autoregressive (1) Correlation Matrix Type* was used. To investigate the burden of CHE and health utilization, GENMOD procedure with *log link, negative binomial distribution,* and *Autoregressive (1) Correlation Matrix Type* was used. To investigate the MOOP beneficiaries, GENMOD procedure with *logit link, binomial distribution,* and *Autoregressive (1) Correlation Matrix Type* was used.

The sensitivity analysis was conducted by assigning weights using Stabilized Inverse Probability Treatment Weighting (Stabilized IPTW)[57,63,64]. In this sensitivity analysis, the characteristics of the two groups were matched by assigning weights to the treatment group and the control group by year included age, sex, types of insured, disability, CCI, and regional level number of beds and physicians.

All analysis was performed using SAS software (version 9.4; SAS Institute, Care, NC) and differences were considered statistically significant at a *p*-value of <0.05.

## 6. Ethics statement

This study was approved by the Institutional Review Board of Yonsei University Health System (IRB number: Y-2020-0211).

# IV. Results

## 1. General characteristics of study population

The general characteristics of the study population are shown in Table 3. The treatment group (1st-3rd income decile) included 175,622, 174,262, 178,244, 183,210, 184,616, 191,471, and 191,451 participants in 2009, 2010, 2011, 2012, 2013, 2014, and 2015, respectively. The control group (4th-5th income decile) included 136,671, 139,977, 140,856, 139,391, 143,315, 143,230, and 145,358 participants in 2009, 2010, 2011, 2012, 2013, 2014, and 2015, respectively. In all years, the number of participants in treatment group was more than the number of participants in control group. In all characteristics, there were statistically significant differences between the treatment group and the control group, and the differences were presented as SMD in percentage (Table 3, Appendix 4-5).

**Table 3.** General characteristics of study population

| variables | Total | | Treatment | | Control | | *p*-value | SMD in percent (%) |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | | |
| **Age** | | | | | | | <.0001 | -1.98 |
| 19-29 | 502,706 | 22.2 | 278,925 | 55.5 | 223,781 | 44.5 | | |
| 30-39 | 461,825 | 20.4 | 230,235 | 49.9 | 231,590 | 50.1 | | |
| 40-49 | 466,356 | 20.6 | 268,179 | 57.5 | 198,177 | 42.5 | | |
| 50-59 | 439,279 | 19.4 | 255,464 | 58.2 | 183,815 | 41.8 | | |
| ≥ 60 | 397,508 | 17.5 | 246,073 | 61.9 | 151,435 | 38.1 | | |
| **Sex** | | | | | | | <.0001 | -11.23 |
| Male | 1,081,986 | 47.7 | 578,952 | 53.5 | 503,034 | 46.5 | | |
| Female | 1,185,688 | 52.3 | 699,924 | 59.0 | 485,764 | 41.0 | | |
| **Types of insured** | | | | | | | <.0001 | -18.06 |
| Self-employed | 698,222 | 30.8 | 347,242 | 49.7 | 350,980 | 50.3 | | |
| Employee | 1,569,452 | 69.2 | 931,634 | 59.4 | 637,818 | 40.6 | | |
| **Disability** | | | | | | | <.0001 | 6.41 |
| No | 2,146,847 | 94.7 | 1,202,776 | 56.0 | 944,071 | 44.0 | | |
| Yes | 120,827 | 5.3 | 76,100 | 63.0 | 44,727 | 37.0 | | |
| **CCI** | | | | | | | <.0001 | 2.34 |
| 0 | 1,759,310 | 77.6 | 983,785 | 55.9 | 775,525 | 44.1 | | |
| 1 | 374,730 | 16.5 | 216,166 | 57.7 | 158,564 | 42.3 | | |
| 2 or over | 133,634 | 5.9 | 78,925 | 59.1 | 54,709 | 40.9 | | |

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.
SMD; Standardized mean difference, CCI; Charlson's comorbidity index

*continued on next page*

**Table 3.** *(Continued)*

| variables | Total | | Treatment | | Control | | *p*-value | SMD in percent (%) |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | | |
| **No. of beds†** | | | | | | | <.0001 | -1.98 |
| Low | 705,515 | 31.1 | 392,769 | 55.7 | 312,746 | 44.3 | | |
| Middle | 1,015,758 | 44.8 | 574,047 | 56.5 | 441,711 | 43.5 | | |
| High | 546,401 | 24.1 | 312,060 | 57.1 | 234,341 | 42.9 | | |
| **No. of physicians†** | | | | | | | <.0001 | -0.57 |
| Low | 192,352 | 8.5 | 107,594 | 55.9 | 84,758 | 44.1 | | |
| Middle | 1,194,835 | 52.7 | 670,325 | 56.1 | 524,510 | 43.9 | | |
| High | 880,487 | 38.8 | 500,957 | 56.9 | 379,530 | 43.1 | | |
| **Year** | | | | | | | <.0001 | -1.53 |
| 2009 | 312,293 | 13.8 | 175,622 | 56.2 | 136,671 | 43.8 | | |
| 2010 | 314,239 | 13.9 | 174,262 | 55.5 | 139,977 | 44.5 | | |
| 2011 | 319,100 | 14.1 | 178,244 | 55.9 | 140,856 | 44.1 | | |
| 2012 | 322,601 | 14.2 | 183,210 | 56.8 | 139,391 | 43.2 | | |
| 2013 | 327,931 | 14.5 | 184,616 | 56.3 | 143,315 | 43.7 | | |
| 2014 | 334,701 | 14.8 | 191,471 | 57.2 | 143,230 | 42.8 | | |
| 2015 | 336,809 | 14.9 | 191,451 | 56.8 | 145,358 | 43.2 | | |
| **Total** | **2,267,674** | **100.0** | **1,278,876** | **56.4** | **988,798** | **43.6** | | |

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.

SMD; Standardized mean difference, CCI; Charlson's comorbidity index

Table 4 shows the study participants' general characteristics and changes in primary dependent variables before and after the intervention by treatment group and the control group. The primary dependent variables also had statistically significant differences before and after the intervention in both the treatment group and the control group. The net-OOPs and total expenditure for covered services increased after intervention. The expected burden of CHE decreased from 0.80% before intervention to 0.59% after intervention in the treatment group, but slightly increased from 0.22% before intervention to 0.23% after intervention in the control group. The general characteristics of the study participants by year, the difference between the treatment group and the control group before and after the intervention by primary dependent variable are presented in the supplementary table (Appendix 6-8).

**Table 4.** General characteristics of study population by before and after intervention

| Variables | Treatment | | | | | Control | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before (2009-2013) | | After (2014-2015) | | *p*-value | Before (2009-2013) | | After (2014-2015) | | *p*-value |
| | N | % | N | % | | N | % | N | % | |
| **Total** | **895,954** | **100.0** | **382,922** | **100.0** | | **700,210** | **100.0** | **288,588** | **100.0** | |
| **Age** | | | | | <.0001 | | | | | <.0001 |
| 19-29 | 198,609 | 22.2 | 80,316 | 21.0 | | 161,293 | 23.0 | 62,488 | 21.7 | |
| 30-39 | 168,437 | 18.8 | 61,798 | 16.1 | | 168,216 | 24.0 | 63,374 | 22.0 | |
| 40-49 | 189,547 | 21.2 | 78,632 | 20.5 | | 141,131 | 20.2 | 57,046 | 19.8 | |
| 50-59 | 174,400 | 19.5 | 81,064 | 21.2 | | 126,830 | 18.1 | 56,985 | 19.7 | |
| ≥ 60 | 164,961 | 18.4 | 81,112 | 21.2 | | 102,740 | 14.7 | 48,695 | 16.9 | |
| **Sex** | | | | | <.0001 | | | | | <.0001 |
| Male | 406,738 | 45.4 | 172,214 | 45.0 | | 357,669 | 51.1 | 145,365 | 50.4 | |
| Female | 489,216 | 54.6 | 210,708 | 55.0 | | 342,541 | 48.9 | 143,223 | 49.6 | |
| **Types of insured** | | | | | <.0001 | | | | | <.0001 |
| Self-employed | 253,359 | 28.3 | 93,883 | 24.5 | | 257,023 | 36.7 | 93,957 | 32.6 | |
| Employee | 642,595 | 71.7 | 289,039 | 75.5 | | 443,187 | 63.3 | 194,631 | 67.4 | |
| **Disability** | | | | | 0.3690 | | | | | 0.2464 |
| No | 842,750 | 94.1 | 360,026 | 94.0 | | 668,428 | 95.5 | 275,643 | 95.5 | |
| Yes | 53,204 | 5.9 | 22,896 | 6.0 | | 31,782 | 4.5 | 12,945 | 4.5 | |
| **CCI** | | | | | <.0001 | | | | | <.0001 |
| 0 | 697,381 | 77.8 | 286,404 | 74.8 | | 555,209 | 79.3 | 220,316 | 76.3 | |
| 1 | 145,995 | 16.3 | 70,171 | 18.3 | | 107,947 | 15.4 | 50,617 | 17.5 | |
| 2 or over | 52,578 | 5.9 | 26,347 | 6.9 | | 37,054 | 5.3 | 17,655 | 6.1 | |

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.
CCI; Charlson's comorbidity index, SD; Standard deviation, OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, KRW; Korean Won

*continued on next page*

**Table 4.** *(Continued)*

| Variables | Treatment | | | | | Control | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before (2009-2013) | | After (2014-2015) | | *p*-value | Before (2009-2013) | | After (2014-2015) | | *p*-value |
| | N | % | N | % | | N | % | N | % | |
| **No. of beds†** | | | | | <.0001 | | | | | <.0001 |
| Low | 309,870 | 34.6 | 82,899 | 21.6 | | 248,731 | 35.5 | 64,015 | 22.2 | |
| Middle | 366,006 | 40.9 | 208,041 | 54.3 | | 283,892 | 40.5 | 157,819 | 54.7 | |
| High | 220,078 | 24.6 | 91,982 | 24.0 | | 167,587 | 23.9 | 66,754 | 23.1 | |
| **No. of physicians†** | | | | | <.0001 | | | | | <.0001 |
| Low | 83,747 | 9.3 | 23,847 | 6.2 | | 66,804 | 9.5 | 17,954 | 6.2 | |
| Middle | 458,994 | 51.2 | 211,331 | 55.2 | | 363,152 | 51.9 | 161,358 | 55.9 | |
| High | 353,213 | 39.4 | 147,744 | 38.6 | <.0001 | 270,254 | 38.6 | 109,276 | 37.9 | <.0001 |
| **Primary outcome variables, mean (SD)** | | | | | | | | | | |
| Net-OOPs (KRW) | 237,061 | 357,178 | 247,750 | 318,427 | <.0001 | 222,611 | 345,421 | 243,795 | 356,332 | <.0001 |
| Expected burden of CHE (%) | 0.80 | 4.25 | 0.59 | 2.31 | <.0001 | 0.22 | 0.73 | 0.23 | 0.73 | <.0001 |
| Total expenditure for covered services (KRW) | 1,061,087 | 2,992,890 | 1,218,766 | 3,394,507 | <.0001 | 958,776 | 2,795,510 | 1,080,688 | 3,045,803 | <.0001 |

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.
CCI; Charlson's comorbidity index, SD; Standard deviation, OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, KRW; Korean Won

## 2. Assumption of study design

The changes in the primary dependent variables of the treatment group and the control group by year are shown in Figure 7. The results of the before intervention parallel trend test for DID analysis are presented in the supplementary (Appendix 9).

The net-OOPs showed a parallel trend in the treatment group and the control group before intervention, and there was no statistically significant difference ($p$=0.9326). After intervention, the treatment group showed a larger drop than the control group. As for the expected burden of CHE, parallel trends could not be seen in the treatment group and the control group both before and after intervention, and there were statistically significant differences in trends before intervention ($p$ <.0001). The total expenditure for covered services showed a parallel trend in the treatment group and the control group both before and after intervention, and there was no statistically significant difference in the trend before intervention ($p$ =0.1536).

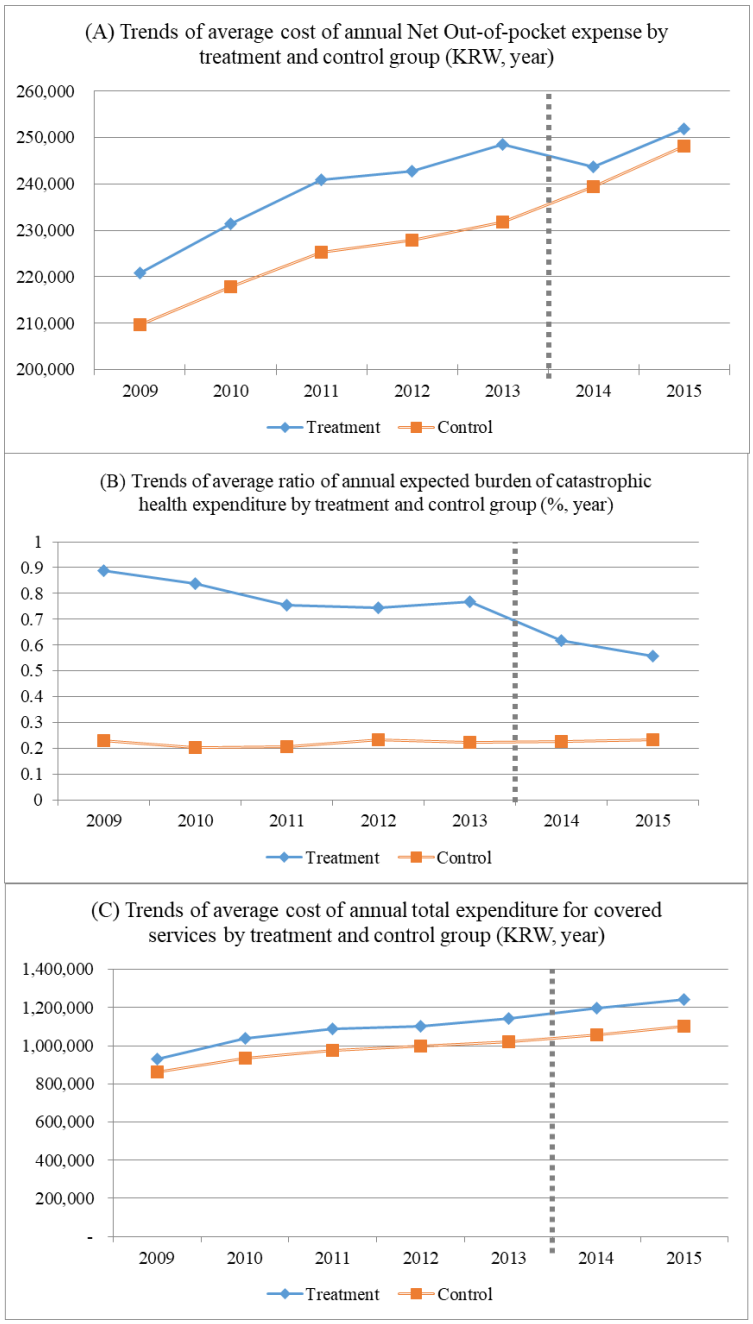


**Figure 7.** Trends of annual mean of primary dependent variables by treatment group and control group

## 3. Results of primary analysis

Table 5 presents the results of segmented regression with DID analysis and shows the differential changes in primary dependent variables (net-OOPs, expected burden of CHE, total expenditure for covered services). In the analysis in which this study assessed the level change of difference between treatment group and control group for changing MOOP amount effects, the reducing MOOP amount in the low-income population was found to be significant associated with a 3% reduction in net-OOPs and 2% reduction in expected burden of CHE (net-OOPs: $\beta$= -0.0356, exp($\beta$)=0.97, SE=0.0088, $p$<.0001; expected burden of CHE: $\beta$= -0.0951, exp($\beta$)=0.91, SE=0.0179, $p$<.0001). However, there was no statistically significant difference in change in total expenditure for covered services ($\beta$= -0.0221, exp($\beta$)=0.98, SE=0.0133, $p$=0.0976).

**Table 5.** Differential change over time in primary dependent variables for treatment group versus the control group

| Variables | Net-OOPs | | | | Expected burden of CHE | | | | Total expenditure for covered services | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **β** | **exp(β)** | **SE** | ***p*-value** | **β** | **exp(β)** | **SE** | ***p*-value** | **β** | **exp(β)** | **SE** | ***p*-value** |
| **Intercept β** | 11.2856 | | 0.0128 | <.0001 | -2.1261 | 0.12 | 0.0367 | <.0001 | 12.5669 | - | 0.0224 | <.0001 |
| **Baseline trend** | 0.0104 | 1.01 | 0.0012 | <.0001 | 0.0006 | 1.00 | 0.0023 | 0.8072 | 0.0219 | 1.02 | 0.0018 | <.0001 |
| **Level change** | 0.0066 | 1.01 | 0.0069 | 0.3344 | -0.0061 | 0.99 | 0.0120 | 0.6089 | 0.0177 | 1.02 | 0.0097 | 0.0688 |
| **Trend change** | 0.0054 | 1.01 | 0.0043 | 0.2131 | -0.0083 | 0.99 | 0.0083 | 0.3166 | -0.0085 | 0.99 | 0.0063 | 0.1785 |
| **Difference between treatment and control** | -0.0226 | 0.98 | 0.0041 | <.0001 | 1.1133 | 3.04 | 0.0103 | <.0001 | -0.0049 | 1.00 | 0.0066 | 0.4517 |
| **Baseline trend of difference between treatment and control** | 0.0040 | 1.00 | 0.0015 | 0.0085 | -0.0539 | 0.95 | 0.0036 | <.0001 | 0.0048 | 1.00 | 0.0024 | 0.0449 |
| **Level change of difference between treatment and control** | **-0.0356** | **0.97** | **0.0088** | **<.0001** | **-0.0951** | **0.91** | **0.0179** | **<.0001** | **-0.0221** | **0.98** | **0.0133** | **0.0976** |
| **Trend change of difference between treatment and control** | -0.0034 | 1.00 | 0.0056 | 0.5467 | 0.0174 | 1.02 | 0.0116 | 0.1353 | 0.0088 | 1.01 | 0.0086 | 0.3054 |
| **Age** | | | | | | | | | | | | |
| 19-29 | ref. | | | | ref. | | | | ref. | | | |
| 30-39 | 0.2195 | 1.25 | 0.0040 | <.0001 | 0.2240 | 1.25 | 0.0166 | <.0001 | 0.2536 | 1.29 | 0.0077 | <.0001 |
| 40-49 | 0.4426 | 1.56 | 0.0042 | <.0001 | 0.4122 | 1.51 | 0.0169 | <.0001 | 0.4709 | 1.60 | 0.0073 | <.0001 |
| 50-59 | 0.8600 | 2.36 | 0.0040 | <.0001 | 0.8249 | 2.28 | 0.0165 | <.0001 | 0.8868 | 2.43 | 0.0074 | <.0001 |
| ≥ 60 | 1.2296 | 3.42 | 0.0041 | <.0001 | 1.4344 | 4.20 | 0.0173 | <.0001 | 1.3929 | 4.03 | 0.0081 | <.0001 |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression analysis.

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a terrtile by each study year.

OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, SE; Standard Error, CCI; Charlson's comorbidity index

*continued on next page*

**Table 5.** *(Continued)*

| Variables | Net-OOPs | | | | Expected burden of CHE | | | | Total expenditure for covered services | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **Sex** | | | | | | | | | | | | |
| Male | ref. | | | | ref. | | | | ref. | | | |
| Female | 0.2549 | 1.29 | 0.0028 | <.0001 | 0.2269 | 1.25 | 0.0079 | <.0001 | 0.2509 | 1.29 | 0.0051 | <.0001 |
| **Types of insured** | | | | | | | | | | | | |
| Self-employed | ref. | | | | ref. | | | | ref. | | | |
| Employee | 0.0675 | 1.07 | 0.0027 | <.0001 | -0.8971 | 0.41 | 0.0076 | <.0001 | -0.0144 | 0.99 | 0.0043 | 0.0009 |
| **Disability** | | | | | | | | | | | | |
| No | ref. | | | | ref. | | | | ref. | | | |
| Yes | 0.3396 | 1.40 | 0.0068 | <.0001 | 0.8341 | 2.30 | 0.0214 | <.0001 | 0.6629 | 0.02 | 0.0199 | <.0001 |
| **CCI** | | | | | | | | | | | | |
| 0 | ref. | | | | ref. | | | | ref. | | | |
| 1 | 0.4226 | 1.53 | 0.0024 | <.0001 | 0.4793 | 1.61 | 0.0064 | <.0001 | 0.4314 | 1.54 | 0.0042 | <.0001 |
| 2 or over | 0.9068 | 2.48 | 0.0041 | <.0001 | 1.4316 | 4.19 | 0.0106 | <.0001 | 1.3087 | 3.70 | 0.0097 | <.0001 |
| **No. of beds†** | | | | | | | | | | | | |
| Low | ref. | | | | ref. | | | | ref. | | | |
| Middle | -0.0151 | 0.99 | 0.0044 | 0.0006 | 0.0412 | 1.04 | 0.0129 | 0.0014 | -0.0239 | 0.98 | 0.0070 | 0.0007 |
| High | 0.0112 | 1.01 | 0.0121 | 0.3533 | 0.1459 | 1.16 | 0.0340 | <.0001 | 0.0318 | 1.03 | 0.0171 | 0.0637 |
| **No. of physicians†** | | | | | | | | | | | | |
| Low | ref. | | | | ref. | | | | ref. | | | |
| Middle | 0.0118 | 1.01 | 0.0061 | 0.0550 | -0.0177 | 0.98 | 0.0133 | 0.1848 | -0.0002 | 1.00 | 0.0088 | 0.9832 |
| High | -0.0219 | 0.98 | 0.0117 | 0.0622 | -0.0872 | 0.92 | 0.0330 | 0.0082 | -0.0427 | 0.96 | 0.0202 | 0.0347 |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression analysis.

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.

OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, SE; Standard Error, CCI; Charlson's comorbidity index

## 4. Results of subgroup analysis

### 1) Results of subgroup analysis on secondary dependent variables

Table 6 shows the mean values before and after the intervention according to the secondary dependent variable and the summary results of the segmented regression with DID analysis. The yearly trend (Appendix 10-11), results of before intervention parallel trend test for DID analysis (Appendix 9), and the overall results of segmented regression with DID analysis for each secondary dependent variable are presented in the supplementary table (Appendix 12-13). The analysis included all covariates and fixed effects.

In order to investigate whether the reduced burden of health expenditure is due to the increased possibility of receiving the benefits of MOOP system according to intervention implementation, the MOOP beneficiaries were set as secondary dependent variables. The unadjusted distribution of MOOP beneficiaries increased significantly in the treatment group after intervention than in the control group. The results of the segmented regression with DID analysis also increased and was statistically significant ($\beta$= 0.7390, exp($\beta$)=2.09, SE=0.0613, $p$<.0001).

To investigate changes in health utilization, it was analyzed by setting the length of stay for inpatient, the number of visits for outpatient, the insured amount, and the total OOPs for covered services as secondary dependent variables of total expenditure for covered services. The unadjusted mean increased after the intervention of all variables in both the treatment group and control groups, and this difference was statistically significant. As a result of the segmented regression with DID analysis, the length of stay for inpatient and the number of visits for outpatient decreased after intervention in the treatment group than in the control group, but it was not statistically significant (length of stay for inpatient: β= -0.0398, exp(β)=0.96, SE=0.0339, *p*=0.2406; number of visits for outpatient: β= -0.0040, exp(β)=1.00, SE=0.0058, *p*=0.4983). In addition, the insured amount and total OOPs decreased, but it was also not statistically significant (insured amount: β= -0.0251, exp(β)=0.98, SE=0.0151, *p*=0.0962; total OOPs: β= -0.0012, exp(β)=1.00, SE=0.0103, *p*=0.2326). However, the trend change of difference between treatment and control in the days of length of stay showed a statistically significant increase in the treatment group after the intervention (β= 0.0461, exp(β)=1.05, SE=0.0231, *p*=0.0459).

**Table 6.** Results of subgroup analysis on secondary dependent variables

| Variables | Unadjusted value (before) | Unadjusted value (after) | *p*-value* | Level change of difference between treatment and control | | | | Trend change of difference between treatment and control | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **MOOP beneficiaries (Yes, %)** | | | | | | | | | | | |
| Treatment | 1.08 | 2.90 | <.0001 | **0.7390** | **2.09** | **0.0613** | **<.0001** | 0.0426 | 1.04 | 0.0379 | 0.2604 |
| Control | 0.96 | 1.25 | <.0001 | | | | | | | | |
| **Length of stay for inpatient** | | | | | | | | | | | |
| Treatment | 2.69 | 3.17 | <.0001 | **-0.0398** | **0.96** | **0.0339** | **0.2406** | 0.0461 | 1.05 | 0.0231 | 0.0459 |
| Control | 2.20 | 2.51 | <.0001 | | | | | | | | |
| **No. of visits for outpatient** | | | | | | | | | | | |
| Treatment | 16.34 | 17.04 | <.0001 | **-0.0040** | **1.00** | **0.0058** | **0.4983** | 0.0023 | 1.00 | 0.0039 | 0.5500 |
| Control | 14.95 | 15.47 | <.0001 | | | | | | | | |
| **Insured amount** | | | | | | | | | | | |
| Treatment | 801,455 | 925,956 | <.0001 | **-0.0251** | **0.98** | **0.0151** | **0.0962** | 0.0104 | 1.01 | 0.0098 | 0.2864 |
| Control | 717,297 | 811,220 | <.0001 | | | | | | | | |
| **Total OOPs** | | | | | | | | | | | |
| Treatment | 256,074 | 287,422 | <.0001 | **-0.0012** | **1.00** | **0.0103** | **0.2326** | 0.0031 | 1.00 | 0.0066 | 0.6380 |
| Control | 239,147 | 265,931 | <.0001 | | | | | | | | |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression analysis.

**p* for before and after difference

MOOP; Maximum out-of-pocket, OOPs; Out-of-pocket expense, SD; Standard deviation, SE; Standard Error

**2) Results of subgroup analysis on covariates**

Table 7, Table 8, and Table 9 shows the results of the subgroup analysis of the independent variable, including covariates and fixed effects.

As a result of the analysis of net-OOPs, the level change of difference between treatment and control decreased significantly in the group over 60 and the group with disabilities, which is a statistically significant result. The higher the CCI, the larger the decrease in the level change of difference between treatment and control group. Additionally, although both self-employed insured group and employee insured group showed a decrease, only the employee insured group was statistically significant.

Analysis of the expected burden of CHE showed decreased levels of change of the difference between treatment and control in most results. In the results according to types of insured, the self-employed insured group decreased significantly and was statistically significant, the employee insured group decreased, but it was not statistically significant. The group with the disability decreased more than the group without the disability. The lower the CCI score, the more it decreased, and the group with a CCI score of 2 or more showed an increase, but it was not statistically significant. The result of the trend change of the difference between treatment and control after intervention showed a decreasing trend in the self-

employed insured group, but an increasing trend in the employee insured group, both of which were statistically significant. In the results of CCI, the group with a score of 0 significantly increased, and the group with a score of 2 or more decreased statistically.

As an analysis of total expenditure for covered services, the results of the level change of difference between treatment and control according to CCI, the group with a score of 0 was statistically significantly decreased, but the group with a score of 2 or more increased statistically significantly. The result of trend change difference between treatment and control, the group with a score of 2 or more decreased statistically significantly.

Because it was calculated by types of insured when calculating the expected burden of CHE, the annual mean value of primary dependent variables according to the types of insured was additionally presented (Appendix 14-15). As a result of the parallel trend test before the intervention, in the self-employed insured group, the expected burden of CHE ($p<.0001$) and total expenditure for covered services ($p<.0001$) were statistically significantly different between the treatment group and control group before intervention.

**Table 7.** The results of subgroup analysis by covariates on net-out-of-pocket expense

| Variables | Net-OOPs | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Level change of difference between treatment and control | | | | Trend change of difference between treatment and control | | | |
| | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **Age** | | | | | | | | |
| 19-29 | -0.0385 | 0.96 | 0.0246 | 0.1181 | 0.0108 | 1.01 | 0.0152 | 0.4790 |
| 30-39 | -0.0207 | 0.98 | 0.0233 | 0.3749 | -0.0097 | 0.99 | 0.0146 | 0.5057 |
| 40-49 | -0.0376 | 0.96 | 0.0206 | 0.0672 | 0.0033 | 1.00 | 0.0129 | 0.7995 |
| 50-59 | -0.0181 | 0.98 | 0.0155 | 0.2440 | -0.0107 | 0.99 | 0.0099 | 0.2822 |
| ≥ 60 | -0.0598 | 0.94 | 0.0131 | <.0001 | -0.0043 | 1.00 | 0.0083 | 0.6023 |
| **Sex** | | | | | | | | |
| Male | -0.0367 | 0.96 | 0.0145 | 0.0113 | 0.0030 | 1.00 | 0.0091 | 0.7437 |
| Female | -0.0363 | 0.96 | 0.0107 | 0.0007 | -0.0078 | 0.99 | 0.0068 | 0.2479 |
| **Types of insured** | | | | | | | | |
| Self-employed | -0.0258 | 0.97 | 0.0174 | 0.1372 | -0.0177 | 0.98 | 0.0110 | 0.1065 |
| Employee | -0.0377 | 0.96 | 0.0104 | 0.0003 | -0.0002 | 1.00 | 0.0065 | 0.9769 |
| **Disability** | | | | | | | | |
| No | -0.0327 | 0.97 | 0.0092 | 0.0004 | -0.0037 | 1.00 | 0.0058 | 0.5209 |
| Yes | -0.0815 | 0.92 | 0.0270 | 0.0025 | -0.0061 | 0.99 | 0.0172 | 0.7222 |
| **CCI** | | | | | | | | |
| 0 | -0.0283 | 0.97 | 0.0110 | 0.0102 | -0.0015 | 1.00 | 0.0069 | 0.8271 |
| 1 | -0.0274 | 0.97 | 0.0168 | 0.1021 | -0.0199 | 0.98 | 0.0105 | 0.0589 |
| 2 or over | -0.0841 | 0.92 | 0.0120 | <.0001 | -0.0015 | 1.00 | 0.0120 | 0.9037 |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression analysis.

CCI; Charlson's comorbidity index, OOPs; Out-of-pocket expense, SE; Standard Error

**Table 8.** The results of subgroup analysis by covariates on expected burden of catastrophic health expenditure

| Variables | Expected burden of CHE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Level change of difference between treatment and control | | | | Trend change of difference between treatment and control | | | |
| | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **Age** | | | | | | | | |
| 19-29 | -0.0655 | 0.94 | 0.0589 | 0.2662 | 0.0159 | 1.02 | 0.0303 | 0.5991 |
| 30-39 | -0.1589 | 0.85 | 0.0550 | 0.0039 | 0.0081 | 1.01 | 0.0321 | 0.8018 |
| 40-49 | -0.1509 | 0.86 | 0.0447 | 0.0007 | -0.0003 | 1.00 | 0.0285 | 0.9915 |
| 50-59 | -0.0356 | 0.97 | 0.0441 | 0.4195 | 0.0384 | 1.04 | 0.0301 | 0.2021 |
| ≥ 60 | -0.0806 | 0.92 | 0.0255 | 0.0015 | 0.0083 | 1.01 | 0.0168 | 0.6235 |
| **Sex** | | | | | | | | |
| Male | -0.0922 | 0.91 | 0.0288 | 0.0013 | 0.0157 | 1.02 | 0.0178 | 0.3790 |
| Female | -0.1040 | 0.90 | 0.0226 | <.0001 | 0.0163 | 1.02 | 0.0151 | 0.2784 |
| **Types of insured** | | | | | | | | |
| Self-employed | -0.1407 | 0.87 | 0.0341 | <.0001 | -0.0910 | 0.91 | 0.0227 | <.0001 |
| Employee | -0.0191 | 0.98 | 0.0209 | 0.3615 | 0.0276 | 1.03 | 0.0133 | 0.0381 |
| **Disability** | | | | | | | | |
| No | -0.0876 | 0.92 | 0.0193 | <.0001 | 0.0067 | 1.01 | 0.0124 | 0.5893 |
| Yes | -0.1077 | 0.90 | 0.0443 | 0.0150 | 0.0432 | 1.04 | 0.0287 | 0.1323 |
| **CCI** | | | | | | | | |
| 0 | -0.1283 | 0.88 | 0.0208 | <.0001 | 0.0343 | 1.03 | 0.0140 | 0.0143 |
| 1 | -0.0894 | 0.91 | 0.0362 | <.0001 | -0.0144 | 0.99 | 0.0232 | 0.5350 |
| 2 or over | 0.0559 | 1.06 | 0.0521 | 0.2831 | -0.0763 | 0.93 | 0.0327 | 0.0197 |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression analysis.

CCI; Charlson's comorbidity index, CHE; Catastrophic Health Expenditure, SE; Standard Error

**Table 9.** The results of subgroup analysis by covariates on total expenditure for covered services

| Variables | Total expenditure for covered services | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Level change of difference between treatment and control | | | | Trend change of difference between treatment and control | | | |
| | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **Age** | | | | | | | | |
| 19-29 | -0.0438 | 0.96 | 0.0332 | 0.1865 | 0.0189 | 1.02 | 0.0202 | 0.3505 |
| 30-39 | -0.0200 | 0.98 | 0.0357 | 0.5748 | 0.0039 | 1.00 | 0.0230 | 0.8662 |
| 40-49 | -0.0294 | 0.97 | 0.0322 | 0.3603 | 0.0003 | 1.00 | 0.0206 | 0.9895 |
| 50-59 | -0.0074 | 0.99 | 0.0293 | 0.8002 | 0.0053 | 1.01 | 0.0189 | 0.7807 |
| ≥ 60 | 0.0099 | 1.01 | 0.0214 | 0.6424 | 0.0098 | 1.01 | 0.0140 | 0.4831 |
| **Sex** | | | | | | | | |
| Male | -0.0185 | 0.98 | 0.0208 | 0.3739 | 0.0168 | 1.02 | 0.0131 | 0.1999 |
| Female | -0.0292 | 0.97 | 0.0170 | 0.0853 | 0.0060 | 1.01 | 0.0110 | 0.5899 |
| **Types of insured** | | | | | | | | |
| Self-employed | -0.0302 | 0.97 | 0.0274 | 0.2711 | 0.0102 | 1.01 | 0.0176 | 0.5635 |
| Employee | -0.0148 | 0.99 | 0.0154 | 0.3371 | 0.0028 | 1.00 | 0.0101 | 0.7789 |
| **Disability** | | | | | | | | |
| No | -0.0251 | 0.98 | 0.0138 | 0.0694 | 0.0052 | 1.01 | 0.0089 | 0.5622 |
| Yes | 0.0073 | 1.01 | 0.0376 | 0.8463 | 0.0432 | 1.04 | 0.0239 | 0.0702 |
| **CCI** | | | | | | | | |
| 0 | -0.0372 | 0.96 | 0.0153 | 0.0152 | 0.0184 | 1.02 | 0.0100 | 0.0648 |
| 1 | 0.0005 | 1.00 | 0.0307 | 0.9872 | -0.0178 | 0.98 | 0.0199 | 0.3710 |
| 2 or over | 0.1407 | 1.15 | 0.0452 | 0.0019 | -0.0626 | 0.94 | 0.0290 | 0.0307 |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression analysis.

CCI; Charlson's comorbidity index, SE; Standard Error

### 3) Results of analysis according to study period and point of intervention

Table 10 shows the results of the analysis by setting the study period and point of intervention differently. The analysis included all covariates and fixed effects. First, the analysis of limiting the study period showed a statistically significant decrease in the net-OOPs and expected burden of CHE, but no statistically significant results were reported for the total expenditure for covered services.

As a result of the analysis by setting the point of intervention differently, at all points, there was no statistically significant change in total expenditure for covered services, and the burden of CHE showed statistically significant reduction. It was investigated that the net-OOPs decreased in a statistically significantly manner when 2015 was set as the point of intervention.

**Table 10.** The results of subgroup analysis by study period and point of intervention

| Variables | Net-OOPs | | | | Expected burden of CHE | | | | Total expenditure for covered services | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **Study period: 2013-2014†** | | | | | | | | | | | | |
| **DID effect (Treatment × Control)** | **-0.0325** | **0.97** | **0.0056** | **<.0001** | **-0.1864** | **0.83** | **0.0118** | **<.0001** | **-0.0046** | **1.00** | **0.0084** | **0.5857** |
| **Study period: 2012-2015†** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0356** | **0.97** | **0.0090** | **<.0001** | **-0.1333** | **0.88** | **0.0182** | **<.0001** | **-0.0248** | **0.98** | **0.0137** | **0.0704** |
| Trend change of difference between treatment and control | -0.0025 | 1.00 | 0.0080 | 0.7505 | -0.0763 | 0.93 | 0.0159 | <.0001 | 0.0007 | 1.00 | 0.0119 | 0.9561 |
| **Study period: 2009-2013, 2015†** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0479** | **0.95** | **0.0074** | **<.0001** | **-0.1144** | **0.89** | **0.0169** | **<.0001** | **-0.0139** | **0.99** | **0.0113** | **0.2190** |
| **Intervention point: 2010** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0018** | **1.00** | **0.0069** | **0.7917** | **-0.0405** | **0.96** | **0.0153** | **0.0081** | **-0.0001** | **1.00** | **0.0103** | **0.9947** |
| Trend change of difference between treatment and control | -0.0211 | 0.98 | 0.0041 | <.0001 | -0.0446 | 0.96 | 0.0090 | <.0001 | -0.0014 | 1.00 | 0.0062 | 0.8215 |
| **Intervention point: 2011** | | | | | | | | | | | | |
| **Level change of difference between group** | **0.0112** | **1.01** | **0.0077** | **0.1442** | **-0.0762** | **0.93** | **0.0148** | **<.0001** | **0.0057** | **1.01** | **0.0120** | **0.6337** |
| Trend change of difference between group | -0.0168 | 0.98 | 0.0046 | 0.0002 | -0.0589 | 0.94 | 0.0102 | <.0001 | 0.0000 | 1.00 | 0.0070 | 0.9953 |

† Intervention point: 2014. 1. 1.
All covariates and fixed effects for residential area (by Si/Do) are included in the regression.
DID; Difference-in-differences, OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, SE; Standard Error

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**Table 10.** *(Continued)*

| Variables | Net-OOPs | | | | Expected burden of CHE | | | | Total expenditure for covered services | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **Intervention point: 2012** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0030** | **1.00** | **0.0077** | **0.6971** | **-0.0444** | **0.96** | **0.0152** | **0.0034** | **-0.0147** | **0.99** | **0.0118** | **0.2128** |
| Trend change of difference between treatment and control | -0.0217 | 0.98 | 0.0043 | <.0001 | -0.0441 | 0.96 | 0.0097 | <.0001 | -0.0063 | 0.99 | 0.0067 | 0.3463 |
| **Intervention point: 2013** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0037** | **1.00** | **0.0065** | **0.5664** | **0.1361** | **1.15** | **0.0134** | **<.0001** | **0.0089** | **1.01** | **0.0097** | **0.3548** |
| Trend change of difference between treatment and control | -0.0210 | 0.98 | 0.0037 | <.0001 | -0.0230 | 0.98 | 0.0082 | 0.0067 | -0.0013 | 1.00 | 0.0057 | 0.8177 |
| **Intervention point: 2015** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0424** | **0.96** | **0.0056** | **<.0001** | **-0.0604** | **0.94** | **0.0168** | **0.0003** | **-0.0044** | **1.00** | **0.0112** | **0.6932** |
| Trend change of difference between treatment and control | -0.0390 | 0.96 | 0.0059 | <.0001 | -0.0778 | 0.93 | 0.0129 | <.0001 | -0.0132 | 0.99 | 0.0088 | 0.1332 |

† Intervention point: 2014. 1. 1.

All covariates and fixed effects for residential area (by Si/Do) are included in the regression.

OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, SE; Standard Error

**4) Results of subgroup analysis of study participants**

Table 11 shows the results of the analysis by setting the study participants differently. The analysis included all covariates and fixed effects.

As a result of the analysis in which the third and fourth deciles were set as study participants, all primary dependent variables were reduced in the level change and only net-OOPs was statistically significant. In the level change result of first vs 4th-5th deciles were set as study population, all primary dependent variables were decreased and net-OOPs and expected burden of CHE was statistically significant. And in the trend change result, the expected burden of CHE decreased and was statistically significant. As a result of the level change analyzed by setting the 2nd-3rd vs 4th-5th deciles as the study participants, net-OOPs decreased in a statistically significant manner, expected burden of CHE increased slightly, but was not statistically significant, and total expenditure for covered services decreased but was not statistically significant.

As a result of analyzing total OOPs for covered services in 2013 by setting the range of the OOPs from 1.2 million won to 2 million won and 1.5 million won to 2 million won and limiting the study participant to that range, both groups showed a statistically significant decrease in the results of the level change of net-OOPs.

As a result of analysis by the patient group, the net-OOPs decreased in cancer patients at the level change, but it was not statistically significant, and the expected burden of CHE and total expenditure for covered services increased statistically. In patients with rare diseases, all dependent variables decreased, but it was not statistically significant. The chronic kidney disease patients decreased in a statistically significant manner only in net-OOPs. Additionally, the trend change results were investigated to decrease in a statistically significant manner only in cancer patients' expected burden of CHE and total expenditure for covered services.

**Table 11.** Results of subgroup analysis of study participants

| Variables | Net-OOPs | | | | Expected burden of CHE | | | | Total expenditure for covered services | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **3rd income decile vs 4th income decile** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0502** | **0.95** | **0.0148** | **0.0007** | **-0.0156** | **0.98** | **0.0284** | **0.5832** | **-0.0411** | **0.96** | **0.0234** | **0.0798** |
| Trend change of difference between treatment and control | 0.0015 | 1.00 | 0.0093 | 0.8729 | -0.0200 | 0.98 | 0.0182 | 0.2708 | 0.0072 | 1.01 | 0.0148 | 0.6273 |
| **1st income decile vs 4th-5th income decile** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0462** | **0.95** | **0.0116** | **<.0001** | **-0.1171** | **0.89** | **0.0240** | **<.0001** | **-0.0160** | **0.98** | **0.0192** | **0.4051** |
| Trend change of difference between treatment and control | 0.0002 | 1.00 | 0.0073 | 0.9746 | -0.0477 | 0.95 | 0.0155 | 0.0021 | 0.0130 | 1.01 | 0.0122 | 0.2867 |
| **2nd-3rd income decile vs 4th-5th income decile** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0309** | **0.97** | **0.0099** | **0.0018** | **0.0118** | **1.01** | **0.0191** | **0.5368** | **-0.0264** | **0.97** | **0.0150** | **0.0775** |
| Trend change of difference between treatment and control | -0.0038 | 1.00 | 0.0062 | 0.5441 | -0.0198 | 0.98 | 0.0125 | 0.1121 | 0.0074 | 1.01 | 0.0098 | 0.4472 |
| **Range of 1,200,000-2,000,000 KRW†** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.1166** | **0.89** | **0.0074** | **<.0001** | **-0.0044** | **1.00** | **0.0438** | **0.9208** | **0.0397** | **1.04** | **0.0295** | **0.1787** |
| Trend change of difference between treatment and control | 0.0002 | 1.00 | 0.0044 | 0.9655 | -0.0241 | 0.98 | 0.0271 | 0.3732 | -0.0192 | 0.98 | 0.0181 | 0.2878 |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression.
† The range of total OOPs for covered services in 2013
OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, SE; Standard Error, KRW; Korean Won

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**Table 11.** *(Continued)*

| Variables | Net-OOPs | | | | Expected burden of CHE | | | | Total expenditure for covered services | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **Range of 1,500,000-2,000,000 KRW†** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.2098** | **0.81** | **0.0078** | **<.0001** | **-0.0393** | **0.96** | **0.0684** | **0.5660** | **0.0432** | **1.04** | **0.0455** | **0.3426** |
| Trend change of difference between treatment and control | 0.0014 | 1.00 | 0.0047 | 0.7677 | 0.0086 | 1.01 | 0.0405 | 0.8311 | 0.0044 | 1.00 | 0.0268 | 0.8703 |
| **Cancer patients** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.0024** | **1.00** | **0.0330** | **0.9424** | **0.1285** | **1.14** | **0.0647** | **0.0471** | **0.1766** | **1.19** | **0.0590** | **0.0027** |
| Trend change of difference between treatment and control | -0.0209 | 0.98 | 0.0212 | 0.3243 | -0.0883 | 0.92 | 0.0428 | 0.0391 | -0.0950 | 0.91 | 0.0391 | 0.0151 |
| **Rare disease patients** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.1741** | **0.84** | **0.0969** | **0.0723** | **-0.2862** | **0.75** | **0.2209** | **0.1950** | **-0.1200** | **0.89** | **0.2940** | **0.6831** |
| Trend change of difference between treatment and control | -0.0910 | 0.91 | 0.0670 | 0.1746 | 0.1335 | 1.14 | 0.1407 | 0.3426 | 0.0992 | 1.10 | 0.2204 | 0.6528 |
| **Chronic renal disease patients** | | | | | | | | | | | | |
| **Level change of difference between treatment and control** | **-0.1681** | **0.85** | **0.0505** | **0.0009** | **-0.0702** | **0.93** | **0.1358** | **0.6050** | **0.0904** | **1.09** | **0.1138** | **0.4268** |
| Trend change of difference between treatment and control | -0.0494 | 0.95 | 0.0342 | 0.1487 | -0.0325 | 0.97 | 0.0898 | 0.7180 | -0.0546 | 0.95 | 0.0772 | 0.4799 |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression analysis.
† The range of total OOPs for covered services in 2013
OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, SE; Standard Error, KRW; Korean Won

## 5. Results of sensitivity analysis

Figure 8 and Table 12 shows the results of the analysis by assigning weights to the study participants by the stabilized IPTW method. When weights were given, the characteristics of the study participants, the change of the dependent variable by year, and the overall results of the segmented regression with DID analysis are presented in the supplementary table (Appendix 16-19). The segmented regression with DID analysis included all covariates and fixed effects.

Weights were assigned to reduce the difference in characteristics between the treatment group and the control group, and in the analysis results, a 3% reduction in net-OOPs and a 10% reduction in expected burden of CHE (net-OOPs: $\beta$= -0.0319, exp($\beta$)= 0.97, SE= 0.0088, $p$= 0.0003; expected burden of CHE: $\beta$= -0.1097, exp($\beta$)= 0.90, SE= 0.0191, $p$< .0001), but the total expenditure for covered services could not be investigated statistically significant ($\beta$= -0.0207, exp($\beta$)= 0.98, SE= 0.0135, $p$= 0.1247).

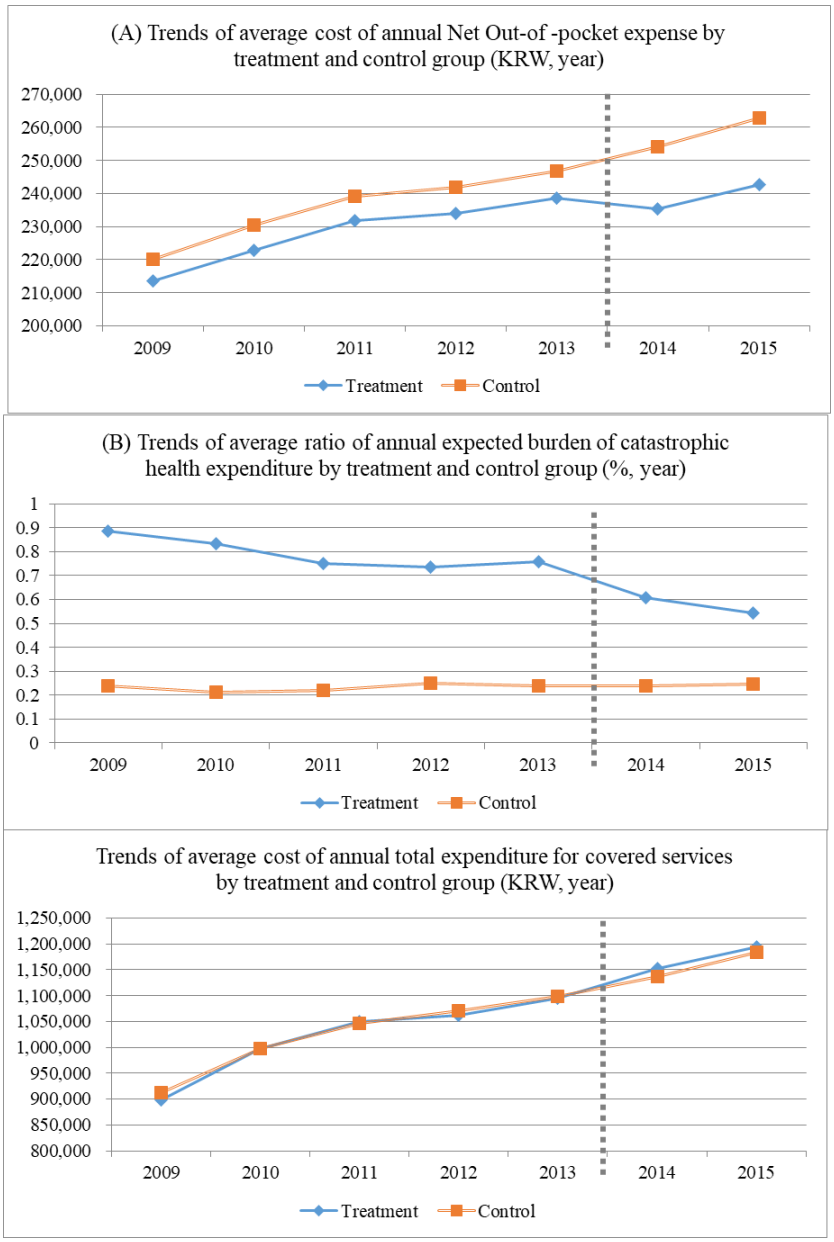


**Figure 8.** Trends of weighted annual mean of primary dependent variables by treatment group and control group

**Table 12.** The results of sensitivity analysis

| Variables | Unadjusted value (before) | Unadjusted value (after) | *p*-value* | Level change of difference between treatment and control | | | | Trend change of difference between treatment and control | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **Net-OOPs** | | | | | | | | | | | |
| Treatment | 228,372 | 239,004 | <.0001 | **-0.0319** | **0.97** | **0.0088** | **0.0003** | -0.0044 | 1.00 | 0.0056 | 0.4277 |
| Control | 235,757 | 258,536 | <.0001 | | | | | | | | |
| **Expected burden of CHE** | | | | | | | | | | | |
| Treatment | 0.79 | 0.58 | <.0001 | **-0.1097** | **0.90** | **0.0191** | **<.0001** | 0.0194 | 1.02 | 0.0122 | 0.1121 |
| Control | 0.23 | 0.24 | <.0001 | | | | | | | | |
| **Total expenditure for covered services** | | | | | | | | | | | |
| Treatment | 1,021,458 | 1,172,600 | <.0001 | **-0.0207** | **0.98** | **0.0135** | **0.1247** | 0.0083 | 1.01 | 0.0087 | 0.3420 |
| Control | 1,025,716 | 1,160,517 | <.0001 | | | | | | | | |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression analysis.

**p* for before and after difference

OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, SD; Standard deviation, SE; Standard Error

# V. Discussion

## 1. Discussion of the study method

This study used a sample cohort of the NHIS and applied a quasi-experimental study design on the low-income population to analyze the effect that the changing MOOP amount has on health expenditure burden and health utilization. This study has a strength in terms of using a nationwide cohort data. The strengths of the analytical model are as follows.

First, most of the previous studies that explored the effect of improving the MOOP system in 2014 did not apply the quasi-experimental study design, so the effects of other policies may have been included[40-43]. However, since this study applied quasi-experimental research, it has the strength of controlling the external factors and investigating the effect of changing the MOOP amount.

Second, in this study, the analysis was performed without matching the characteristics of the control group and the treatment group in order to mimic real world data. However, there are some issues in selecting a control group in the quasi-experimental study design. Therefore, this study has employed the stabilized IPTW[63,65] for each year were given to the treatment group and the control group to

perform the sensitivity analysis, and the robustness of the results was also investigated.

Even though the study has these strengths, there are some limitations that should be noted when interpreting the results. There is a limitation of the study period and information due to the data. The study period was from 2009 to 2015, and the period of follow-up after January 1, 2014, when the changed MOOP system was implemented, was 2 years, therefore more long-term effect could not be evaluated.

In addition, information not provided by the data were not included in the study, estimates were used instead of actual information. A few of those included individual factors such as education level and occupation. In addition, the data includes only the income decile for insurance premium, not the actual income, so this study used the provided data. Although there may be a difference from the actual income, it can be considered that the individual's income level is reflected because the insurance premium income decile is based on their actual income. In addition, since the MOOP system evaluated in this study is based on the premium income decile, it is considered appropriate to use this income decile.

The MOOP beneficiaries were defined by calculation based on the cohort data. Since the cohort includes all claim information for covered health services by NHIS, it could be calculated to determine the eligibility for benefits[43,46].

Calculations to define the MOOP beneficiaries were performed according to the method presented in the law on the MOOP system[17]. In particular, health expenditures for dental implants for the elderly, which have been included in covered health services by NHIS since 2014, were not included in the calculation as it was deemed non-essential. Taking these aspects into consideration, the calculations in this study were done as accurately as possible.

The expected burden of CHE might be different from the actual burden because it was estimated by linking the household income decile with the insurance premium income decile. In addition, since the OOPs for non-covered health services by NHIS were calculated by estimating them using the OOPs for covered health services, there may be differences from the actual OOPs for non-covered services. In addition, people who have low OPPs for covered services and have high OOPs for non-covered services were considered as have low health expenditure. Therefore, the expected burden of CHE might have been underestimated.

A limitation of the analytical design was that the expected burden of CHE did not satisfy the parallel trend for DID design assumption in the main analysis[56]. This fact can be explained as a difference between the types of insured when calculating the expected burden of CHE. When examining the parallel trend by dividing the types of insured, the assumption of the parallel trend was satisfied only in the employee insured group. Although there was a difference in the statistical

significance of the results, decreasing results were investigated with the analysis for primary dependent variables and the collinear results.

Finally, there is the limitation of statistical analysis. In this study, since the inter-individual analysis was not possible, estimates of inter-group were presented. A generalized linear mixed model (GLMM) using the PROC GLIMMIX procedure was suitable, but it was impossible to perform due to the limitations of the analytical tool[66,67]. Methods to perform inter-individual estimation included the following methods, in addition to estimation through GLMM. Weighted GEE is one of the methods used for analyze longitudinal data with missing observations and it can be applied when there are monotonic missing values. Since the data of this study included non-monotonic missing values, weighted GEE required a process of imputation of missing values, such as Expectation Maximization or the Markov chain Monte Carlo method[68,69]. However, the data used is big data that has been followed-up as national sample data for many years, and there are limitations in the statistical program to analyze it because many research participants are included. Therefore, since the results analyzed by applying the GEE method are presented, caution is required in interpreting the results.

## 2. Discussion of the results

This study investigated the effect of the reduction of the MOOP amount on the burden of health expenditure and health utilization of the low-income population. According to the results, the reduction of the MOOP amount reduced the burden of health expenditure of the low-income population, and it did not lead to an increase in health utilization. Accordingly, it could be evaluated that the reduction of the MOOP amount worked for its purpose, which was reduction burden of health expenditure for low-income population. The interpretation that could be explained through the results is as follows. Owing to the reduction of the MOOP amount, the net-OOPs have decreased and the number of MOOP beneficiaries has increased, which could be seen as improving financial accessibility of health for the low-income population. This interpretation could also be supported in previous studies[42,43].

In the main analysis result of this study, as a result of the level change immediately after the implementation of the change in the MOOP amount, the total health expenditure for covered services, length of stay for inpatients, and the number of visit for outpatients decreased, but it was not statistically significant. It could be said that the moral hazard in which health utilization increases

indiscriminately as financial accessibility of health is eased has not been investigated. However, even in the trend change after the implementation of the system, the total health expenditure for covered services and the number of visits for outpatients did not show any significant results, but the length of stay for inpatients showed an increasing trend. Contrary to the results of this study, in the previous study, the length of stay decreased and the number of outpatient visits increased[42,43]. Considering that the MOOP system is a form in which refunds are reimbursed in the following year, a long-term evaluation is needed on the trend of the increase in the length of stay for inpatients.

The moral hazard caused by the change in cost-sharing could be reported from the various health policies implemented[32-34]. One of the policies that caused a moral hazard in South Korea is the policy of exempting hospitalized children under the age of six from cost-sharing[70-72]. This policy allowed cost-sharing exemption for children, but owing to the moral hazard to health consumers, the cost was imposed again. However, as children's healthcare use requires support for health expenditure, the discussion on introducing a MOOP system for children's hospital costs continues. Under the MOOP system, the total health expenditure paid for one year is supported in the form of a reimbursement after that year, but the policy of cost-sharing for children or other OOPs-related policies differs in that it recognizes and receives benefits whenever health services are used. Therefore, this study may

have a policy implication that could be used as a reference for studies related to OOPs, including cost-sharing for children.

Following subgroup analysis according to independent variables, the group with 0 of CCI decreased net-OOPs, expected burden of CHE, and total health expenditure for covered services. These results could be interpreted as a result of a decrease in health utilization in the relatively healthy group. On the contrary, in the group with high comorbidity severity, net-OOPs decreased but the total expenditure for covered services increased. According to the results of subgroup analysis of severely ill patients, there were no significant changes in patients with rare diseases or chronic kidney disease, but the expected burden of CHE and the total expenditure increased in cancer patients.

These results seem to be owing to the patients with rare diseases and chronic kidney disease, who were receiving relatively sufficient health services through benefits such as medical aid. For cancer patients, it could be interpreted that the total expenditure increased as the insurance coverage increased in 2014, and the expected burden of CHE based on health expenditure for covered services also increased[10].

In this study, the effect of the reduction of the MOOP amount on the low-income population was confirmed. As an additional study, since the initial purpose of the introduction of the MOOP system is to alleviate the burden of excessive

health expenditure for severely ill patients who spend too much on health expenditure, a longer-term effect evaluation is needed for such individuals, including cancer patients.

Owing to the reduction of the MOOP amount according to the subdivision into seven sections, the number of MOOP beneficiaries has been expanded and their burden of health expenditure has been reduced compared to the situation before implementation. Since reduced health costs were linked to greater benefits, policymakers could think about further reducing the MOOP amount. However, if further improvement of the sections or reduction of the maximum is pursued to reduce the health expenditure burden, consideration should be given to set the MOOP amount at a level that would not indiscriminately cause moral hazard along with the health expenditure burden.

# VI. Conclusion

The reduction of the MOOP amount reduced the burden of health expenditure without affecting the health utilization by the low-income population. Based on the results of this study, it can be stated that the downward adjustment of the MOOP amount worked for its purpose. However, there is a need to evaluate long-term effects on health expenditure for cancer patients and for those with severe illness. The results of this study may serve as a reference for system related to OOPs, including the MOOP. Furthermore, it is recommended that future evidence be presented to improve financial accessibility of health in low-income population.

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# Appendix

**Appendix 1.** Annual health insurance coverage rate by income decile in each insurance type

| Year | Income decile by insurance type | Coverage rate (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 (Low) | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 (High) |
| **2009** | **self-employee** | 68.8 | 61.8 | 60.7 | 60.7 | 59.2 | 59.5 | 58.1 | 57.5 | 56.8 | 54.2 |
| | **employed** | 58.3 | 56.4 | 58.3 | 57.6 | 57.1 | 57.8 | 57.2 | 56.9 | 54.9 | 54.3 |
| **2010** | **self-employee** | 71 | 66.3 | 63.7 | 64 | 63.6 | 63.4 | 61.3 | 60.8 | 59.9 | 58.9 |
| | **employed** | 62 | 60.9 | 60.8 | 60.4 | 60.7 | 60 | 60.7 | 61 | 61.4 | 60.7 |
| **2011** | **self-employee** | 71.9 | 66.2 | 62.8 | 63.8 | 63 | 61.9 | 60.9 | 60.1 | 59.7 | 57.3 |
| | **employed** | 60.8 | 60.3 | 60.5 | 60.8 | 59.2 | 59.6 | 59.8 | 60.6 | 59.9 | 58.7 |
| **2012** | **self-employee** | 68.2 | 62.1 | 61.4 | 61.4 | 59.6 | 59.3 | 59.1 | 56.3 | 55 | 51.8 |
| | **employed** | 56.4 | 55.5 | 56.3 | 55.9 | 56.2 | 55.6 | 56.2 | 55.2 | 55.4 | 52.6 |
| **2013** | **self-employee** | 70.6 | 63.8 | 61.5 | 61.5 | 60.6 | 58.8 | 57.6 | 57.1 | 56.7 | 54.4 |
| | **employed** | 58.8 | 57.5 | 57 | 56.8 | 58.1 | 57.1 | 57.4 | 58.2 | 57.9 | 56.5 |
| **2014** | **self-employee** | 73.3 | 62.8 | 63.9 | 62.6 | 61 | 60.2 | 58.1 | 57.4 | 56.6 | 55.8 |
| | **employed** | 58.7 | 58 | 57.8 | 58.1 | 57.5 | 58.1 | 58.6 | 58.6 | 59.3 | 58 |
| **2015** | **self-employee** | 72 | 63.9 | 62.5 | 62.7 | 62.1 | 60.3 | 58.6 | 58.1 | 57.1 | 56.5 |
| | **employed** | 59.2 | 58.6 | 57.7 | 57.8 | 58.2 | 58.1 | 58.5 | 58.8 | 59.2 | 58.3 |

**Appendix 2.** Households disposable income by income decile

| year | Income decile by type | Disposable income | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 (Low) | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 (High) |
| 2009 | employed | 958,563 | 1,562,696 | 1,944,301 | 2,316,963 | 2,656,393 | 3,023,468 | 3,442,558 | 3,876,511 | 4,554,935 | 6,585,332 |
| | self-employee | 286,549 | 813,391 | 1,218,144 | 1,578,075 | 1,947,717 | 2,342,313 | 2,699,246 | 3,145,482 | 3,837,102 | 5,805,198 |
| 2010 | employed | 1,054,397 | 1,690,047 | 2,111,272 | 2,469,048 | 2,788,420 | 3,178,556 | 3,545,550 | 3,982,703 | 4,681,953 | 6,537,706 |
| | self-employee | 320,711 | 879,415 | 1,301,380 | 1,756,204 | 2,161,081 | 2,485,250 | 2,907,431 | 3,382,497 | 4,129,062 | 6,444,764 |
| 2011 | employed | 1,095,975 | 1,768,333 | 2,227,411 | 2,582,117 | 2,954,958 | 3,310,502 | 3,688,899 | 4,195,372 | 4,969,073 | 6,983,487 |
| | self-employee | 342,598 | 898,510 | 1,355,605 | 1,815,649 | 2,278,283 | 2,695,570 | 3,124,988 | 3,577,484 | 4,184,572 | 6,767,331 |
| 2012 | employed | 1,175,748 | 1,882,574 | 2,362,227 | 2,732,841 | 3,108,776 | 3,507,809 | 3,886,710 | 4,460,943 | 5,251,881 | 7,498,902 |
| | self-employee | 391,444 | 968,017 | 1,429,068 | 1,957,594 | 2,401,319 | 2,826,356 | 3,322,774 | 3,807,484 | 4,494,148 | 7,034,201 |
| 2013 | employed | 1,202,967 | 1,959,672 | 2,454,597 | 2,862,991 | 3,207,689 | 3,590,330 | 4,065,434 | 4,602,100 | 5,303,326 | 7,593,530 |
| | self-employee | 380,052 | 969,214 | 1,448,233 | 2,013,295 | 2,436,665 | 2,764,435 | 3,238,013 | 3,817,162 | 4,645,733 | 6,849,238 |
| 2014 | employed | 1,286,218 | 2,023,256 | 2,502,246 | 2,910,705 | 3,326,402 | 3,713,522 | 4,150,051 | 4,703,060 | 5,450,505 | 7,760,627 |
| | self-employee | 461,356 | 1,031,869 | 1,524,054 | 2,027,069 | 2,517,272 | 2,896,273 | 3,357,429 | 3,923,267 | 4,819,773 | 7,394,518 |
| 2015 | employed | 1,298,969 | 2,080,919 | 2,601,978 | 2,991,275 | 3,391,195 | 3,777,287 | 4,168,128 | 4,790,677 | 5,589,610 | 7,859,955 |
| | self-employee | 570,908 | 1,134,189 | 1,637,492 | 2,065,132 | 2,516,550 | 2,925,351 | 3,484,083 | 4,056,541 | 4,865,259 | 7,193,527 |

Households disposable income by income decile for 2 or more household member (Korean Won)

**Appendix 3.** Households food expenses by income decile

| year | Income decile by type | Food expenses | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1 (Low)** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10 (High)** |
| **2009** | **employed** | 199,327 | 231,303 | 247,477 | 276,339 | 287,719 | 310,270 | 327,346 | 348,475 | 364,856 | 407,860 |
| | **self-employee** | 197,630 | 219,557 | 241,376 | 276,815 | 294,942 | 311,243 | 310,271 | 335,268 | 350,699 | 400,360 |
| **2010** | **employed** | 219,204 | 245,704 | 267,415 | 295,492 | 297,097 | 319,593 | 334,684 | 360,655 | 383,108 | 440,126 |
| | **self-employee** | 223,724 | 238,509 | 266,087 | 294,645 | 311,573 | 330,397 | 333,486 | 355,707 | 391,981 | 431,339 |
| **2011** | **employed** | 234,655 | 273,991 | 287,810 | 315,027 | 326,728 | 341,946 | 353,148 | 387,621 | 407,035 | 453,603 |
| | **self-employee** | 220,494 | 262,496 | 287,894 | 320,195 | 335,950 | 353,378 | 357,567 | 416,267 | 388,654 | 468,683 |
| **2012** | **employed** | 255,006 | 286,868 | 297,870 | 326,264 | 346,611 | 348,951 | 376,049 | 394,403 | 421,200 | 475,598 |
| | **self-employee** | 222,598 | 271,971 | 282,385 | 322,380 | 335,139 | 354,990 | 385,634 | 388,788 | 404,984 | 460,198 |
| **2013** | **employed** | 248,938 | 288,937 | 305,043 | 330,534 | 332,712 | 362,034 | 388,635 | 398,647 | 422,216 | 464,965 |
| | **self-employee** | 228,155 | 254,428 | 292,415 | 323,307 | 338,241 | 346,314 | 358,606 | 383,496 | 403,927 | 449,003 |
| **2014** | **employed** | 242,408 | 294,419 | 317,582 | 328,733 | 364,381 | 362,500 | 384,405 | 395,652 | 416,576 | 470,552 |
| | **self-employee** | 226,545 | 263,502 | 284,670 | 307,666 | 347,553 | 357,902 | 363,976 | 375,780 | 418,964 | 449,583 |
| **2015** | **employed** | 241,919 | 282,911 | 319,328 | 330,525 | 354,943 | 370,402 | 390,991 | 412,224 | 448,322 | 462,122 |
| | **self-employee** | 211,650 | 272,466 | 292,934 | 328,743 | 332,305 | 355,403 | 391,545 | 378,083 | 418,132 | 428,680 |

Food expenses by income decile for 2 or more household member (Korean Won)

**Appendix 4.** General characteristics of study population by year in treatment group

| Variables | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| **Treatment group** | | | | | | | |
| **Age** | | | | | | | |
| 19-29 | 41,995 | 39,682 | 39,026 | 39,092 | 38,814 | 40,243 | 40,073 |
| 30-39 | 35,221 | 33,865 | 33,811 | 33,466 | 32,074 | 31,717 | 30,081 |
| 40-49 | 37,840 | 37,260 | 37,640 | 38,204 | 38,603 | 39,605 | 39,027 |
| 50-59 | 31,007 | 32,523 | 35,284 | 37,186 | 38,400 | 40,570 | 40,494 |
| ≥ 60 | 29,559 | 30,932 | 32,483 | 35,262 | 36,725 | 39,336 | 41,776 |
| **Sex** | | | | | | | |
| Male | 80,953 | 79,635 | 80,829 | 82,613 | 82,708 | 86,475 | 85,739 |
| Female | 94,669 | 94,627 | 97,415 | 100,597 | 101,908 | 104,996 | 105,712 |
| **Types of insured** | | | | | | | |
| Self-employed | 54,881 | 51,263 | 49,925 | 49,238 | 48,052 | 46,638 | 47,245 |
| Employee | 120,741 | 122,999 | 128,319 | 133,972 | 136,564 | 144,833 | 144,206 |
| **Disability** | | | | | | | |
| No | 166,167 | 163,907 | 167,485 | 171,923 | 173,268 | 179,961 | 180,065 |
| Yes | 9,455 | 10,355 | 10,759 | 11,287 | 11,348 | 11,510 | 11,386 |
| **CCI** | | | | | | | |
| 0 | 140,004 | 137,815 | 139,356 | 139,647 | 140,559 | 143,347 | 143,057 |
| 1 | 26,237 | 26,583 | 28,603 | 32,328 | 32,244 | 35,209 | 34,962 |
| 2 or over | 9,381 | 9,864 | 10,285 | 11,235 | 11,813 | 12,915 | 13,432 |
| **No. of beds†** | | | | | | | |
| Q1 | 76,597 | 75,906 | 77,761 | 39,559 | 40,047 | 41,581 | 41,318 |
| Q2 | 55,343 | 55,126 | 56,469 | 98,883 | 100,185 | 103,782 | 104,259 |
| Q3 | 43,682 | 43,230 | 44,014 | 44,768 | 44,384 | 46,108 | 45,874 |
| **No. of physicians†** | | | | | | | |
| Q1 | 22,119 | 21,978 | 9,488 | 19,912 | 10,250 | 13,558 | 10,289 |
| Q2 | 83,156 | 83,113 | 98,555 | 91,506 | 102,664 | 103,719 | 107,612 |
| Q3 | 70,347 | 69,171 | 70,201 | 71,792 | 71,702 | 74,194 | 73,550 |

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.

CCI; Charlson's comorbidity index

**Appendix 5.** General characteristics of study population by year in control group

| Variables | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| **Control group** | | | | | | | |
| **Age** | | | | | | | |
| 19-29 | 33,667 | 33,434 | 32,440 | 30,638 | 31,114 | 30,853 | 31,635 |
| 30-39 | 33,755 | 34,157 | 33,901 | 33,029 | 33,374 | 32,269 | 31,105 |
| 40-49 | 27,885 | 28,164 | 28,249 | 28,019 | 28,814 | 28,635 | 28,411 |
| 50-59 | 22,301 | 24,262 | 25,960 | 26,533 | 27,774 | 28,065 | 28,920 |
| ≥ 60 | 19,063 | 19,960 | 20,306 | 21,172 | 22,239 | 23,408 | 25,287 |
| **Sex** | | | | | | | |
| Male | 69,745 | 71,496 | 72,146 | 71,295 | 72,987 | 72,398 | 72,967 |
| Female | 66,926 | 68,481 | 68,710 | 68,096 | 70,328 | 70,832 | 72,391 |
| **Types of insured** | | | | | | | |
| Self-employed | 54,557 | 53,210 | 51,648 | 49,137 | 48,471 | 47,326 | 46,631 |
| Employee | 82,114 | 86,767 | 89,208 | 90,254 | 94,844 | 95,904 | 98,727 |
| **Disability** | | | | | | | |
| No | 130,805 | 133,657 | 134,237 | 132,951 | 136,778 | 136,718 | 138,925 |
| Yes | 5,866 | 6,320 | 6,619 | 6,440 | 6,537 | 6,512 | 6,433 |
| **CCI** | | | | | | | |
| 0 | 110,470 | 112,735 | 112,232 | 108,247 | 111,525 | 109,312 | 111,004 |
| 1 | 19,490 | 20,093 | 21,303 | 23,462 | 23,599 | 25,320 | 25,297 |
| 2 or over | 6,711 | 7,149 | 7,321 | 7,682 | 8,191 | 8,598 | 9,057 |
| **No. of beds†** | | | | | | | |
| Q1 | 60,283 | 62,584 | 63,567 | 30,433 | 31,864 | 31,682 | 32,333 |
| Q2 | 43,005 | 43,573 | 43,485 | 75,999 | 77,830 | 78,503 | 779,316 |
| Q3 | 33,383 | 33,820 | 33,804 | 32,959 | 33,621 | 33,045 | 33,709 |
| **No. of physicians†** | | | | | | | |
| Q1 | 18,012 | 18,150 | 7,321 | 15,666 | 7,655 | 10,253 | 7,701 |
| Q2 | 65,405 | 67,144 | 79,071 | 70,543 | 80,989 | 78,798 | 82,560 |
| Q3 | 53,254 | 54,683 | 54,464 | 53,182 | 54,671 | 54,179 | 55,097 |

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.

CCI; Charlson's comorbidity index

**Appendix 6.** Changes of annual net out-of-pocket expenses by before and after intervention among study participants (KRW)

| Variables | Treatment | | | | | Control | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before (2009-2013) | | After (2014-2015) | | *p*-value* | Before (2009-2013) | | After (2014-2015) | | *p*-value* |
| | Mean | SD | Mean | SD | | Mean | SD | Mean | SD | |
| **Total** | 237,061 | 357,178 | 247,750 | 318,427 | <.0001 | 222,611 | 345,421 | 243,795 | 356,332 | <.0001 |
| **Age** | | | | | | | | | | |
| 19-29 | 106,221 | 179,820 | 113,556 | 172,325 | <.0001 | 107,001 | 178,196 | 114,696 | 182,115 | <.0001 |
| 30-39 | 140,883 | 233,075 | 152,444 | 219,886 | <.0001 | 136,090 | 218,273 | 151,230 | 228,887 | <.0001 |
| 40-49 | 182,665 | 281,959 | 184,529 | 253,522 | 0.0936 | 175,635 | 276,970 | 183,970 | 276,077 | <.0001 |
| 50-59 | 302,964 | 375,977 | 295,743 | 325,239 | <.0001 | 307,535 | 383,644 | 305,793 | 370,262 | 0.3564 |
| ≥ 60 | 485,625 | 507,817 | 466,563 | 406,949 | <.0001 | 505,464 | 522,565 | 527,463 | 519,942 | 0.2626 |
| **Sex** | | | | | | | | | | |
| Male | 209,949 | 354,483 | 220,690 | 314,697 | <.0001 | 193,504 | 334,169 | 213,093 | 341,706 | <.0001 |
| Female | 259,602 | 357,843 | 269,866 | 319,748 | <.0001 | 253,004 | 354,248 | 274,956 | 367,977 | <.0001 |
| **Types of insured** | | | | | | | | | | |
| Self-employed | 245,133 | 393,057 | 253,857 | 344,542 | <.0001 | 220,194 | 356,545 | 243,289 | 370,156 | <.0001 |
| Employee | 233,879 | 341,946 | 245,767 | 309,445 | <.0001 | 224,013 | 338,794 | 244,039 | 349,463 | <.0001 |
| **Disability** | | | | | | | | | | |
| No | 223,279 | 335,891 | 236,067 | 305,921 | <.0001 | 209,994 | 324,909 | 231,258 | 338,176 | <.0001 |
| Yes | 455,363 | 557,318 | 431,455 | 433,922 | <.0001 | 487,957 | 578,569 | 510,755 | 566,455 | 0.0001 |
| **CCI** | | | | | | | | | | |
| 0 | 170,168 | 266,914 | 180,025 | 249,326 | <.0001 | 160,331 | 255,100 | 172,915 | 262,178 | <.0001 |
| 1 | 372,725 | 408,983 | 367,596 | 352,078 | 0.0027 | 358,007 | 405,420 | 370,474 | 406,229 | <.0001 |
| 2 or over | 747,611 | 627,250 | 664,764 | 453,619 | 0.0016 | 761,365 | 631,682 | 765,115 | 603,442 | 0.5033 |
| **No. of beds†** | | | | | | | | | | |
| Q1 | 226,317 | 345,598 | 238,918 | 311,664 | <.0001 | 205,118 | 324,619 | 225,400 | 333,861 | <.0001 |
| Q2 | 236,285 | 351,814 | 243,480 | 312,020 | <.0001 | 223,927 | 344,953 | 238,765 | 349,590 | <.0001 |
| Q3 | 253,480 | 380,693 | 265,367 | 337,568 | <.0001 | 246,345 | 373,537 | 273,328 | 389,672 | <.0001 |
| **No. of physicians†** | | | | | | | | | | |
| Q1 | 234,622 | 353,541 | 252,994 | 322,671 | <.0001 | 228,574 | 357,336 | 260,746 | 379,650 | <.0001 |
| Q2 | 240,824 | 361,584 | 250,331 | 320,866 | <.0001 | 227,703 | 350,658 | 247,847 | 361,268 | <.0001 |
| Q3 | 232,750 | 352,187 | 243,212 | 314,153 | <.0001 | 214,294 | 335,015 | 235,026 | 344,639 | <.0001 |

**p* for before and after difference
†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.
KRW; Korean Won, CCI; Charlson's comorbidity index, SD; Standard deviation

**Appendix 7.** Changes of annual burden of catastrophic health expenditure by before and after intervention among study participants (%)

| Variables | Treatment | | | | | Control | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before (2009-2013) | | After (2014-2015) | | *p*-value* | Before (2009-2013) | | After (2014-2015) | | *p*-value* |
| | Mean | SD | Mean | SD | | Mean | SD | Mean | SD | |
| **Total** | 0.80 | 4.25 | 0.59 | 2.31 | <.0001 | 0.22 | 0.73 | 0.23 | 0.73 | <.0001 |
| **Age** | | | | | | | | | | |
| 19-29 | 0.23 | 2.39 | 0.16 | 0.69 | <.0001 | 0.09 | 0.42 | 0.08 | 0.27 | 0.0196 |
| 30-39 | 0.37 | 2.75 | 0.27 | 1.20 | <.0001 | 0.12 | 0.45 | 0.12 | 0.42 | 0.0991 |
| 40-49 | 0.49 | 3.04 | 0.35 | 1.53 | <.0001 | 0.16 | 0.58 | 0.16 | 0.57 | 0.6752 |
| 50-59 | 0.80 | 3.96 | 0.61 | 2.65 | <.0001 | 0.29 | 0.83 | 0.27 | 0.88 | 0.0101 |
| ≥ 60 | 2.26 | 7.31 | 1.46 | 3.65 | <.0001 | 0.59 | 1.23 | 0.58 | 1.18 | <.0001 |
| **Sex** | | | | | | | | | | |
| Male | 0.69 | 4.23 | 0.54 | 2.30 | <.0001 | 0.20 | 0.75 | 0.20 | 0.76 | 0.0003 |
| Female | 0.88 | 4.26 | 0.63 | 2.32 | <.0001 | 0.24 | 0.70 | 0.25 | 0.71 | <.0001 |
| **Types of insured** | | | | | | | | | | |
| Self-employed | 1.85 | 7.63 | 1.19 | 4.03 | <.0001 | 0.26 | 0.87 | 0.28 | 0.89 | <.0001 |
| Employee | 0.38 | 1.27 | 0.39 | 1.28 | 0.0001 | 0.19 | 0.63 | 0.20 | 0.64 | <.0001 |
| **Disability** | | | | | | | | | | |
| No | 0.64 | 3.20 | 0.49 | 1.83 | <.0001 | 0.19 | 0.62 | 0.20 | 0.62 | <.0001 |
| Yes | 3.28 | 11.63 | 2.18 | 5.80 | <.0001 | 0.73 | 1.85 | 0.74 | 1.83 | 0.5489 |
| **CCI** | | | | | | | | | | |
| 0 | 0.43 | 2.26 | 0.32 | 1.33 | <.0001 | 0.13 | 0.36 | 0.13 | 0.34 | 0.0781 |
| 1 | 1.16 | 4.45 | 0.78 | 2.29 | <.0001 | 0.32 | 0.69 | 0.31 | 0.79 | 0.4023 |
| 2 or over | 4.60 | 12.95 | 2.94 | 6.17 | <.0001 | 1.26 | 2.35 | 1.19 | 2.10 | 0.0004 |
| **No. of beds†** | | | | | | | | | | |
| Q1 | 0.69 | 4.02 | 0.50 | 1.84 | <.0001 | 0.19 | 0.72 | 0.20 | 0.69 | 0.0010 |
| Q2 | 0.78 | 3.97 | 0.57 | 2.26 | <.0001 | 0.22 | 0.71 | 0.22 | 0.73 | <.0001 |
| Q3 | 0.98 | 4.93 | 0.72 | 2.75 | <.0001 | 0.25 | 0.77 | 0.27 | 0.78 | <.0001 |
| **No. of physicians†** | | | | | | | | | | |
| Q1 | 0.85 | 4.49 | 0.69 | 2.67 | <.0001 | 0.23 | 0.73 | 0.25 | 0.76 | 0.0006 |
| Q2 | 0.85 | 4.48 | 0.61 | 2.47 | <.0001 | 0.23 | 0.74 | 0.23 | 0.75 | 0.0001 |
| Q3 | 0.71 | 3.86 | 0.54 | 1.98 | <.0001 | 0.21 | 0.71 | 0.22 | 0.69 | 0.0003 |

**p* for before and after difference
†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as tertile by each study year.
CCI; Charlson's comorbidity index, SD; Standard deviation

**Appendix 8.** Changes of annual total expenditure for covered services by before and after intervention among study participants (KRW)

| Variables | Treatment | | | | | Control | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before (2009-2013) | | After (2014-2015) | | *p*-value* | Before (2009-2013) | | After (2014-2015) | | *p*-value* |
| | Mean | SD | Mean | SD | | Mean | SD | Mean | SD | |
| **Total** | 1,061,087 | 2,992,890 | 1,218,766 | 3,394,507 | <.0001 | 958,776 | 2,795,510 | 1,080,688 | 3,045,803 | <.0001 |
| **Age** | | | | | | | | | | |
| 19-29 | 393,772 | 1,549,820 | 418,539 | 1,420,948 | <.0001 | 390,966 | 1,517,862 | 408,366 | 1,119,810 | 0.0030 |
| 30-39 | 567,091 | 1,930,247 | 634,991 | 2,201,061 | <.0001 | 524,595 | 1,717,559 | 587,527 | 1,763,980 | <.0001 |
| 40-49 | 752,454 | 2,270,874 | 807,435 | 2,437,774 | <.0001 | 699,605 | 2,092,254 | 755,348 | 2,252,224 | <.0001 |
| 50-59 | 1,287,374 | 3,248,618 | 1,358,459 | 3,695,402 | <.0001 | 1,272,473 | 3,172,494 | 1,301,275 | 3,489,415 | 0.0925 |
| ≥ 60 | 2,484,321 | 4,679,420 | 2,715,053 | 5,097,307 | 0.0386 | 2,529,839 | 4,783,285 | 2,708,262 | 5,040,161 | 0.8173 |
| **Sex** | | | | | | | | | | |
| Male | 992,928 | 3,247,255 | 1,152,437 | 3,637,595 | <.0001 | 860,109 | 2,899,948 | 968,000 | 3,092,974 | <.0001 |
| Female | 1,117,755 | 2,762,365 | 1,272,978 | 3,181,050 | <.0001 | 1,061,801 | 2,678,250 | 1,195,061 | 2,992,843 | <.0001 |
| **Types of insured** | | | | | | | | | | |
| Self-employed | 1,291,882 | 3,679,176 | 1,581,505 | 4,312,031 | <.0001 | 991,225 | 2,938,414 | 1,141,996 | 3,291,214 | <.0001 |
| Employee | 970,090 | 2,668,850 | 1,100,944 | 3,028,102 | <.0001 | 939,958 | 2,709,008 | 1,051,091 | 2,919,508 | <.0001 |
| **Disability** | | | | | | | | | | |
| No | 931,134 | 2,490,706 | 1,064,915 | 2,843,999 | <.0001 | 858,310 | 2,368,299 | 972,677 | 2,616,788 | <.0001 |
| Yes | 3,119,543 | 6,933,485 | 3,637,978 | 7,700,875 | <.0001 | 3,071,752 | 7,038,176 | 3,380,610 | 7,447,933 | <.0001 |
| **CCI** | | | | | | | | | | |
| 0 | 648,624 | 1,619,294 | 727,669 | 1,946,574 | <.0001 | 592,448 | 1,487,272 | 649,046 | 1,544,930 | <.0001 |
| 1 | 1,534,789 | 2,848,107 | 1,643,800 | 3,238,965 | <.0001 | 1,416,314 | 2,686,880 | 1,510,103 | 3,240,776 | <.0001 |
| 2 or over | 5,216,538 | 8,671,170 | 5,425,207 | 8,805,893 | <.0001 | 5,114,845 | 8,579,680 | 5,235,987 | 8,463,344 | 0.1192 |
| **No. of beds†** | | | | | | | | | | |
| Q1 | 979,333 | 2,935,431 | 1,123,386 | 3,193,052 | <.0001 | 857,475 | 2,722,455 | 970,673 | 2,892,914 | <.0001 |
| Q2 | 1,055,975 | 2,931,997 | 1,180,562 | 3,351,355 | <.0001 | 967,799 | 2,768,002 | 1,049,709 | 2,988,181 | <.0001 |
| Q3 | 1,184,698 | 3,164,231 | 1,391,134 | 3,651,873 | <.0001 | 1,093,842 | 2,939,201 | 1,259,428 | 3,305,161 | <.0001 |
| **No. of physicians†** | | | | | | | | | | |
| Q1 | 1,041,589 | 2,756,025 | 1,299,176 | 3,607,099 | <.0001 | 997,903 | 2,782,134 | 1,196,752 | 3,288,160 | <.0001 |
| Q2 | 1,093,584 | 3,061,723 | 1,243,772 | 3,484,726 | <.0001 | 988,802 | 2,833,678 | 1,105,577 | 3,102,729 | <.0001 |
| Q3 | 1,023,481 | 2,955,648 | 1,170,019 | 3,223,434 | <.0001 | 908,758 | 2,746,009 | 1,024,867 | 2,915,786 | <.0001 |

**p* for before and after difference
†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.
CCI; Charlson's comorbidity index, SD; Standard deviation

**Appendix 9.** Parallel trend test results for dependent variables in study participants by treatment and control group

| Variables | Treatment * Year (interaction effect) | | |
|---|---|---|---|
| | β | SE | p-value |
| **Net-OOPs** | 46.3848 | 343.7730 | 0.8927 |
| **Expected burden of CHE** | -0.0395 | 0.0035 | <.0001 |
| **Total expenditure for covered services** | 4,791.3190 | 3,025.5390 | 0.1133 |
| **MOOP beneficiaries (Yes, %)** | 0.0001 | 0.0001 | 0.6022 |
| **Length of stay for inpatient** | 0.0489 | 0.0208 | 0.0189 |
| **No. of visits for outpatient** | 0.0518 | 0.0218 | 0.0174 |
| **Insured amount†** | 4,080.5220 | 2,604.1890 | 0.1171 |
| **Total OOPs** | 36.3607 | 529.3934 | 0.4922 |

OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, MOOP; Maximum out-of-pocket

All covariates and fixed effects for residential area (by Si/Do) are included in the regression.

**Appendix 10.** The trends of dependent variables by year among study participants

| Variables | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| **Net-OOPs** | | | | | | | |
| Treatment | 220,767 | 231,413 | 240,918 | 242,770 | 248,504 | 243,722 | 251,778 |
| Control | 209,658 | 217,859 | 225,371 | 227,894 | 231,754 | 239,464 | 248,063 |
| **Expected burden of CHE** | | | | | | | |
| Treatment | 0.89 | 0.84 | 0.75 | 0.75 | 0.77 | 0.62 | 0.56 |
| Control | 0.23 | 0.20 | 0.21 | 0.23 | 0.22 | 0.22 | 0.23 |
| **Total expenditure for covered services** | | | | | | | |
| Treatment | 928,049 | 1,037,165 | 1,088,518 | 1,103,256 | 1,141,892 | 1,195,241 | 1,242,293 |
| Control | 863,377 | 934,264 | 977,148 | 997,280 | 1,018,188 | 1,057,412 | 1,103,623 |
| **MOOP beneficiaries (Yes, %)** | | | | | | | |
| Treatment | 0.95 | 0.98 | 1.07 | 1.15 | 1.24 | 2.74 | 3.06 |
| Control | 0.88 | 0.85 | 0.95 | 1.04 | 1.08 | 1.19 | 1.30 |
| **Length of stay for inpatient** | | | | | | | |
| Treatment | 2.12 | 2.66 | 2.70 | 2.89 | 3.03 | 3.12 | 3.21 |
| Control | 1.93 | 2.11 | 2.17 | 2.35 | 2.45 | 2.50 | 2.52 |
| **No. of visits for outpatient** | | | | | | | |
| Treatment | 15.69 | 16.12 | 16.30 | 16.66 | 16.88 | 17.09 | 16.98 |
| Control | 14.55 | 14.88 | 14.96 | 15.14 | 15.21 | 15.48 | 15.45 |
| **Insured amount†** | | | | | | | |
| Treatment | 690,139 | 785,845 | 825,368 | 835,778 | 864,935 | 908,786 | 943,127 |
| Control | 637,231 | 700,570 | 733,613 | 748,584 | 763,523 | 793,938 | 828,250 |
| **Total OOPs** | | | | | | | |
| Treatment | 236,332 | 248,139 | 259,397 | 263,052 | 272,211 | 281,826 | 293,019 |
| Control | 224,696 | 231,725 | 241,091 | 245,698 | 251,896 | 260,423 | 271,357 |

OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, MOOP; Maximum out-of-pocket

**Appendix 11.** The trends of secondary dependent variables by treatment group and control group


Note: MOOP; Maximum out-of-pocket, OOPs; Out-of-pocket expense

**Appendix 12.** Differential change over time in dependent variables including MOOP beneficiaries for treatment group versus the control group

| Variables | MOOP beneficiaries (Yes, %)* | | | |
|---|---|---|---|---|
| | **β** | **exp(b)** | **SE** | ***p*-value** |
| **Intercept β** | -6.8587 | - | 0.0921 | <.0001 |
| **Baseline trend** | 0.0252 | 1.03 | 0.0092 | 0.0061 |
| **Level change** | 0.0259 | 1.03 | 0.0509 | 0.6118 |
| **Trend change** | 0.0333 | 1.03 | 0.0320 | 0.2974 |
| **Difference between treatment and control** | -0.0310 | 0.97 | 0.0315 | 0.3252 |
| **Baseline trend of difference between treatment and control** | 0.0016 | 1.00 | 0.0117 | 0.8913 |
| **Level change of difference between treatment and control** | **0.7390** | **2.09** | **0.0613** | **<.0001** |
| **Trend change of difference between treatment and control** | 0.0429 | 1.04 | 0.0379 | 0.2604 |
| **Age** | | | | |
| 19-29 | ref. | | | |
| 30-39 | 0.6409 | 1.90 | 0.0521 | <.0001 |
| 40-49 | 1.0999 | 3.00 | 0.0490 | <.0001 |
| 50-59 | 1.7239 | 5.61 | 0.0466 | <.0001 |
| ≥ 60 | 2.5623 | 12.97 | 0.0460 | <.0001 |
| **Sex** | | | | |
| Male | ref. | | | |
| Female | 0.0983 | 1.10 | 0.0161 | <.0001 |
| **Types of insured** | | | | |
| Self-employed | ref. | | | |
| Employee | -0.2095 | 0.81 | 0.0158 | <.0001 |
| **Disability** | | | | |
| No | ref. | | | |
| Yes | 0.9090 | 2.48 | 0.0226 | <.0001 |
| **CCI** | | | | |
| 0 | ref. | | | |
| 1 | 0.9596 | 2.61 | 0.0177 | <.0001 |
| 2 or over | 2.2925 | 9.90 | 0.0185 | <.0001 |
| **No. of beds†** | | | | |
| Q1 | ref. | | | |
| Q2 | -0.0201 | 0.98 | 0.0337 | 0.5516 |
| Q3 | 0.3087 | 1.36 | 0.0795 | 0.0001 |
| **No. of physicians†** | | | | |
| Q1 | ref. | | | |
| Q2 | -0.0114 | 0.99 | 0.0465 | 0.8059 |
| Q3 | -0.2014 | 0.82 | 0.0764 | 0.0084 |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression.
†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region(Si/Do) as a tertile by each study year.
MOOP; Maximum out-of-pocket, SE; Standard Error, CCI; Charlson's comorbidity index

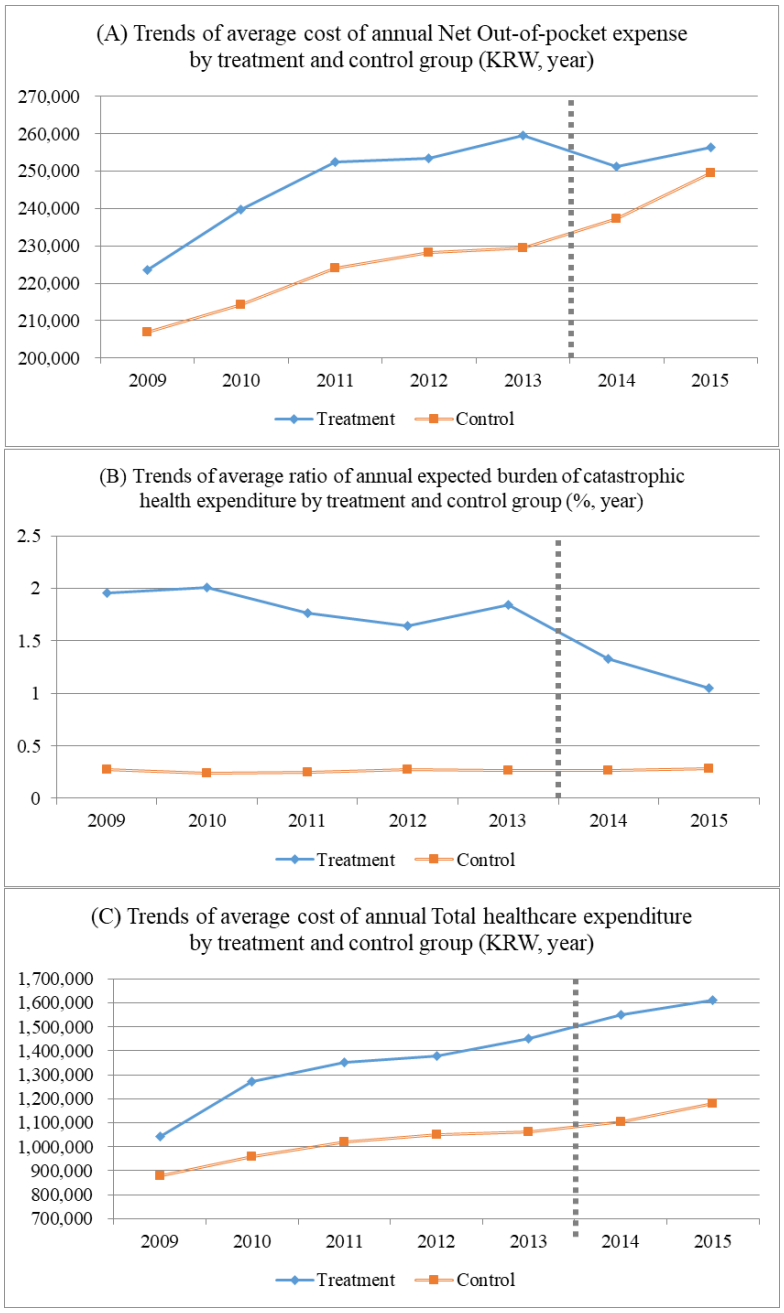
**Appendix 13.** Differential change over time in dependent variables including length of stay for inpatient, number of visits for outpatient, insured amount, and total OOPs for treatment group versus the control group

| Variables | Length of stay for inpatient | | | | No. of visits for outpatient | | | | Insured amount | | | | Total OOPs | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | Exp (β) | SE | *p*-value | β | Exp (b) | SE | *p*-value | β | Exp (β) | SE | *p*-value | β | Exp (β) | SE | *p*-value |
| **Intercept β** | -0.4116 | - | 0.0697 | <.0001 | 1.8040 | - | 0.0114 | <.0001 | 12.2255 | - | 0.0259 | <.0001 | 11.3182 | - | 0.0157 | <.0001 |
| **Baseline trend** | 0.0525 | 1.05 | 0.0057 | <.0001 | -0.0025 | 1.00 | 0.0009 | 0.0036 | 0.0246 | 1.02 | 0.0020 | <.0001 | 0.0133 | 1.01 | 0.0015 | <.0001 |
| **Level change** | 0.0225 | 1.02 | 0.0264 | 0.3932 | 0.0187 | 1.02 | 0.0044 | <.0001 | 0.0214 | 1.02 | 0.0109 | 0.0503 | 0.0100 | 1.01 | 0.0078 | 0.1976 |
| **Trend change** | -0.0512 | 0.95 | 0.0181 | 0.0048 | -0.0120 | 0.99 | 0.0029 | <.0001 | -0.0127 | 0.99 | 0.0071 | 0.0736 | 0.0027 | 1.00 | 0.0049 | 0.5827 |
| **Difference between treatment and control** | 0.0463 | 1.05 | 0.0194 | 0.0173 | -0.0042 | 1.00 | 0.0030 | 0.1609 | -0.0003 | 1.00 | 0.0074 | 0.9695 | -0.0201 | 0.98 | 0.0051 | <.0001 |
| **Baseline trend of difference between treatment and control** | 0.0001 | 1.00 | 0.0069 | 0.9913 | 0.0016 | 1.00 | 0.0011 | 0.1278 | 0.0050 | 1.01 | 0.0027 | 0.0596 | 0.0039 | 1.00 | 0.0019 | 0.0391 |
| **Level change of difference between treatment and control** | **-0.0398** | **0.96** | **0.0339** | **0.2406** | **-0.0040** | **1.00** | **0.0058** | **0.4983** | **-0.0251** | **0.98** | **0.0151** | **0.0962** | **-0.0123** | **0.99** | **0.0103** | **0.2326** |
| **Trend change of difference between treatment and control** | 0.0461 | 1.05 | 0.0231 | 0.0459 | 0.0023 | 1.00 | 0.0039 | 0.5500 | 0.0104 | 1.01 | 0.0116 | 0.2864 | 0.0031 | 1.00 | 0.0066 | 0.6380 |
| **Age** | | | | | | | | | | | | | | | | |
| 19-29 | ref. | | | | ref. | | | | ref. | | | | ref. | | | |
| 30-39 | 0.3395 | 1.40 | 0.0204 | <.0001 | 0.1855 | 1.20 | 0.0030 | <.0001 | 0.2662 | 1.30 | 0.0091 | <.0001 | 0.2227 | 1.25 | 0.0050 | <.0001 |
| 40-49 | 0.6336 | 1.88 | 0.0218 | <.0001 | 0.4030 | 1.50 | 0.0033 | <.0001 | 0.4789 | 1.61 | 0.0085 | <.0001 | 0.4492 | 1.57 | 0.0050 | <.0001 |
| 50-59 | 1.0095 | 2.74 | 0.0213 | <.0001 | 0.7472 | 2.11 | 0.0033 | <.0001 | 0.8913 | 2.44 | 0.0087 | <.0001 | 0.8743 | 2.40 | 0.0050 | <.0001 |
| ≥ 60 | 1.6326 | 5.12 | 0.0222 | <.0001 | 1.1230 | 3.07 | 0.0037 | <.0001 | 1.4201 | 4.14 | 0.0094 | <.0001 | 1.3106 | 3.71 | 0.0057 | <.0001 |

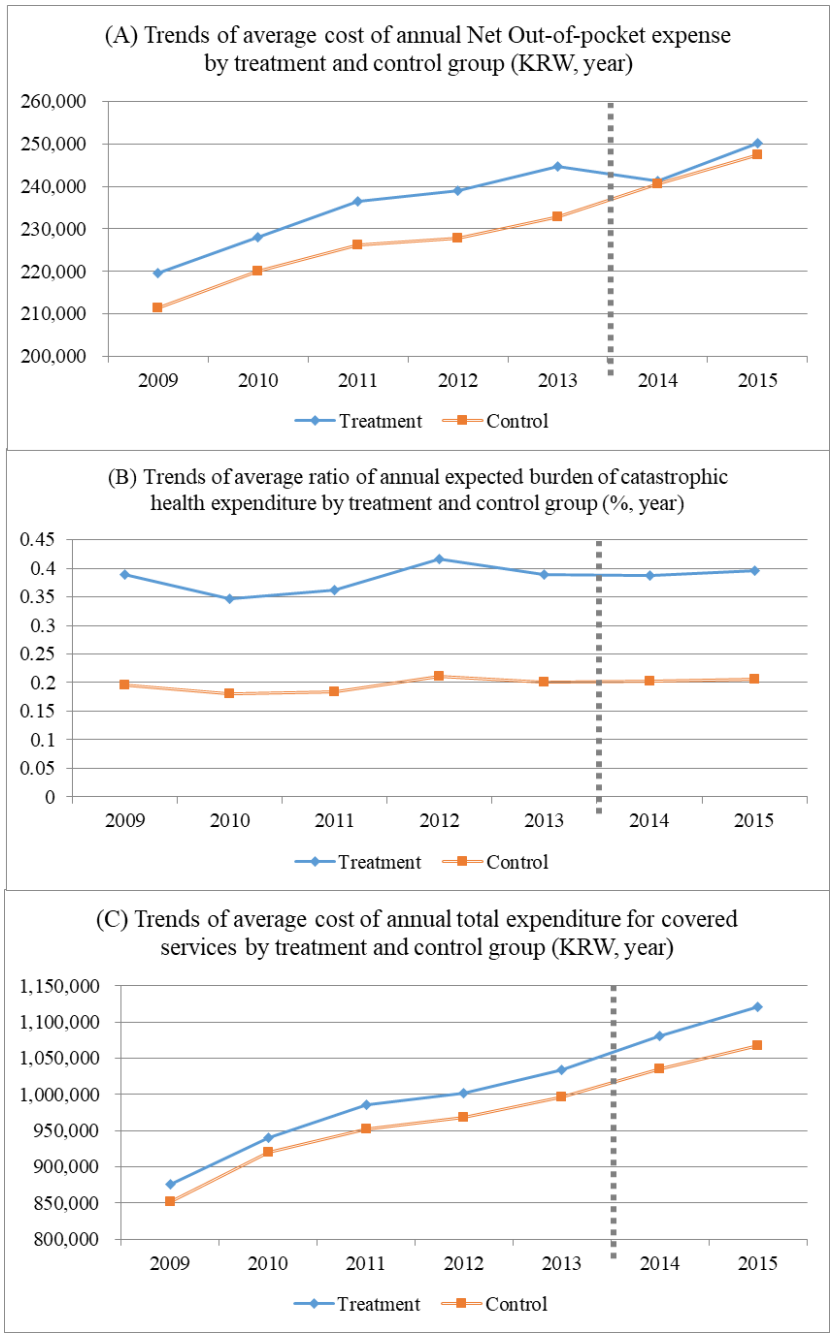
| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sex** | | | | | | | | | | | | | | | | |
| Male | ref. | | | | ref. | | | | ref. | | | | ref. | | | |
| Female | 0.0481 | 1.05 | 0.0152 | <.0001 | 0.3989 | 1.49 | 0.0029 | <.0001 | 0.2559 | 1.29 | 0.0059 | <.0001 | 0.2472 | 1.28 | 0.0035 | <.0001 |
| **Types of insured** | | | | | | | | | | | | | | | | |
| Self-employed | ref. | | | | ref. | | | | ref. | | | | ref. | | | |
| Employee | -0.3453 | 0.71 | 0.0130 | <.0001 | 0.0360 | 1.04 | 0.0022 | <.0001 | -0.0339 | 0.97 | 0.0049 | <.0001 | 0.0478 | 1.05 | 0.0033 | <.0001 |
| **Disability** | | | | | | | | | | | | | | | | |
| No | ref. | | | | ref. | | | | ref. | | | | ref. | | | |
| Yes | 0.7358 | 2.09 | 0.0271 | <.0001 | 0.2503 | 1.28 | 0.0065 | <.0001 | 0.7193 | 2.05 | 0.0229 | <.0001 | 0.4379 | 1.55 | 0.0128 | <.0001 |
| **CCI** | | | | | | | | | | | | | | | | |
| 0 | ref. | | | | ref. | | | | ref. | | | | ref. | | | |
| 1 | 0.3933 | 1.48 | 0.0109 | <.0001 | 0.2490 | 1.28 | 0.0017 | <.0001 | 0.4365 | 1.55 | 0.0048 | <.0001 | 0.4169 | 1.52 | 0.0030 | <.0001 |
| 2 or over | 1.4016 | 4.06 | 0.0165 | <.0001 | 0.3786 | 1.46 | 0.0031 | <.0001 | 1.4010 | 4.06 | 0.0112 | <.0001 | 0.9951 | 2.70 | 0.0063 | <.0001 |
| **No. of beds†** | | | | | | | | | | | | | | | | |
| Q1 | ref. | | | | ref. | | | | ref. | | | | ref. | | | |
| Q2 | -0.0280 | 0.97 | 0.0228 | <.0001 | -0.0085 | 0.99 | 0.0034 | 0.0113 | -0.0258 | 0.97 | 0.0079 | 0.0010 | -0.0173 | 0.98 | 0.0054 | 0.0013 |
| Q3 | 0.2563 | 1.29 | 0.0615 | <.0001 | -0.0117 | 0.99 | 0.0116 | 0.3149 | 0.0334 | 1.03 | 0.0190 | 0.0786 | 0.0254 | 1.03 | 0.0141 | 0.0714 |
| **No. of physicians†** | | | | | | | | | | | | | | | | |
| Q1 | ref. | | | | ref. | | | | ref. | | | | ref. | | | |
| Q2 | -0.0880 | 0.92 | 0.0252 | 0.0005 | 0.0056 | 1.01 | 0.0044 | 0.2094 | -0.0018 | 1.00 | 0.0099 | 0.8585 | 0.0047 | 1.00 | 0.0070 | 0.5043 |
| Q3 | 0.1914 | 1.21 | 0.0634 | 0.0025 | 0.0213 | 1.02 | 0.0105 | 0.0432 | -0.0463 | 0.95 | 0.0234 | 0.0480 | -0.0355 | 0.97 | 0.0143 | 0.0128 |

All covariates and fixed effects for residential area (by Si/Do) are included in the regression.
†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region(Si/Do) as a tertile by each study year.
OOPs; Out-of-pocket expense, SE; Standard Error, CCI; Charlson's comorbidity index

**Appendix 14.** Trends of annual mean of primary dependent variables by treatment group and control group in self-employed insured beneficiaries



**Appendix 15.** Trends of annual mean of primary dependent variables by treatment group and control group in employee insured beneficiaries



**Appendix 16.** General characteristics of weighted study participants

| variables | Total | | Treatment | | Control | | *p*-value | SMD in percent (%) |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | | |
| **Age** | | | | | | | 0.1555 | -0.07 |
| 19-29 | 503,081 | 22.2 | 283,565 | 22.2 | 219,516 | 22.2 | | |
| 30-39 | 463,938 | 20.5 | 261,710 | 20.5 | 202,228 | 20.4 | | |
| 40-49 | 462,150 | 20.4 | 261,200 | 20.4 | 200,950 | 20.3 | | |
| 50-59 | 438,717 | 19.3 | 247,555 | 19.4 | 191,162 | 19.3 | | |
| ≥ 60 | 400,088 | 17.6 | 225,052 | 17.6 | 175,036 | 17.7 | | |
| **Sex** | | | | | | | 0.6192 | 0.07 |
| Male | 1,081,262 | 47.7 | 609,991 | 47.7 | 471,271 | 47.7 | | |
| Female | 1,186,713 | 52.3 | 669,092 | 52.3 | 517,621 | 52.3 | | |
| **Types of insured** | | | | | | | 0.9596 | 0.01 |
| Self-employed | 699,636 | 30.8 | 305,041 | 23.8 | 394,595 | 39.9 | | |
| Employee | 1,568,339 | 69.2 | 683,851 | 53.5 | 884,488 | 89.4 | | |
| **Disability** | | | | | | | 0.0006 | -0.46 |
| No | 2,144,601 | 94.6 | 1,210,088 | 94.6 | 934,513 | 94.5 | | |
| Yes | 123,374 | 5.4 | 68,995 | 5.4 | 54,379 | 5.5 | | |
| **CCI** | | | | | | | 0.6702 | 0.05 |
| 0 | 1,759,078 | 77.6 | 992,129 | 77.6 | 766,949 | 77.6 | | |
| 1 | 374,467 | 16.5 | 211,289 | 16.5 | 163,178 | 16.5 | | |
| 2 or over | 134,429 | 5.9 | 75,664 | 5.9 | 58,765 | 5.9 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **No. of beds†** | | | | | | | 0.0027 | -0.38 |
| Q1 | 705,140 | 31.1 | 396,689 | 31.0 | 308,451 | 31.2 | | |
| Q2 | 1,015,514 | 44.8 | 573,929 | 44.9 | 441,585 | 44.7 | | |
| Q3 | 547,321 | 24.1 | 308,465 | 24.1 | 238,856 | 24.2 | | |
| **No. of physicians†** | | | | | | | 0.7168 | -0.11 |
| Q1 | 192,536 | 8.5 | 108,416 | 8.5 | 84,120 | 8.5 | | |
| Q2 | 1,195,373 | 52.7 | 674,244 | 52.7 | 521,129 | 52.7 | | |
| Q3 | 880,068 | 38.8 | 496,422 | 38.8 | 383,646 | 38.8 | | |
| **Year** | | | | | | | <.0001 | -1.53 |
| 2009 | 312,309 | 13.8 | 175,674 | 13.7 | 136,635 | 13.8 | | |
| 2010 | 314,274 | 13.9 | 174,285 | 13.6 | 139,989 | 14.2 | | |
| 2011 | 319,139 | 14.1 | 178,263 | 13.9 | 140,876 | 14.2 | | |
| 2012 | 322,652 | 14.2 | 183,208 | 14.3 | 139,444 | 14.1 | | |
| 2013 | 327,987 | 14.5 | 184,653 | 14.4 | 143,334 | 14.5 | | |
| 2014 | 334,759 | 14.8 | 191,520 | 15.0 | 143,239 | 14.5 | | |
| 2015 | 2,060,145 | 90.8 | 1,914,769 | 149.7 | 145,376 | 14.7 | | |
| **Total** | **2,267,975** | **100.0** | **1,279,083** | **100.0** | **988,892** | **100.0** | | |

Weighted by the stabilized inverse probability treatment weight (stabilized IPTW) method

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.

*SMD; Standardized mean difference

**Appendix 17.** General characteristics of weighted study participants by before and after intervention

| Variables | Treatment | | | | | Control | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before (2009-2013) | | After (2014-2015) | | *p*-value | Before (2009-2013) | | After (2014-2015) | | *p*-value |
| | N | % | N | % | | N | % | N | % | |
| **Total** | 896,083 | 100.0 | 382,999 | 100.0 | | 700,277 | 100.0 | 288,615 | 100.0 | |
| **Age** | | | | | <.0001 | | | | | <.0001 |
| 19-29 | 202,114 | 22.6 | 81,451 | 21.3 | | 158,109 | 22.6 | 61,407 | 21.3 | |
| 30-39 | 189,868 | 21.2 | 71,842 | 18.8 | | 148,213 | 21.2 | 54,015 | 18.7 | |
| 40-49 | 184,359 | 20.6 | 76,841 | 20.1 | | 143,328 | 20.5 | 57,622 | 20.0 | |
| 50-59 | 168,935 | 18.9 | 78,620 | 20.5 | | 131,947 | 18.8 | 59,215 | 20.5 | |
| ≥ 60 | 150,807 | 16.8 | 74,245 | 19.4 | | 118,680 | 16.9 | 56,356 | 19.5 | |
| **Sex** | | | | | <.0001 | | | | | <.0001 |
| Male | 428,824 | 47.9 | 181,167 | 47.3 | | 334,814 | 47.8 | 136,457 | 47.3 | |
| Female | 467,260 | 52.1 | 201,832 | 52.7 | | 365,463 | 52.2 | 152,158 | 52.7 | |
| **Types of insured** | | | | | <.0001 | | | | | <.0001 |
| Self-employed | 287,109 | 32.0 | 107,486 | 28.1 | | 224,208 | 32.0 | 80,833 | 28.0 | |
| Employee | 608,975 | 68.0 | 275,513 | 71.9 | | 476,069 | 68.0 | 207,782 | 72.0 | |
| **Disability** | | | | | 0.7436 | | | | | 0.5163 |
| No | 847,786 | 94.6 | 362,302 | 94.6 | | 661,836 | 94.5 | 272,677 | 94.5 | |
| Yes | 48,297 | 5.4 | 20,698 | 5.4 | | 38,441 | 5.5 | 15,938 | 5.5 | |
| **CCI** | | | | | <.0001 | | | | | <.0001 |
| 0 | 703,106 | 78.5 | 289,023 | 75.5 | | 549,289 | 78.4 | 217,660 | 75.4 | |
| 1 | 142,484 | 15.9 | 68,806 | 18.0 | | 111,322 | 15.9 | 51,856 | 18.0 | |
| 2 or over | 50,494 | 5.6 | 25,170 | 6.6 | | 39,666 | 5.7 | 19,099 | 6.6 | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **No. of beds†** | | | | | <.0001 | | | | | <.0001 |
| Q1 | 313,046 | 34.9 | 83,643 | 21.8 | | 245,526 | 35.1 | 62,925 | 21.8 | |
| Q2 | 365,268 | 40.8 | 208,660 | 54.5 | | 284,363 | 40.6 | 157,222 | 54.5 | |
| Q3 | 217,769 | 24.3 | 90,696 | 23.7 | | 170,388 | 24.3 | 68,468 | 23.7 | |
| **No. of physicians†** | | | | | <.0001 | | | | | <.0001 |
| Q1 | 84,517 | 9.4 | 23,899 | 6.2 | | 66,106 | 9.4 | 18,014 | 6.2 | |
| Q2 | 461,608 | 51.5 | 212,636 | 55.5 | | 360,810 | 51.5 | 160,318 | 55.5 | |
| Q3 | 349,958 | 39.1 | 146,465 | 38.2 | | 273,361 | 39.0 | 110,283 | 38.2 | |
| **Primary outcome variables, mean (SD)** | | | | | | | | | | |
| Net-OOPs (KRW) | 228,372 | 350,688.2 | 239,004 | 313,346.6 | <.0001 | 235,757 | 358,022.8 | 258,536 | 369,771.7 | <.0001 |
| Expected burden of CHE (%) | 0.79 | 4.3 | 0.58 | 2.3 | <.0001 | 0.23 | 0.8 | 0.24 | 0.8 | <.0001 |
| Total expenditure for covered services (KRW) | 1,021,458 | 2,941,458.2 | 1,172,600 | 3,329,039.7 | <.0001 | 1,025,716 | 2,924,368.3 | 1,160,517 | 3,201,393.0 | <.0001 |

Weighted by the stabilized inverse probability treatment weight (stabilized IPTW) method

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region (by Si/Do) as a tertile by each study year.

CCI; Charlson's comorbidity index, SD; Standard deviation, OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, KRW; Korean Won

**Appendix 18.** Parallel trend test results for dependent variables in stabilized weighted study participants by treatment group and control group

| Variables | Treatment * Year (interaction effect) | | |
|---|---|---|---|
| | **b** | **SE** | **p-value** |
| **Net-OOPs** | -281.1866 | 345.1996 | 0.4153 |
| **Expected burden of CHE** | -0.0387 | 0.0035 | <.0001 |
| **Total expenditure for covered services** | 1,722.5890 | 3,051.0321 | 0.5724 |
| **MOOP beneficiaries (Yes, %)** | 0.0000 | 0.0001 | 0.7346 |
| **Length of stay for inpatient** | 0.0214 | 0.0211 | 0.3089 |
| **No. of visits for outpatient** | 0.0392 | 0.0219 | 0.0734 |
| **Insured amount†** | 1,787.9790 | 2,626.8870 | 0.4961 |
| **Total OOPs** | -353.4519 | 533.3754 | 0.5075 |

OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, MOOP; Maximum out-of-pocket

All covariates and fixed effects for residential area (by Si/Do) are included in the regression.

**Appendix 19.** Weighted differential change over time in dependent variables for treatment group versus the control group

| Variables | Net-OOPs | | | | Expected burden of CHE | | | | Total expenditure for covered services | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value | β | exp(β) | SE | *p*-value |
| **Intercept β** | 11.2930 | - | 0.0130 | <.0001 | -2.1111 | - | 0.0411 | <.0001 | 12.5724 | - | 0.0228 | <.0001 |
| **Baseline trend** | 0.0101 | 1.01 | 0.0012 | <.0001 | 0.0002 | 1.00 | 0.0024 | 0.9339 | 0.0218 | 1.02 | 0.0018 | <.0001 |
| **Level change** | 0.0054 | 1.01 | 0.0066 | 0.4160 | 0.0035 | 1.00 | 0.0123 | 0.7764 | 0.0172 | 1.02 | 0.0095 | 0.0706 |
| **Trend change** | 0.0054 | 1.01 | 0.0042 | 0.1963 | -0.0169 | 0.98 | 0.0086 | 0.0488 | -0.0093 | 0.99 | 0.0062 | 0.1309 |
| **Difference between treatment and control** | -0.0265 | 0.97 | 0.0041 | <.0001 | 1.1092 | 3.03 | 0.0106 | <.0001 | -0.0100 | 0.99 | 0.0065 | 0.1267 |
| **Baseline trend of difference between treatment and control** | 0.0049 | 1.00 | 0.0015 | 0.0014 | -0.0558 | 0.95 | 0.0039 | <.0001 | 0.0060 | 1.01 | 0.0024 | 0.0129 |
| **Level change of difference between treatment and control** | **-0.0319** | **0.97** | **0.0088** | **0.0003** | **-0.1097** | **0.90** | **0.0191** | **<.0001** | **-0.0207** | **0.98** | **0.0135** | **0.1247** |
| **Trend change of difference between treatment and control** | -0.0044 | 1.00 | 0.0056 | 0.4277 | 0.0194 | 1.02 | 0.0122 | 0.1121 | 0.0083 | 1.01 | 0.0087 | 0.3420 |
| **Age** | | | | | | | | | | | | |
| 19-29 | ref. | | | | ref. | | | | ref. | | | |
| 30-39 | 0.2184 | 1.24 | 0.0041 | <.0001 | 0.2160 | 1.24 | 0.0188 | <.0001 | 0.2520 | 1.29 | 0.0080 | <.0001 |
| 40-49 | 0.4405 | 1.55 | 0.0042 | <.0001 | 0.3985 | 1.49 | 0.0181 | <.0001 | 0.4700 | 1.60 | 0.0074 | <.0001 |
| 50-59 | 0.8580 | 2.36 | 0.0041 | <.0001 | 0.8130 | 2.25 | 0.0177 | <.0001 | 0.8859 | 2.43 | 0.0075 | <.0001 |
| ≥ 60 | 1.2281 | 3.41 | 0.0042 | <.0001 | 1.4260 | 4.16 | 0.0186 | <.0001 | 1.3915 | 4.02 | 0.0083 | <.0001 |
| **Sex** | | | | | | | | | | | | |
| Male | ref. | | | | ref. | | | | ref. | | | |
| Female | 0.2558 | 1.29 | 0.0029 | <.0001 | 0.2291 | 1.26 | 0.0085 | <.0001 | 0.2512 | 1.29 | 0.0052 | <.0001 |
| **Types of insured** | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Self-employed | ref. | | | | ref. | | | | ref. | | | |
| Employee | 0.0669 | 1.07 | 0.0028 | <.0001 | -0.8870 | 0.41 | 0.0077 | <.0001 | -0.0158 | 0.98 | 0.0045 | 0.0004 |
| **Disability** | | | | | | | | | | | | |
| No | ref. | | | | ref. | | | | ref. | | | |
| Yes | 0.3416 | 1.41 | 0.0069 | <.0001 | 0.8512 | 2.34 | 0.0229 | <.0001 | 0.6620 | 0.02 | 0.0200 | <.0001 |
| **CCI** | | | | | | | | | | | | |
| 0 | ref. | | | | ref. | | | | ref. | | | |
| 1 | 0.4236 | 1.53 | 0.0025 | <.0001 | 0.4933 | 1.64 | 0.0070 | <.0001 | 0.4327 | 1.54 | 0.0043 | <.0001 |
| 2 or over | 0.9070 | 2.48 | 0.0041 | <.0001 | 1.4607 | 4.31 | 0.0116 | <.0001 | 1.3087 | 3.70 | 0.0100 | <.0001 |
| **No. of beds†** | | | | | | | | | | | | |
| Q1 | ref. | | | | ref. | | | | ref. | | | |
| Q2 | -0.0160 | 0.98 | 0.0045 | 0.0004 | 0.0331 | 1.03 | 0.0141 | 0.0190 | -0.0261 | 0.97 | 0.0070 | 0.0002 |
| Q3 | 0.0112 | 1.01 | 0.0123 | 0.3612 | 0.1391 | 1.15 | 0.0372 | 0.0002 | 0.0304 | 1.03 | 0.0177 | 0.0861 |
| **No. of physicians†** | | | | | | | | | | | | |
| Q1 | ref. | | | | ref. | | | | ref. | | | |
| Q2 | 0.0107 | 1.01 | 0.0062 | 0.0839 | -0.0125 | 0.99 | 0.0144 | 0.3846 | 0.0001 | 1.00 | 0.0089 | 0.9914 |
| Q3 | -0.0256 | 0.97 | 0.0119 | 0.0312 | -0.0835 | 0.92 | 0.0372 | 0.0250 | -0.0431 | 0.96 | 0.0205 | 0.0359 |

Weighted by the stabilized inverse probability treatment weight (IPTW) method

All covariates and fixed effects for residential area (by Si/Do) are included in the regression.

†Regional level variables. Categorized the number of beds/physicians per 1,000 population in the region(Si/Do) as a tertile by each study year.

OOPs; Out-of-pocket expense, CHE; Catastrophic Health Expenditure, SE; Standard Error, CCI; Charlson's comorbidity index

**Korean Abstract (국문 요약)**

# 본인부담상한제의 상한액 변화가 저소득층의 의료비 부담에 미치는 영향

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**서론:** 2014 년부터 저소득층의 의료비 부담 경감을 목적으로 본인부담상한제가 개선되었다. 보험료 소득 분위 기준 3 구간으로 구분하던 상한액을 7 구간으로 세분화하며 조정하여 저소득층의 상한액은 하향 조정되었다. 이 연구는 본인부담상한제의 상한액 조정에 따른 저소득층의 의료비 부담과 의료이용의 변화를 분석하고자 한다.

**연구방법:** 이 연구는 국민건강보험공단 표본코호트 자료를 활용하여 2009~2015 년간 각 연도별 보험료 소득 분위 10 분위 중 1~5 분위의 성인을 연구대상자로 한다. 이 중 상한액이 하향된 1~3 분위는 실험군으로, 상한액의 변동이 없던 4~5 분위는 비교군으로 설정했다. 주요 종속변수는 순-급여본인부담금, 재난적의료비 예측 부담률, 총 급여본인부담금이다. 연구분석 모델은 Segmented regression with difference-in-differences (DID)로 제도 시행 전후 실험군과 비교군의 교호작용항을 중심으로 확인했다.

추가 종속변수에 대한 분석, 하위 그룹 분석, 대상자에 연도별 Stabilized inverse probability treatment weight 를 적용한 민감도 분석을 추가로 수행했다. 통계분석 방법으로 Generalized estimation equation model 을 활용했다.

**연구결과:** 본인부담상한액 하향 조정은 저소득층의 의료비 부담 경감과 관련 있었다. DID 분석 결과 상한액 하향 조정은 소득 1~3 분위의 순 본인부담금액 감소, 재난적의료비 예측 부담률 감소와 관련이 있었다 (순 급여본인부담금액: EXP(β)= 0.97, $p$<.0001; 재난적의료비 예측 부담률 EXP(β)= 0.91, $p$<.0001). 총 급여본인부담금은 감소하는 경향이었으나 통계적 유의성이 적었다 (EXP(β)= 0.98, $p$=0.0976). 하위 그룹 분석 결과, 동반질환 중증도가 높은 군과 암환자에서 재난적의료비 예측 부담률과 총 급여본인부담금이 시행 직후 증가하고 이후 감소하는 경향이 있었다. 민감도 분석 결과는 주요 분석결과와 유사했다.

**결론:** 본인부담상한제의 상한액 하향조정은 저소득층의 의료이용에 영향을 주지 않으면서 의료비 부담을 경감했다. 이 연구 결과를 바탕으로 본인부담상한액의 하향 조정은 목적에 맞게 작동했다고 평가할 수 있다. 하지만 암환자 및 중증 질환자의 제도 시행 직후 의료비는 증가하고 이후 감소 추세를 보여 장기적인 효과 평가의 필요성이 있다. 이 연구 결과가 본인부담상한제를 포함한 본인부담금 관련 제도의 참고자료가 되길 바라며 추후 발전적인 근거들이 제시되어 의료이용에 대한 저소득층의 경제적 접근성이 향상되길 기대한다.

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**핵심어**: 본인부담상한제, 본인부담금, 의료비 부담, 의료이용