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ABSTRACT

The Effects of Patient Cost-Sharing on Adolescents' Healthcare Utilization and Financial Risk Protection: Evidence from South Korea*

We examine the effects of patient cost-sharing on adolescents' healthcare utilization and out-of-pocket medical expenditures by exploiting the healthcare reform in South Korea that lowered the coinsurance rate for inpatient care from 20% to 5% for children under 16. We apply a difference-in-regression-discontinuities design using administrative claims data. We find that the reform increased adolescents' inpatient care utilization. It also reduced out-of-pocket healthcare expenditures. This effect was larger among low-income households, facilitating income redistribution. However, the lack of evidence on health improvements and household consumption spending responses suggests that generous patient cost-sharing for adolescent healthcare may cause efficiency losses.

JEL Classification: I12, I13, I18

Keywords: patient cost-sharing, healthcare utilization, out-of-pocket expenditure, income redistribution, consumption spending, difference in regression discontinuities design

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* Abbreviations: ACSCs, Ambulatory Care Sensitive Conditions; AHRQ, Agency for Healthcare Research and Quality; CHIP, Children's Health Insurance Program; DRD, Difference-in-Regression Discontinuity; ER, Emergency Room; ICD, International Classification of Diseases; KCD, Korean Standard Classification of Disease; KHIES, Korean Household Income and Expenditure Survey; KHPS, Korean Health Panel Survey; KRW, South Korean Won; KYRBS, Korea Youth Risky Behavior Survey; MCA, Medical Care Assistance; NHI, National Health Insurance; NHIS, National Health Insurance System; NHISS, National Health Insurance Sharing Services; OOP, Out-of-Pocket; US$, United States Dollar. Funding information: Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2020S1A3A2A02104190) and by Korea University grant (K2401821).

1. Introduction

Childhood health has been found to have lasting effects on human capital accumulation and adult well-being (Currie, 2020). In addition, children's catastrophic healthcare expenditure can cause significant financial distress to their households. Thus, many governments provide generous public health insurance coverage for children to improve their access to healthcare. For example, the Children's Health Insurance Program (CHIP) in the U.S. allows children from low- and middle-income families to be exempt from cost-sharing requirements for many healthcare services.

Despite its benefits, the public provision of generous health benefits can induce the excessive use of healthcare, resulting in efficiency losses. To minimize this problem, government-provided health plans often require cost-sharing in the form of a deductible, copayment, or coinsurance rate.[1] Therefore, it is crucial to understand patients' behavioral responses to cost-sharing for designing an efficient health insurance program.

In this study, we examine the effects of patient cost-sharing on adolescents' healthcare utilization and financial risk protection, as measured by out-of-pocket (OOP) medical expenditures. To do so, we use the healthcare reform implemented in South Korea (hereafter, Korea), wherein the government lowered the coinsurance rate for inpatient care from 20% to 5% in October 2017 for individuals under 16 years. We apply a difference-in-regression discontinuities (DRD) design that compares discontinuities between pre- and post-reform periods in the healthcare utilization for adolescents and OOP expenditure, using administrative healthcare claims data.

We present the two main findings. First, a 15-percentage point reduction in the inpatient care coinsurance rate increased adolescents' inpatient care utilization in terms of total medical expenditure by 11.5%. This was driven by increases in both the number of hospital admissions (by 6.3%) and expenditure per admission (by 8.3%). As possible mechanisms, we find that i) patients increased inpatient care use immediately before their cost-sharing for inpatient care increases, ii) the reform increased the probability of visiting advanced-tier hospitals (by 2.1%), and iii) the effects on total expenditure for inpatient care were greater among low-income patients and patients with deferrable health conditions. However, we find little evidence of significant changes in healthcare expenditures for outpatient and emergency room care. When

[1] The coinsurance rate is defined as a fixed proportion of total medical expenditure paid by a patient.

combining the results with the findings of null health impact, these results imply that reduced patient cost-sharing may have induced overutilization of healthcare among adolescents.

Second, we find that the reform decreased the burden of OOP medical expenditure. By using unique information on households' NHI contributions in administrative claims data, we document that the reductions in OOP medical expenditure relative to the NHI contribution were larger among low-income households and households with greater healthcare demands. This finding indicates that improved financial protection via the reform may have improved income redistribution. However, by analyzing household survey data, we find little evidence that the reform increased household consumption spending. The null impacts on household spending, along with the null health impacts, suggests that the reform did not improve households' welfare although it improved income redistribution.

This study contributes to the literature by documenting novel evidence on the potential efficiency loss and the redistributive role of generous cost-sharing among adolescents. Our work is closely related to Nilsson and Paul (2018), Iizuka and Shigeoka (2022, 2023), and Han et al. (2020) documenting causal evidence on efficiency loss of patient cost-sharing for adolescents in Sweden, Japan, and Taiwan, respectively. However, while causing efficiency loss, public health insurance programs provide safety nets for patients' financial losses due to unexpected health shocks by transferring NHI contributions. As low-income patients are likely to have a greater demand for healthcare while paying a smaller NHI premium, the relative amounts of the transferred NHI contribution can be greater for low-income groups. Despite existing studies investigating the redistributive role of other social insurance and means-tested programs (Causa and Hermansen, 2017; Hoynes and Patel, 2018), to the best of our knowledge, those previous studies provided limited evidence on the distributive effects of patient cost-sharing of public health insurance programs. We fill this gap by utilizing unique information on households' NHI contributions in administrative claims data and document evidence of the role of a public health insurance program in income redistribution. In particular, combined with our results on healthcare utilization, this study suggests a potential trade-off between efficiency loss and income redistribution induced by governments' NHIs.

In addition, combining with those previous studies documenting evidence of potential efficiency losses of generous cost-sharing in other stages of the life-cycle, our findings can help better understand how the efficiency losses of patient cost-sharing varies over the life-cycle, which is crucial for designing an optimal NHI program. Adolescents are least likely to use health care compared to patients in other life-cycle stages such as infants or children (Han et al., 2020; Iizuka and Shigeoka, 2022, 2023) or elderly (Shigeoka, 2014; Fukushima et al., 2016), our estimates can provide insights into how small the efficiency losses would be over the life-cycle. Our results on non-zero efficiency losses among adolescents imply that governments' generous cost-sharing programs are likely to incur more significant efficiency losses over patients' overall life-cycle.

Lastly, our unique institutional setting allows us to identify both own-price and cross-price elasticities cleanly. Some studies encounter challenges in distinguishing own-price from cross-price effects due to simultaneous price changes in other healthcare services (Shigeoka, 2014; Han et al., 2020). However, the Korean healthcare reform we study reduced the inpatient coinsurance rate only without changing the price of other healthcare services. This enables us to cleanly identify the own-price elasticity of inpatient care and the cross-price elasticity of other types of healthcare.

The remainder of this paper is organized as follows: section 2 describes the background of the NHI system and patient cost-sharing policy reform in Korea; sections 3 and 4 present the data and empirical strategies, respectively, to identify the causal effects of cost-sharing; section 5 presents the results of the study; section 6 provides our conclusions.

2. Background

Korea operates a single-payer system via the NHI program, providing identical health insurance benefits across a variety of medical care services (inpatient and outpatient care, dental care, prescription drugs, health check-ups, vaccinations, and traditional Korean medicine) to all residents, without gatekeeping.[2] The absence of gatekeeping within the system allows patients to freely choose health care providers without requiring referrals.[3] Institutional characteristics of the NHI program offer an advantageous setting for estimating the effects of patient cost-sharing by minimizing biases due to (i) patients' health insurance choices based on unobservable characteristics (e.g., health conditions, risk preferences, and other behavioral

[2] National health insurance systems of other East Asian countries such as Japan and Taiwan share similar features.

[3] One major exception is patients who are covered by the Medical Care Assistance (MCA) program, means-tested health benefits for low-income families. MCA beneficiaries must obtain a referral from a lower-tier hospital or a clinic to visit a more advanced-tier healthcare provider.

traits such as inertia) or (ii) healthcare providers' choice of treatment based on patients' health insurance type (Shigeoka, 2014; Han et al., 2020).[4]

The NHI program is financed predominantly using payroll taxes. If an individual is employed, the insurance premium is set at 6.99% of their earnings. This is inclusive of the employer's contribution, which accounts for 50% of the premium and does not have an upper limit. If the policyholder is not working (including retirees) or is self-employed, the premium is determined by their level of economic means based on their overall income and assets.

To minimize moral hazards, such as overusing the healthcare system, patients are required to pay a certain share of the total medical expenditure. The coinsurance rate for general practitioner visits is 30%, with a deductible of KRW 1,500 (US$1.15) for the general population.[5] The coinsurance rate for inpatient care is generally fixed at 20%. Low-income individuals, children, and the elderly are eligible for lower OOP medical expenses. The government also sets an annual maximum OOP expenditure to reduce the financial burden of catastrophic medical expenditures. If the patients' total annual OOP expenditure exceeds the cutoff, the excess amount is fully borne by the government.[6]

After President Moon Jae-In took office in May 2017, his administration implemented reforms to lower citizens' financial burden of catastrophic healthcare expenditures, known as "MoonCare." One of the key changes was to lower the coinsurance rate of inpatient care among children under 16 years of age from 20% to 5%, which is the focus of this study. This change was introduced in October 2017. There were no changes in the coinsurance rate for outpatient visits and other types of healthcare. These institutional features offer an advantageous setting to cleanly isolate the impact of inpatient care cost-sharing on inpatient care utilization to calculate own price elasticity and cross-price elasticities for other types of healthcare. Table 1 summarizes how the coinsurance rates for inpatient care, outpatient visits, and emergency room visits changed by age before and after the MoonCare reform.

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[4] The composition of health insurance enrollees might have been endogenously influenced by cost-sharing plans (Chandra et al., 2010) or healthcare providers' medical treatment might depend on patients' health insurance type (Clemens and Gottlieb, 2017).

[5] As of July 10, 2022, US$1 is equivalent to KRW 1,303.

[6] For example, in 2022, the maximum OOP amounts range between KRW 830,000 (US$637) and KRW 5.98 million (US$4,589), depending on household income and the length of hospital stay. During our sample period, 0.12% of adolescents reached the annual maximum OOP cutoff. Table A1 shows the full schedule.

3. Data

To investigate the effects of the MoonCare reform on adolescents' healthcare utilization and expenditure, we use administrative claims data from the NHI system from 2016 until 2019. It provides information regarding healthcare claims across the entire Korean population, including OOP payments, total expenditures by type of medical care (inpatient/outpatient/emergency room), province of residence, sex, health insurance contributions, date of admission (visit), and diagnosis codes based on the Korean Standard Classification of Disease (KCD), which are compatible with the International Classification of Disease (ICD).[7]

To construct the running variable for an age-based DRD, we calculate patients' age-in-quarter by combining patients' year and quarter of birth and their visit date.[8] Compared to the case using a more granular running variable such as age-in-month, our setting can be less ideal for constructing counterfactual. To alleviate this limitation, we adopt an age-based DRD by using pre-reform data as an additional counterfactual. For the primary dependent variable, we calculate the patient-level total healthcare expenditure for inpatient care. We also calculate the total number of admissions or visits and expenditure per admission for inpatient care to estimate the effect of the reform on the intensive and extensive margins of inpatient care. Although our baseline analysis mainly focuses on estimating own price elasticities, we also calculate the total healthcare expenditure for outpatient care and emergency room (ER) care to estimate cross-price elasticities of healthcare demand.

We restrict the sample to those aged 14–18 years (two years before and after the cutoff age), which includes a total of 4,017,166 individuals from 2016 to 2019. We exclude patients with critical health conditions such as cancer, heart diseases, and cerebrovascular diseases, making up approximately 0.01% of total adolescents. We also exclude patients subject to other healthcare benefits with different cost-sharing rules, e.g., patients with orphan diseases and whose immediate family members are veterans and military personnel (2.9% of total adolescents).[9] These exclusions are because the NHI had been applying an inpatient care

[7] Moreover, it allows us to track each individual's healthcare utilization and expenditure over time. However, in the empirical analysis, we aggregated the administrative claims data at the age-in-quarter and pre/post-reform period cells following Lee and Card (2008). Given computing constraints available at the NHI data center, we could not execute the regression analysis using the individual-level data.

[8] The NHIS does not allow researchers to access the information of the exact birthdate to protect anonymity. As such, a quarter is the most disaggregated unit of age available to researchers.

[9] It was not possible to use this group for the placebo test because their coinsurance rates vary from 0% to 20% depending on their healthcare benefits and diagnoses, which are not cleanly identifiable.

coinsurance rate of 5% to those patients even before the MoonCare reform. We also exclude those covered by the MCA program (4.22% of total adolescents), because (i) they could not choose more advanced-tier healthcare providers without referrals and (ii) a reduction in the coinsurance rate for inpatient care induced by the MoonCare reform did not apply to these beneficiaries.[10]

Table A2 reports the descriptive statistics of the healthcare utilization measures by type of medical care before the reform. All variables are quarterly averages and CPI-adjusted real values, with 2015 as the base year. Similar to our main analysis, we calculate the average values two years before and after the 16th birthday (excluding the quarter of the 16th birthday). The average number of admissions/visits is similar below and above the age cutoff of 16, with inpatient care, outpatient visits, and ER visits are 0.02 (0.023), 1.75 (1.79), and 0.025 (0.027), respectively, for ages below (above) 16. The average total medical expenditure for ages below (above) 16 is KRW 20,300 (KRW 23,800) for inpatient visits, KRW 40,900 (KRW 41,700) for outpatient visits, and KRW 2,100 (KRW 2,400) for emergency room visits.

4. Empirical Strategy

To identify the causal effects of patient cost-sharing for adolescents, we exploit the discontinuous change in patients' coinsurance rate for inpatient care during the quarter of their 16th birthday. To further strengthen our identification, we use pre-reform data (January 2016 through September 2017) to construct additional counterfactual age profiles of the outcome variables of interest. Hence, we applied a DRD that compares the discontinuities of patients' healthcare utilization and other outcomes of interest at the cutoff age between the pre- and post-reform periods (Landais, 2015; Deshpande, 2016; Grembi et al., 2016; Bluhm and Pinkovskiy, 2021). To do so, we aggregate the administrative claims data into age-in-quarter and pre/post-reform period cells and calculate the cell-specific averages. We estimate the following model using the number of observations in each cell as a weight (Lee and Card, 2008):

$$y_{a,t} = \beta_0 + \beta_1 1[age_a < 0] * Post_t + \beta_2 1[age_a < 0] + \beta_3 Post_t + f(age_a; t) + \varepsilon_{a,t}\,, (1)$$

[10] The Korean government covers most or large parts of OOP expenditures for those covered by the MCA. Regarding inpatient care, there was no-cost sharing for Tier 1 beneficiaries, while Tier 2 beneficiaries are subject to the coinsurance rate of 10%, but the MoonCare reform reduced the coinsurance rate for inpatient care from 10% to 3% for Tier 2 beneficiaries. Unfortunately, the NHIS data does not allow us to distinguish Tier 1 and Tier 2 beneficiaries. Thus, we cannot conduct a falsification check using the sample of Tier 1 beneficiaries who were not affected by the policy reform.

where $y_{a,t}$ indicates the outcome of interest, such as the logarithm values of total healthcare expenditure, number of admissions (visits), and average expenditure per admission (visit) by healthcare type (inpatient care, outpatient care, and ER care) in standardized age-in-quarter a in period t. age_a is an individual's age-in-quarter, normalized to zero in the quarter of the 16th birthday. $1[age_a < 0]$ indicates whether a patient's age-in-quarter is below the cutoff age.[11] $Post_t$ indicates the post-reform period (the 4th quarter of 2017 and after). $f(age_a; t)$ is a smooth function of the standardized age-in-quarter. In the baseline specification, we restrict the ages of sample respondents to two years older and younger than the cutoff age. Assuming that the bandwidth is reasonably narrow, we approximate the age profiles of healthcare utilization using a quadratic function of age-in-quarter and its interaction with $1[age_a < 0]$, $Post_t$, and $1[age_a < 0] * Post_t$ (Gelman and Imbens, 2019).

β_1 represents the parameter of interest, capturing changes in the discontinuities in the outcomes of interest at the cutoff age following the policy reform. For statistical inference, we calculate standard errors clustered at the age-in-quarter level by allowing serial correlations within each age-in-quarter. The statistical inference remains similar when using heteroskedasticity-robust standard errors (Kolesár and Rothe, 2018). To interpret the estimated value of β_1 as the causal effect of the reduced coinsurance rate for inpatient care at the cutoff age, two conditions must be satisfied. First, patients' observable and unobservable characteristics should change smoothly at the cutoff age (Bluhm and Pinkovskiy, 2021). As an indirect test of the validity of this key identification assumption, we estimate discontinuities in patient characteristics at the age cutoff using equation (1). Table A3 shows little evidence of discontinuous changes in the observed patient or household characteristics at the age cutoff. The estimates are small in magnitude and statistically insignificant.[12] Second, individuals should be unable to manipulate the running variable. We argue that this assumption is unlikely to be violated because the biological age in the administrative data cannot be manipulated.

[11] We do not include the observations in the quarter of the 16th birthday because respondents who have already turned 16 and have not turned 16 yet are mixed within the quarter.

[12] Since healthcare claims data do not contain much information on individual characteristics, we also use nationally representative survey data of adolescent health. Columns (4) to (7) of Table A3 indicate that DRD estimates of other adolescent characteristics are small in magnitude and statistically insignificant.

5. Results

5.1. Effects on Inpatient Care Utilization

Main analysis

Figure 1 shows the age profile of the difference in inpatient care utilization before and after the MoonCare reform. To measure inpatient care utilization, we use the logarithm values of total expenditure, number of admissions, and average expenditure per admission (Panels A to C). Vertical lines indicate the quarter of the patient's 16th birthday.[13] Panel A shows a discontinuous increase in total inpatient care expenditure in the quarter of the 16th birthday. The results suggest that the reduced coinsurance rate for inpatient care increased adolescents' total expenditure on inpatient care. Panel A of Table 2 shows our DRD estimates for the logarithm values of total expenditure, number of admissions, and average expenditure per admission using equation (1). Column (1) reports that the DRD estimate of the total healthcare expenditure for inpatient care is 11.5%, which is statistically significant at 1%. To further understand the source of the increase in inpatient care utilization, we examine difference-in-discontinuities in the number of admissions (extensive margin) and average expenditure per admission (intensive margin). Panels B and C of Figure 1 indicate discontinuous increases in both margins at the age cutoff. Columns (2) and (3) of Table 2 report that the number of admissions and expenditures per admission increased by 6.3% and 8.3%, respectively. The estimates are statistically significant at 5%.[14] These findings suggest that the reform increased inpatient care utilization through both extensive and intensive margins.[15]

Figure 1 demonstrates that patients appear to use more hospital care before their cost-sharing increases at age 16. For example, total expenditure appears to jump before age 16 and to drop immediately after age 16. These patterns suggest that patients might have intertemporally substituted their healthcare use near the age cutoff. To indirectly examine the role of intertemporal substitution in inpatient care, we employ a donut-hole approach by excluding observations with patients' age in quarter being one quarter away from the quarter

[13] The respective age profiles of healthcare utilization during the pre- and post-reform periods are available in Figure A1.

[14] Table A4 shows that statistical significance of estimates remains similar when using heteroskedasticity-robust standard errors.

[15] We estimate the effects of the MoonCare Reform on the logarithm value of the number of overnight hospital stays. The DRD estimate is 0.104 with the standard error of 0.026, suggesting that the reform increased the length of hospital stay.

of 16th birthday while using the baseline bandwidth. We conjecture that the estimates become smaller in magnitude if the intertemporal substitution in hospital care use is a leading mechanism. Panel B of Table 2 shows that the DRD estimates for the total expenditure and expenditure per admission indeed become smaller in magnitude and statistically insignificant, although the DRD estimate for the number of admissions is still statistically significant at the 5% level and greater than our original DRD estimate.

We further investigate the effects of the patient cost-sharing reform on additional outcome variables in Table A5. First, lower cost-sharing can incentivize patients to visit advanced-tier providers more often because the healthcare price at advanced-tier hospitals (e.g., teaching hospitals) is higher than that of lower-tier healthcare providers (Han et al., 2020). Column (1) provides evidence consistent with this hypothesis. Our DRD estimate indicates that the reform increased the probability of advanced-tier hospital admissions by 2.1 percentage points (a 24% increase from the pre-reform mean), which is statistically significant at the 5% level. This finding suggests that lower financial burden induces patients to use more expensive healthcare.[16] Second, patients could have switched from outpatient visits to inpatient admissions, as the MoonCare reform reduced the OOP costs of inpatient care. To test this conjecture, we estimate the effect of the reform on adolescents' hospital admissions for pneumonia. Pneumonia is one of the most common conditions among patients admitted to hospitals in Korea, although it is relatively less fatal to adolescents (Lee et al., 2021). Thus, healthcare providers and patients may have more discretion regarding admission decisions. Column (2) shows that the DRD estimate on the logarithm value of the number of hospital admissions for pneumonia is -0.069, but the estimate is statistically insignificant, offering little evidence that the reform encouraged patients to switch from outpatient visits to inpatient care.

To strengthen the causal interpretation of our baseline results, we conduct the following checks. First, our baseline bandwidth (eight quarters) may be broader than the ideal length suggested in the literature (Gelman and Imbens, 2019). As the choice of a bandwidth can cause a bias in estimation, we examine whether the results are similar when using narrower bandwidths. Figure A2 presents DRD estimates and 95% confidence intervals for the logarithm values of total expenditure, number of admissions, and average expenditure per admission, using narrower bandwidths in panels A to C, respectively. The horizontal axis represents bandwidths. The red horizontal lines represent the baseline DRD estimates reported in Table 2.

[16] The DRD estimate for visiting low-tier providers is -0.21 (with the standard error of 0.007).

We find that DRD estimates with alternative bandwidths presented in all panels are generally similar to those in the baseline analysis, while DRD estimates for total healthcare expenditure and expenditure per admission increased with narrower bandwidths.

Next, we consider alternative regression specifications in Table A6. Panel A of Table A6 shows that the results for total expenditures and expenditures per admission remain robust when including higher-order polynomials (i.e., cubic) to approximate the age profiles of healthcare utilization with a more flexible parametric function, while using the baseline bandwidth. As the DRD estimate for the number of admissions is no longer statistically significant, we argue that the effects of the reform on the extensive margin of healthcare demand should be interpreted with caution. Panel B of Table A6 shows that the results are robust when additionally controlling for the individual characteristics considered in Table A3. To better account for an increase in healthcare expenditure over time, we use year-quarter fixed effects instead of a dummy variable indicating the post-reform period. Panel C shows the results remain similar.

Finally, we estimate the impact of the reform among patients with critical conditions such as cancer, heart diseases, and cerebrovascular diseases. Since the NHI had been applying an inpatient care coinsurance rate of 5% to patients with these conditions prior to MoonCare, the reform would not increase inpatient care utilization among these patients if our baseline findings captured the causal effects of lower patient cost-sharing on inpatient care utilization. Columns (1) through (3) of Table A7 show that the DRD estimates are negative or statistically insignificant if the sign of the estimate is positive. However, as mentioned in Section 3, the proportion of adolescents with these critical health conditions is low (0.01%), thereby warranting cautious interpretation.

Additional Analyses

Heterogeneous effects on inpatient care utilization

In Table 3, we examine the heterogeneous effects of the reduced coinsurance rate on inpatient care utilization by household income, health conditions, place of residence, and type of care.[17] First, although the cost-sharing schedule is uniform across patients' household income levels, low-income patients' healthcare demand can be more sensitive to a lower price than that of

[17] Table A8 shows that statistical significance of estimates remains similar when using heteroskedasticity-robust standard errors.

high-income patients when low-income patients are subject to more binding liquidity constraints. To test this conjecture, we use households' NHI premiums, determined primarily by household income and wealth, and split the sample into two groups using median income. Column (1) shows that the DRD estimate for the low-income group is 0.192 and is statistically significant at 1%. In contrast, column (2) indicates that the high-income group's estimate is 0.077, which is statistically significant at 5%. The results imply that the inpatient care demand response to lower patient cost-sharing is mainly driven by low-income patients.

Second, healthcare demand is derived from an individual's health status (Grossman, 1972). Hence, demand response might be greater among those with underlying health conditions. To examine this issue, we approximate pre-existing health conditions by calculating adolescents' total healthcare spending before turning 16. Then, we define sickly adolescents as those with the top 10% healthcare spending; the rest are classified as healthy adolescents.[18] Columns (3) and (4) show that the DRD estimates are similar between the two groups. This result implies little heterogeneity in the inpatient care demand response to the lower coinsurance rate by adolescents' pre-existing health status.

Third, we examine whether the effects of the lower inpatient care coinsurance rate are heterogeneous in terms of patients' accessibility to healthcare providers. If patients live in areas with greater access to healthcare providers, healthcare utilization can be easily increased. In Korea, most advanced-tier hospitals are concentrated in the larger cities. Thus, we divide the sample according to whether patients live in areas that are classified as metropolitan cities (e.g., Seoul and Busan). Columns (5) and (6) show that the DRD estimates for metropolitan and non-metropolitan residents are 0.099 and 0.143, respectively, and are statistically significant at 10% and 5%, respectively. The results imply that the accessibility of healthcare providers does not play an important role in explaining the effects of the MoonCare reform on inpatient care utilization. However, the large magnitude among non-metropolitan residents could be also because household income is generally higher in metropolitan cities than it is in non-metropolitan cities.

Fourth, patients' healthcare demand responses can be more sensitive to conditions that do not require urgent care. We analyze heterogeneous effects on inpatient care utilization by

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[18] When defining sickly adolescents, we exclude patients subject to non-regular cost-sharing rules due to their exceptional status (e.g., rare, incurable, or long-term diseases). Healthy patients' quarterly total healthcare spending is about KRW 14,500 (US$11.1) on average, while sickly patients' quarterly healthcare spending is about KRW 119,200 (US$91.5) on average. We do not split the sample by median spending because many adolescents report zero total healthcare expenditure when their healthcare spending before the reform was small.

non-deferrable health conditions (e.g., heart attacks) in Panel D.[19] Column (7) indicates that the DRD estimate of total expenditure for deferrable healthcare is 0.082 and is statistically significant at 1%. However, Column (8) shows that the sign of the DRD estimate on total expenditure on non-deferrable healthcare is negative and is statistically insignificant. The results imply that the reform could have induced the moral hazard problem by increasing healthcare utilization of deferrable health conditions.

Implied price elasticities of healthcare demand

Our baseline estimate in Table 2 indicates that the reform increased the total expenditure on inpatient care by 11.5%. Since the coinsurance rate is reduced by 75% (from 20% to 5%), the implied price elasticity of the quantity demanded is -0.15. If we calculate the implied price elasticity of healthcare demand using the estimates of the number of hospital admissions, as in some of the existing studies (e.g., Shigeoka, 2014), it becomes -0.07. Our elasticity estimate is smaller than the price elasticity of inpatient care (-0.16) for the elderly aged 70 and above in Japan (Shigeoka, 2014), while it is larger than that estimated for children aged 3 and below in Taiwan (Han et al., 2020) which implies zero elasticity. Given that South Korea, Japan, and Taiwan operate national health insurance plans with similar features, the difference in the price elasticities of inpatient care demand by age illustrates the evolution of healthcare demand over the life cycle.

To gain a more comprehensive understanding of the effects of the reform on healthcare utilization, we examine the cross-price elasticities of healthcare demand by estimating the effects of the reform on total expenditure in outpatient care and ER care. Figure A3 presents the differences in the age profiles of total healthcare expenditure for outpatient care and emergency room care in Panels A and B, respectively. Both figures provide little evidence of discontinuous changes in outpatient healthcare utilization. Consistent with the graphical evidence, Table A10 indicates that the DRD estimates for the logarithm values of total expenditure are small in magnitude and statistically insignificant for both outpatient and ER utilization. The results imply that the cross-price elasticities of healthcare demand are close to zero and similar to those found in previous studies.

Our setting is ideal for the identification of own- and cross-price elasticities of

[19] We define non-deferrable health conditions as the ones that have similar visit rates between weekdays and weekends before the reform, following Han et al. (2020)'s approach. For example, we classify a health condition as non-deferrable if its weekend visit rate is between 0.28 and 0.30 (around 2/7) and its weekday visit rate is between 0.70 and 0.72 (around 5/7). Table A9 lists the top 5 non-deferrable and deferrable health conditions.

healthcare demand because the coinsurance rate only for inpatient care was reduced without simultaneous changes in outpatient care and emergency care. Since previous studies examined policy reforms or interventions where cost-sharing simultaneously changes across different healthcare types, they indirectly estimated own- and cross-price elasticities of healthcare demand by restricting the sample to patients with diseases whose treatments are mainly conducted in one specific type of healthcare (e.g., inpatient care only). Given that our results are generally similar to those of previous studies, our findings justify the previous studies' approach as a reasonable alternative for calculating own- and cross-price elasticities of healthcare demand when patient cost-sharing simultaneously changes across healthcare types.

Health impacts

We also investigate the health impacts of the reform. Given the age range of the sample population, we use self-reported health status and mental health status as the primary measure of health. Using nationally representative data of youths from the Korea Youth Risky Behavior Survey (KYRBS) for 2015–2020, we find little evidence that lower patient cost-sharing improved adolescents' health status in the month of their 16th birthday.[20] Figure A4 indicates few difference-in-discontinuities in self-reported physical and mental health status in panels A and B, respectively. The DRD estimates are also small and statistically insignificant. Consistent with this result, we find little evidence that the reform reduced the mortality rate using the NHI's administrative claims data.

Effects on beneficial healthcare

We find that the increase in total healthcare expenditure was mainly due to increases in healthcare expenditures for deferrable health conditions. Combined with the null health impacts of the reform, the results provide suggestive evidence that reduced patient cost-sharing incurs efficiency loss. Since the nature of our identification strategy only captures short-term changes within a narrow age bandwidth, we cannot exclude the possibility of long-term health benefits, as studied in the US (Chandra et al., 2021).

To partially address this limitation, we study whether the MoonCare reform increased children's healthcare utilization for ambulatory care sensitive conditions (ACSCs), which is a group of outpatient care treatments that could decrease the demand for future inpatient

[20] For more details about the KYRBS, see Appendix A.

healthcare according to the Agency for Healthcare Research and Quality (AHRQ) in the US (AHRQ, 2004). As these treatments are expected to be less likely to be associated with moral hazards, they can be considered beneficial healthcare (Han et al., 2020).[21] Figure A5 shows the differences in the age profiles of total healthcare expenditure for beneficial healthcare. We do not find a significant difference-in-discontinuities in total healthcare expenditures for beneficial healthcare in the quarter of the 16th birthday. The DRD estimate is 0.002 with a standard error of 0.011. These results imply that the reform did not increase patients' healthcare utilization for beneficial care.[22] The results provide little evidence that the reform might decrease the demand for inpatient care by improving children's health in the longer run.[23]

5.2. Effects on OOP Spending and Consumption Spending

The major goal of the MoonCare reform was to reduce patients' OOP burden on healthcare utilization. Figure 2 shows the difference in the age profile of the logarithm value of the total OOP expenditure before and after the reform. This indicates a difference in the discontinuities of OOP expenditures at the cutoff age. The corresponding DRD estimate for the logarithm value of total OOP expenditure is -0.122, with a standard error of 0.009. The estimates are robust to the alternative specifications used in Table A6, and we find little evidence of discontinuous changes in total OOP expenditures among non-eligible adolescents. The results imply that despite the increase in inpatient care utilization, the MoonCare reform strengthened the NHI's role as a social safety net by reducing patients' OOP burden.

To better understand how the reduced OOP burden affects household welfare, we examine two possible implications. First, we examine the implications of income redistribution. The NHI system is financed by the insurance premiums paid by citizens, whose amounts are primarily determined by their income level, as stated in Section 2. In contrast, the reduced OOP burden via the MoonCare reform was independent of patients' NHI contributions. As a result, the reduction in patients' total OOP expenditure relative to their NHI contributions could be greater among low-income patients.

To examine this distributional implication of patient cost-sharing, we calculate patients'

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[21] In Table A11, we present a list of treatments classified as beneficial care.

[22] The DRD estimate on total healthcare expenditure for less beneficial care is also small in magnitude and statistically insignificant.

[23] As a supplementary analysis, we estimate the effects of the MoonCare reform on total healthcare expenditure for children's psychiatric care, following Han et al. (2020). Figure A6 shows little evidence that the reform increased psychiatric care utilization. The DRD estimate is -0.02 with the standard error of 0.02.

relative OOP burden compared to their households' NHI premium. We then examine the heterogeneity in the reductions in relative OOP expenditure by household income level. Panel A of Figure 3 plots the DRD estimates of the relative OOP expenditure in each income decile using equation (1). Dashed lines represent 95% confidence intervals. This indicates that low-income households experienced larger reductions in their relative financial burdens due to healthcare costs more so than high-income households did. In addition to household income, patients with a greater demand for healthcare may experience larger financial gains from reduced OOP. To examine this conjecture, we approximate patients' demand for healthcare by calculating the average total healthcare expenditure before the reform. Panel B presents DRD estimates of patients' relative OOP to their NHI contribution in each decile of pre-reform healthcare expenditure, using equation (1). This shows that the relative reduction in the financial burden of healthcare costs was greater among those who incurred greater medical treatment costs. The results imply that lower patient cost-sharing can provide a stronger safety net for lower income persons or those with greater healthcare demands by redistributing NHI contributions to them.

Second, we investigate the effects of the MoonCare reform on household consumption spending because lower patient cost-sharing can increase disposable household income. As the NHI claims data do not provide information on household consumption spending, we use nationally representative household-level spending survey data from the Korean Household Income and Expenditure Survey (KHIES) from 2016 to 2019 (see Appendix A for details).[24] For identification, we examine the differences in discontinuities in consumption spending measures after turning 16 years old. Figure 4 presents the age profiles of differences in the total consumption spending measures. This indicates little evidence of a discontinuous increase in the logarithm of total consumption spending at the cutoff age. Table 4 presents the DRD estimates of household consumption spending measures using equation (1). Column (1) indicates that the DRD estimate for total consumption spending is -0.021, which is statistically insignificant.[25]

[24] We use the age-in-year of the youngest child of a household as the running variable when estimating the effects of the MoonCare reform on consumption spending with the KHIES data. Since the KHIES is an annual survey, we define the post-reform period if the survey years are 2018 and 2019. We use 10 years around the cutoff age for the baseline bandwidth. Since we use the single year of age as the running variable, the bandwidth was too short if we use the bandwidth of 2 years as in the healthcare utilization analysis.

[25] The reduced OOP burden of healthcare expenditure might generate income effects to parents, potentially discouraging their labor supply. Since the NHIS data do not provide information on parents' labor supply, we use the KHIES data. Our DRD estimate for the employment probability of adult household members is -0.034 and statistically insignificant (the standard error of 0.024). The results imply that the reduced OOP spending did not

The MoonCare reform also aimed to facilitate children's effective human capital accumulation by lowering the financial burden on healthcare spending. As a potential pathway to achieving this goal, reduced OOP spending can lead to increased investment in children's education. To test this conjecture, we estimate the effects of spending on adolescents' education to understand whether reduced OOP can be associated with the accumulation of other human capital in children. Column (2) of Table 4 shows that the reform increased spending on education by 23.3%, but the estimate is statistically insignificant.

Although there is little evidence that the reform discontinuously improved adolescents' health at the cutoff age, it may have a long-term health impact on other household members. As another potential channel for beneficial health impacts, reduced OOP may result in improved health due to improvements in nutrition. As a potential channel for adverse health impacts, several studies have demonstrated that increases in income encourage risky health behaviors, such as smoking and drinking alcohol (Apouey and Clark, 2015). To test these potential pathways, we estimate the effects of the reform on household spending on groceries, cigarette purchases, and alcohol consumption. Column (3) of Table 4 shows that the reform decreased household spending on food and beverages by 0.2% and is statistically insignificant. Column (4) of Table 4 shows that the reform decreased household spending of alcohol and cigarettes by 14%, which is statistically insignificant. These results imply that the reform may neither improve household members' nutrition nor encourage risky behaviors.

Reduced OOP medical expenditure for adolescents' healthcare would decrease the financial burden that other household members' healthcare utilization may have had before the reform. Since it is difficult to construct household expenditure in administrative claims data, we circumvent this limitation by using nationally representative survey data from the Korea Health Panel Study (KHPS) from 2016 to 2019 (see Appendix A for the details). We estimate the differences in discontinuities in households' total healthcare expenditure and expenditure for healthcare uncovered by the NHI using equation (1). Columns (1) and (2) of Table A12 show that the DRD estimates on the logarithm values of households' healthcare expenditure measures are 0.101 and 0.052, respectively, while both estimates are statistically insignificant. These results imply that the reduced OOP expenditure for adolescents' healthcare may be associated with an increase in other household members' healthcare demands.

discourage household members' labor supply. The results are similar when estimating the effects of the reform on mothers' labor supply.

As of 2019, 73% of the total population was enrolled in private supplementary health insurance plans to avoid large OOP healthcare bills even after cost-sharing by the government and the maximum OOP limit (Financial Services Commission, 2020). These supplementary health plans reimburse part of the OOP costs, including types of healthcare not covered by the NHI, such as manual therapy, newly developed cancer drugs, and robotic surgery (Chung and Mun, 2019). Since the reform reduced the financial burden of OOP healthcare expenditure, we examine the effects of the MoonCare reform on the demand for supplementary private health insurance coverage using the KHPS data. Column (3) of Table A12 shows that private health insurance coverage decreases by 3.5%, but the estimate is statistically insignificant.

6. Conclusion

This study investigates the effects of patient cost-sharing on adolescents' healthcare utilization and OOP medical expenditures by exploiting the recent healthcare reform in Korea. Our DRD analysis provides two main findings. First, the reform increased adolescents' utilization of inpatient healthcare. As potential mechanisms, we show that the reform (i) induced patients increased the use of inpatient care before experiencing a sharp increase in cost-sharing, (ii) encouraged patients to visit advanced-tier healthcare providers, (iii) may have relaxed liquidity constraints, and (iv) increased healthcare expenditures for deferrable health conditions. However, we do not find evidence of health improvements. Second, the reform reduced total OOP spending for healthcare. When comparing the relative reduction in OOP spending to health insurance contributions, we find that the reduction is larger among lower income patients or those with greater healthcare demands. This shows how patient cost-sharing plays a role in income redistribution. However, using household survey data, we find little evidence that the reform increased household consumption spending.

Our results have several policy implications. First, our results on healthcare utilization and health among adolescents imply that reduced patient cost-sharing may cause overutilization of healthcare among adolescents. Our results on intertemporal substitution in health care use and the effects on healthcare use for deferrable health conditions provide suggestive evidence on why reduced patient cost-sharing does not improve adolescents' health. The lack of increases in beneficial healthcare and household spending on groceries and other family members' healthcare expenditures implies limited long-term welfare gains and intra-household health improvements. Second, reduced patient cost-sharing can provide stronger financial protection to patients. The effects can be greater for low-income patients or patients with greater healthcare demands, which indicates how public health insurance plays a role in redistributing income across citizens. However, the lack of significant increases in household consumption spending or health improvements also suggests limited welfare gains.

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Data Availability Statement

Korean NHIS claims data is not publicly available. This data is only available to users to limited-access in the National Health Insurance Sharing Services (NHISS) data centers. The rest of the data used in our analysis are publicly available but subject to redistribution restrictions. The specific details about data availability and replication codes are available in OpenICPSR at https://doi.org/10.3886/E198301V2.

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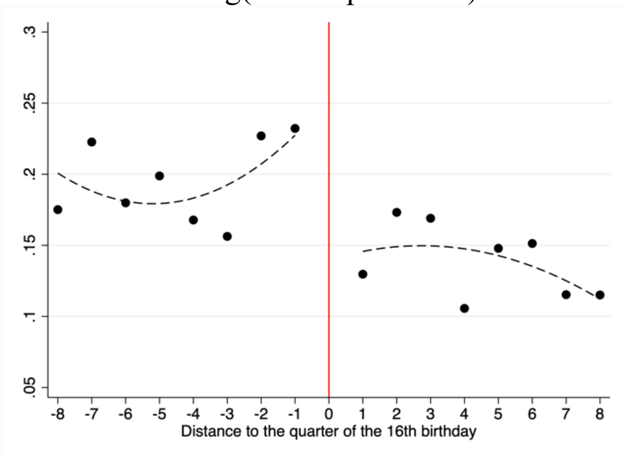
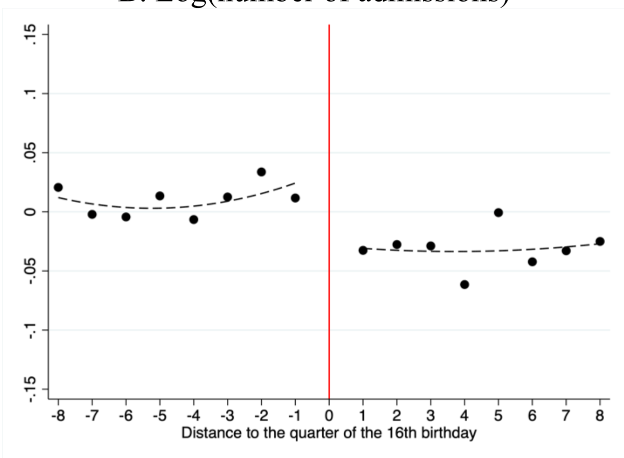
Figures and Tables

Figure 1. Difference in Age Profiles of Inpatient Care Utilization

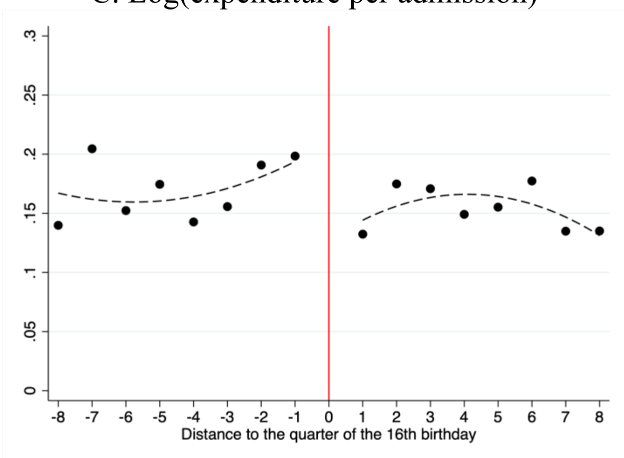
A. Log(total expenditure)



B. Log(number of admissions)

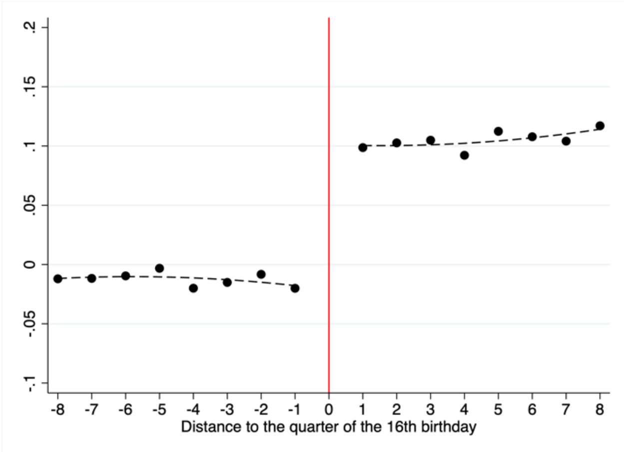


C. Log(expenditure per admission)



Data source: Korean NHIS claims data, 2016–2019.

Figure 2. Difference in Age Profiles of Patients' Out-of-pocket (OOP) Expenditure

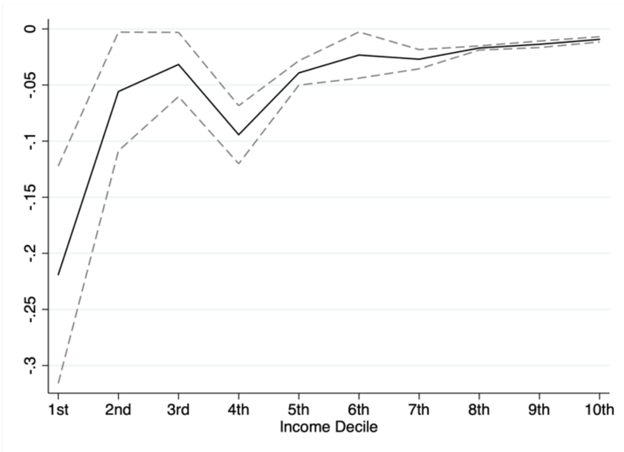


Difference-in-Discontinuities (S.E.): -0.122*** (0.009)

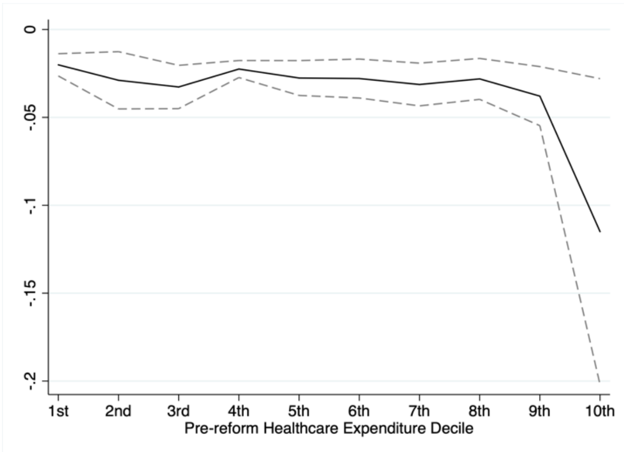
Data source: Korean NHIS claims data, 2016–2019.
Notes: For the dependent variable, we use the logarithm value of total OOP medical expenditure. We use the number of observations in each age cell as analytical weights. Standard errors are clustered at the age-in-quarter level. *** p<0.01, ** p<0.05, * p<0.1.

Figure 3. Difference in Discontinuities in Patients' OOP over their Paid Health Insurance Premium by Income and Underlying Health Status

A. By income



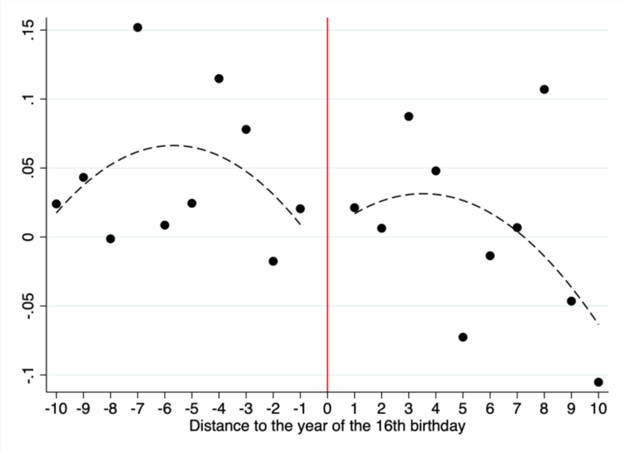
B. By healthcare expenditure before the reform



Data source: Korean NHIS claims data, 2016–2019.

Note: Solid and dashed lines present DRD estimates and 95% confidence intervals for each decline, respectively.

Figure 4. Difference in Age Profiles of Household Total Consumption Spending



Data source: Korean Household Income and Expenditure Survey, 2016–2019.

Table 1. Changes in Coinsurance Rates by Healthcare Type and Age

	Pre-reform period (Before October 2017)		Post-reform period (October 2017 onward)	
	Below 16	16 and above	Below 16	16 and above
	(1)	(2)	(3)	(4)
Panel A. Inpatient admission				
Total medical treatment costs	20%	20%	5%	20%
Total food expenses	50%	50%	50%	50%
Panel B. Outpatient visit				
Higher level general hospital	60%	60%	60%	60%
General Hospital	45%–50%	45%–50%	45%–50%	45%–50%
Pharmacy	35%–40%	35%–40%	35%–40%	35%–40%
Hospital	30%	30%	30%	30%
General practitioner	30%	30%	30%	30%
Government-run clinic	30%	30%	30%	30%
Panel C. Emergency room visit				
Emergency patient	Same as the outpatient coinsurance rate above			
Non-emergency patient	100%			

Source: Korean National Health Insurance Service.

Table 2. Difference in Discontinuities in Inpatient Care Use
in the Quarter of the 16th Birthday

Dependent variables:	Log(total expenditure)	Log(number of admissions)	Log(expenditure per admission)
	(1)	(2)	(3)
A. Baseline			
1[age<16]×Post	0.115***	0.063**	0.083**
	(0.038)	(0.030)	(0.030)
B. Conducting Donut hole approach			
1[age<16]×Post	0.038	0.106**	0.021
	(0.088)	(0.048)	(0.064)

Data source: Korean NHIS claims data, 2016–2019.
Notes: We use the number of observations in each age cell as analytical weights. Standard errors are clustered at the age-in-quarter level. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Heterogeneity in Difference in Discontinuities in Inpatient Care Use
in the Quarter of the 16th Birthday

Dependent variable:	Log(total inpatient care expenditure)							
Characteristics:	Income		Health status		Healthcare accessibility		Essential healthcare status	
	Low income	High income	Sickly	Healthy	Metropolitan area	Other	Non-essential care	Essential care
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1[age<16]×Post	0.192***	0.077**	0.087*	0.066**	0.099*	0.143**	0.082***	-0.353
	(0.061)	(0.036)	(0.044)	(0.026)	(0.049)	(0.058)	(0.024)	(0.445)

Data source: Korean NHIS claims data, 2016–2019.
Notes: We use the number of observations in each age cell as analytical weights. Standard errors are clustered at the age-in-quarter level. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Difference in Discontinuities in Household Consumptions Spending

Spending categories:	Total (1)	Education (2)	Food and beverages (3)	Alcohol and cigarettes (4)
1[age<16]×Post	-0.021	0.233	-0.002	-0.140
	(0.064)	(0.208)	(0.084)	(0.243)

Data source: Korean Household Expenditure and Income Survey, 2016–2019.

Notes: We aggregate data into the age-year cell. We use +/-10 age-in-year bandwidth around the year of the 16th birthday. We exclude observations in the year of the 16th birthday from estimation. 1[age<16] indicates 1 if age in year is less than 16 years. *Post* is 1 if survey year is 2018 or 2019. To approximate age profiles of outcome variables, we use a quadratic function of age in year, and its interactions with 1[age<16], Post, and 1[age<16]×Post. For dependent variables, we use the logarithm value of annual household consumption spending. In column (1), we exclude spending on housing, durable goods, and healthcare. We do not include control variables. We use the household weight given by KHEIS. Standard errors are clustered at the age-in-year level. *** p<0.01, ** p<0.05, * p<0.1.

Appendix

A. Additional datasets

Korea Youth Risky Behavior Survey (KYRBS)

For the analysis on children's health impacts of the MoonCare reform, we use a nationally representative survey of Korean youths from the KYRBS for the period of 2015–2020. It is a repeated cross-sectional survey that provides detailed information on children's self-reported health status, demographic and socio-economic characteristics.

For dependent variables, we use children's self-reported physical and mental health. Both variables measure physical and mental health status on a 5-item Likert scale. A respondent chooses either "excellent" (1), "very good" (2), "good" (3), "not so much" (4), or "bad" (5) to the question "how would you evaluate your physical (mental) health status in your daily life?" We construct dummy variables, indicating whether a child's subjective physical (mental) health status is either excellent or very good.

To construct the running variable for an age-based RDD, we calculate adolescents' age-in-month using the information on adolescents' year and month of birth and survey date. The cost-sharing reform was introduced in October 2017. Thus, we define the pre- and post-periods if the survey years are from 2015 to 2017 and from 2018 to 2020, respectively. Consistent with the baseline analysis with the NHIS claims data, we restrict the baseline sample to be between 14 and 18 years old.

Korean Household Income and Expenditure Study (KHIES)

For the analysis on household consumption spending, we use nationally representative household survey data from the KHIES for the period of 2016–2019. It is a repeated cross-sectional survey that collects rich information on household consumption spending and characteristics from around 8,700 nationally representative households for the 2016 survey and 12,000 households for the 2017–2019 survey.

For dependent variables, we construct the logarithm values of total annual consumption spending, including foods and beverages, clothing, housekeeping services, transportation, telecommunication, entertainment, education, and so on. When calculating the total household consumption spending, we do not include durables due to the different reference period.[26] In addition, to examine if change in household consumption spending can lead to an improvement in children's human capital accumulation, we construct household spending on children's education. To examine potential impacts on household members' health behaviors, we calculate household spending on groceries and tobacco and alcohol. We use these two spending measures to understand if the reform can improve households' health via an improved nutrition or worsen their health through risky behaviors.

For the running variable, we calculate the age of the youngest child within each household by using information on household relations and age of household members. Since the KHIES do not provide information on household members' birth month or quarter, we use age-in-year as the running variable. This running variable might be too aggregated to apply a standard regression discontinuity design. However, we argue that we can alleviate this issue by using pre-reform data to construct additional counterfactual age profiles of consumption spending (Landais, 2015; Deshpande, 2016; Grembi et al., 2016; Bluhm and Pinkovskiy, 2021). The results are similar when using each child's age-in-year as an alternative running variable.

Korean Health Panel Survey (KHPS)

For the analysis on households' healthcare expenditure and private supplementary health insurance coverage for children, we use nationally representative survey data from the KHPS for 2016–2018. Unlike the KYRBS and the KHIES data, the KHPS data surveyed in 2019 is not publicly available for researchers as of March 2022. It collects information about the healthcare utilization and private health insurance coverage along with demographic characteristics of households and their members from approximately 6,500 households with 17,000 household members every year.

For dependent variables, we calculate the logarithm values of total household annual healthcare expenditure and expenditure not covered by the NHI, excluding those from children. We also construct a dummy variable indicating whether a respondent is covered by any private health insurance.

Since the KHPS data does not provide information about the birth month or quarter, we

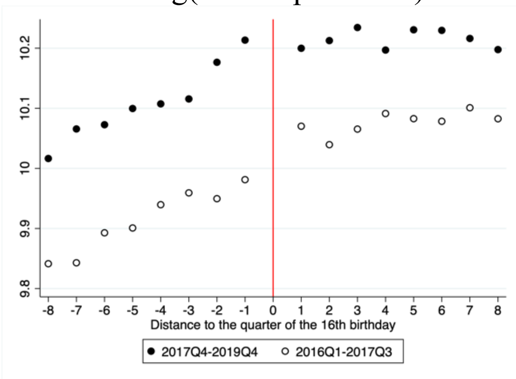
[26] In the KHIES data, durables spending is measured as of one year prior to the year nondurables spending is measured. For example, the 2017 KHIES data provides the information on nondurables spending in 2017 and durables spending in 2016. We also exclude households' spending on healthcare since we estimate the effects of the reform on households' total healthcare expenditure as a complementary analysis for the effects on adolescents' healthcare utilization.

use age-in-year as a running variable. For the analysis of household-level healthcare expenditure, similar to the analysis of using the KHIES, we calculate the age of the youngest child within each household by using information on household relations and age of household members. The results are similar when using each child's age-in-year as an alternative running variable. For the analysis of individual-level private health insurance coverage, we calculate individuals' age-in-year as a running variable. These running variables might be too aggregated to apply a standard regression discontinuity design. However, we argue that we can alleviate this issue by using pre-reform data to construct additional counterfactual age profiles of household-level annual healthcare expenditure and individual-level private health insurance coverage (Landais, 2015; Deshpande, 2016; Grembi et al., 2016; Bluhm and Pinkovskiy, 2021).

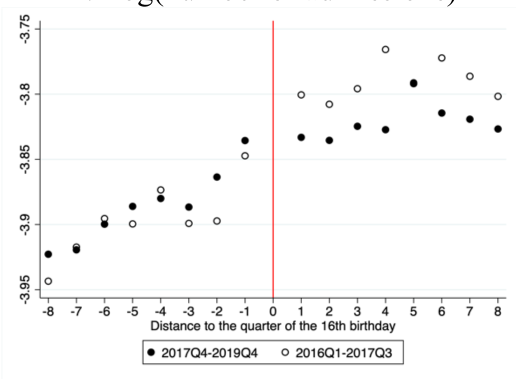
B. Appendix Figures and Tables

Figure A1. Age Profiles of Healthcare Expenditure

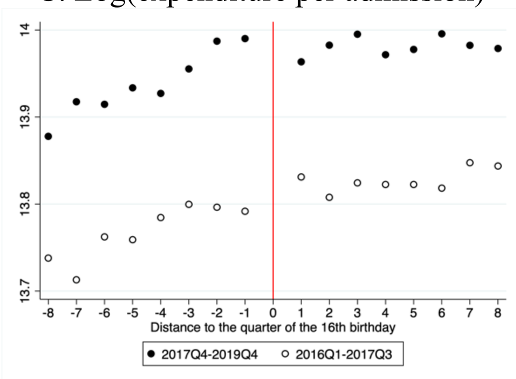
A. Log(total expenditure)



B. Log(number of admissions)



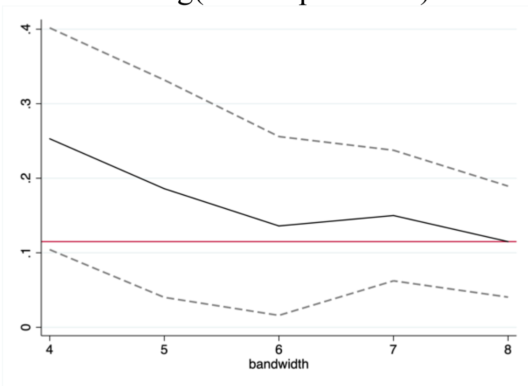
C. Log(expenditure per admission)



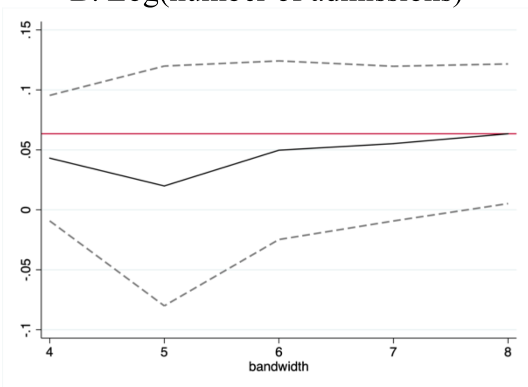
Data source: Korean NHIS claims data, 2016–2019.

Figure A2. Difference-in-Discontinuities in Inpatient Care Utilization
in the Quarter of the 16th Birthday
Using Alternative Bandwidths

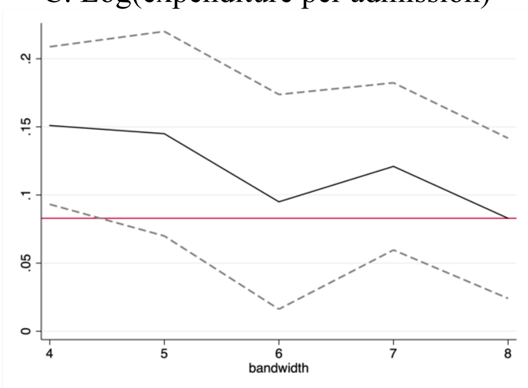
A. Log(total expenditure)



B. Log(number of admissions)



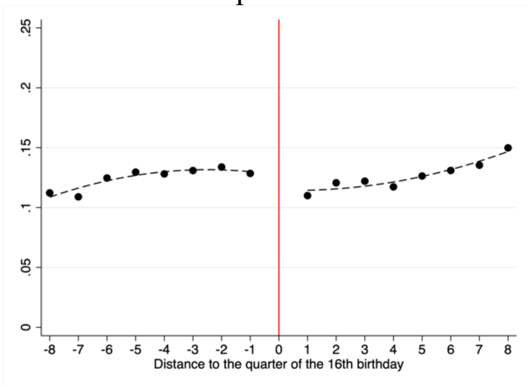
C. Log(expenditure per admission)



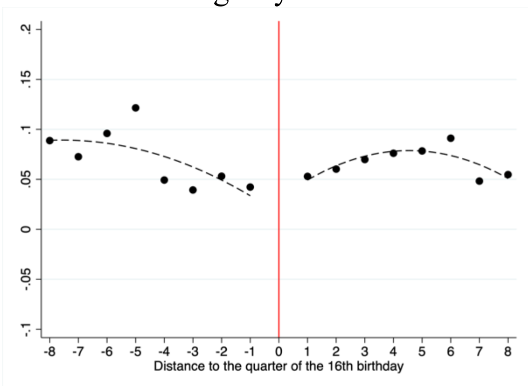
Data source: Korean NHIS claims data, 2016–2019.
Notes: Red horizontal lines represent the DRD estimates in Table 2. Solid lines present DRD estimates for each bandwidth. Dashed lines indicate the 95% confidence intervals for each DRD estimate.

Figure A3. Difference in Age Profiles of Total Expenditure in Outpatient and Emergency Room Care Utilization

A. Outpatient care



B. Emergency room care



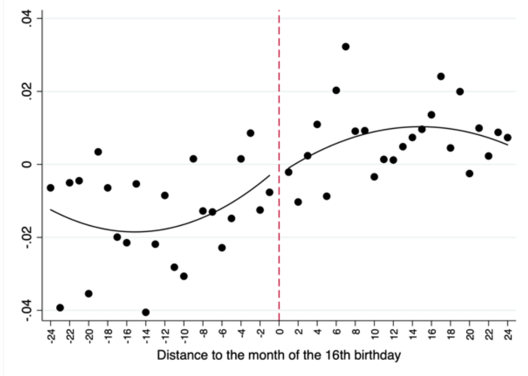
Data source: Korean NHIS claims data, 2016–2019.

Figure A4. Difference in Age Profiles of Self-reported Health Status

A. Pr(overall physical health is very good or excellent)

Difference-in-Discontinuities (S.E.): 0.012 (0.009)

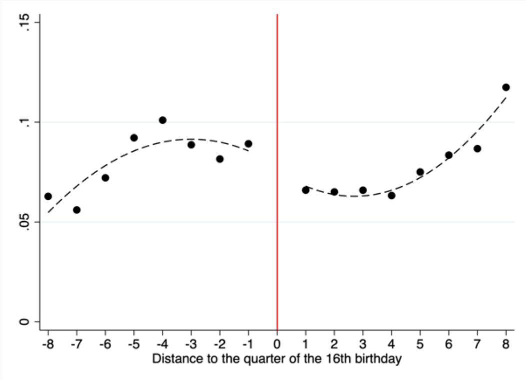
B. Pr(overall mental health is very good or excellent)



Difference-in-Discontinuities (S.E.): 0.003 (0.008)

Data source: Korea Youth Risky Behavior Survey, 2015–2020.
Notes: For the dependent variable, we use dummy variables indicating whether a respondent's self-reported physical and mental health status is either very good or excellent in panels A and B. To estimate difference-in-discontinuities, we use equation (1). Standard errors are clustered at the age-in-month level. *** p<0.01, ** p<0.05, * p<0.1.

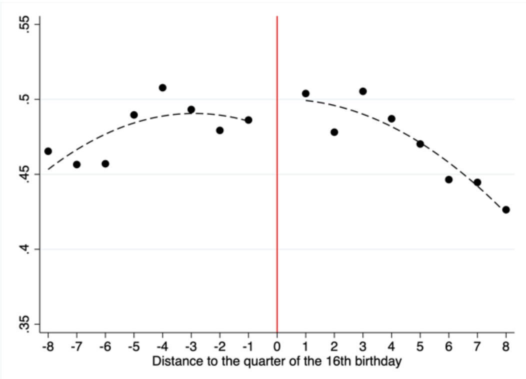
Figure A5. Difference in Age Profiles of Total Expenditures for Beneficial Care



Difference-in-Discontinuities (S.E.): 0.002 (0.011)

Data source: Korean NHIS claims data, 2016–2019.
Notes: For dependent variable we use total healthcare expenditure for beneficial care, which is defined only in outpatient care setting. To estimate difference-in-discontinuities, we use equation (1). Standard errors are clustered at the age-in-quarter level.

Figure A6. Difference in Age Profiles of Total Expenditures for Psychiatric Care



Difference-in-Discontinuities (S.E.): -0.02 (0.02)

Data source: Korean NHIS claims data, 2016–2019.
Notes: For dependent variable we use healthcare expenditure for psychiatric care, which is only defined in outpatient care setting. To estimate difference-in-discontinuities, we use equation (1). Standard errors are clustered at the age-in-quarter level.

Table A1. Maximum Out-of-pocket Expenditure Schedule by Year (in million KRW)

Average annual premium decile	lower-income group			higher-income group			
Year	1st	2nd and 3rd	4th and 5th	6th and 7th	8th	9th	10th
Panel A. pre-reform period							
2017	1.22	1.53	2.05	2.56	3.08	4.11	5.14
Panel B. post-reform period							
2018							
Number of days of hospitalization ≤ 120	0.8	1.00	1.50	2.60	3.13	4.18	5.23
Number of days of hospitalization > 120	1.24	1.55	2.08	2.60	3.13	4.18	5.23
2019							
Number of days of hospitalization ≤120	0.81	1.01	1.52	2.80	3.50	4.30	5.82
Number of days of hospitalization > 120	1.25	1.57	2.11	2.80	3.50	4.30	5.82
2020							
Number of days of hospitalization ≤ 120	0.81	1.01	1.52	2.81	3.51	4.31	5.82
Number of days of hospitalization > 120	1.25	1.57	2.11	2.81	3.51	4.31	5.82
2021							
Number of days of hospitalization ≤ 120	0.81	1.01	1.52	2.82	3.52	4.33	5.84
Number of days of hospitalization > 120	1.25	1.57	2.12	2.82	3.52	4.33	5.84
2022							
Number of days of hospitalization ≤ 120	0.83	1.03	1.55	2.89	3.60	4.43	5.98
Number of days of hospitalization > 120	1.28	1.60	2.17	2.89	3.60	4.43	5.98

Source: Korean National Health Insurance Service.

Table A2. Descriptive Statistics of Healthcare Utilization

	Inpatient care		Outpatient care		Emergency room care	
	Before 16th birthday	After 16th birthday	Before 16th birthday	After 16th birthday	Before 16th birthday	After 16th birthday
Number of visits/admissions per person	0.020	0.023	1.75	1.79	0.025	0.027
	(0.211)	(0.207)	(2.65)	(2.73)	(0.183)	(0.195)
Average expenditure	95.37	101.17	2.24	2.24	8.68	9.05
(per visit or admission)	(148.57)	(140.91)	(3.47)	(3.62)	(8.11)	(8.56)
Average OOP expenses	19.99	21.31	0.75	0.74	4.42	4.62
(per visit or admission)	(23.9)	(24.52)	(1.23)	(1.15)	(4.52)	(4.8)
Average total medical expenditure	2.03	2.38	4.09	4.17	0.21	0.24
	(39.54)	(37.48)	(20.08)	(15.19)	(1.91)	(2.13)
Total number of adolescents	1,738,034	2,014,814	1,738,034	2,014,814	1,738,034	2,014,814
Observations	6,881,289	8,051,977	6,881,289	8,051,977	6,881,289	8,051,977

Data source: Korean NHIS claims data, 2016–2017 Q3.
Notes: Monetary values are in KRW 10,000. We use individuals aged two years before and after the 16th birthday to compute for the descriptive statistics. Standard deviations are in parentheses.

Table A3. Difference in Discontinuities in Individual Characteristics

Individual characteristics:	Share of male	Log(NHI contributions)	Share of self-employed or non-employed	Parents' education ≥college	Not living with a parent	Height (cm)	Weight (kg)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1[Age<16]×Post	0.001	-0.0002	-0.002	-0.009	-0.001	-0.148	-0.430
	(0.001)	(0.002)	(0.002)	(0.014)	(0.007)	(0.218)	(0.331)

Data sources: the Korean NHIS claims data, 2016–2019 in columns (1)–(3) and the Korea Youth Risky Behavior Survey, 2015–2020 in columns (4)–(7)
Notes: We exclude observations in the quarter (month) of the 16th birthday from estimation. Monetary values (NHI contributions) are in Korean won. We do not include control variables. We use the number of observations as a weight. Standard errors are clustered at the age-in-quarter (year) level. *** p<0.01, ** p<0.05, * p<0.1.

Table A4. Difference in Discontinuities in Inpatient Care Use
in the Quarter of the 16th Birthday
Using Heteroskedasticity-robust Standard Errors for Statistical Inferences

Dependent variables:	Log(total expenditure) (1)	Log(number of admissions) (2)	Log(expenditure per admission) (3)
A. Baseline			
1[age<16]×Post	0.115***	0.063	0.083***
	(0.035)	(0.043)	(0.025)
B. Conducting Donut hole approach			
1[age<16]×Post	0.038	0.106**	0.021
	(0.064)	(0.039)	(0.049)

Data source: Korean NHIS claims data, 2016–2019.
Notes: We use the number of observations in each age cell as analytical weights. Standard errors are heteroskedasticity-robust standard errors. *** p<0.01, ** p<0.05, * p<0.1.

Table A5. Difference in Discontinuities in Other Outcome Measures for Inpatient Care Use
in the Quarter of the 16th Birthday

Dependent variables:	Pr(advanced-tier hospital admission) (1)	Hospital admission with Pneumonia (2)
1[age<16]×Post	0.021**	-0.069
	(0.007)	(0.161)

Data source: Korean NHIS claims data, 2016–2019.
Notes: We use the number of observations in each age cell as analytical weights. Standard errors are clustered at the age-in-quarter level. *** p<0.01, ** p<0.05, * p<0.1.

Table A6. Difference in Discontinuities in Inpatient Care Utilization
in the Quarter of the 16th Birthday
Robustness Checks

Dependent variables:	Log(total expenditure) (1)	Log(number of admissions) (2)	Log(expenditure per admission) (3)
A. Using a cubic specification			
1[age<16]×Post	0.213**	0.025	0.167**
	(0.077)	(0.035)	(0.057)
B. Including control variables			
1[age<16]×Post	0.119**	0.073**	0.079*
	(0.042)	(0.029)	(0.037)
C. Using year-quarter fixed effects			
1[age<16]×Post	0.113***	0.062**	0.081***
	(0.034)	(0.026)	(0.025)

Data source: Korean NHIS claims data, 2016–2019.
Notes: We use the number of observations in each age cell as analytical weights. Standard errors are clustered at the age-in-quarter level. *** p<0.01, ** p<0.05, * p<0.1.

Table A7. Difference in Discontinuities in Inpatient Care Utilization
in the Quarter of the 16th Birthday
Using Non-eligible Adolescents

Dependent variables:	Log(total expenditure) (1)	Log(number of admissions) (2)	Log(expenditure per admission) (3)
1[age<16]×Post	-0.260	-1.089**	0.373
	(0.961)	(0.463)	(0.811)

Data source: Korean NHIS claims data, 2016–2019.
Notes: We use the number of observations in each age cell as analytical weights. Standard errors are clustered. at the age-in-quarter level. *** p<0.01, ** p<0.05, * p<0.1.

Table A8. Heterogeneity in Difference in Discontinuities in Inpatient Care Use
in the Quarter of the 16th Birthday
Using Heteroskedasticity-robust Standard Errors for Statistical Inferences

Dependent variable:	Log(total inpatient care expenditure)							
Characteristics:	Income		Health status		Healthcare accessibility		Essential healthcare status	
	Low income	High income	Sickly	Healthy	Metropolitan area	Other	Non-essential care	Essential care
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1[age<16]×Post	0.192***	0.077**	0.087	0.066**	0.099**	0.143**	0.082**	-0.353
	(0.057)	(0.036)	(0.055)	(0.031)	(0.040)	(0.060)	(0.030)	(0.416)

Data source: Korean NHIS claims data, 2016–2019.
Notes: We use the number of observations in each age cell as analytical weights. Standard errors are heteroskedasticity-robust standard errors. *** p<0.01, ** p<0.05, * p<0.1.

Table A9. List of Top 5 Non-Deferrable and Deferrable Health Conditions for Inpatient Care

Diagnoses	ICD-9 Code	Share
A. Top 5 Non-Deferrable Health Conditions		
1. Chronic anal fissure	565	19.23%
2. Traumatic subdural haemorrhage, without open intracranial wound	852.2	9.65%
3. Injury of flexor muscle and tendon of other finger at wrist and hand level, laceration	842	7.11%
4. Malignant neoplasm of ovary	183	4.86%
5. Follicular cyst of ovary	620	4.42%
B. Top 5 Deferrable Health Conditions		
1. Infectious colitis, enteritis, and gastroenteritis	009	9.42%
2. Acute appendicitis, other and unspecified	540	3.28%
3. Acute bronchitis, unspecified	466	1.77%
4. Rupture of ligaments at ankle and foot level	824	1.53%
5. Pneumonia, unspecified organism	486	1.48%

Data Source: Korean NHIS claims data, 2015.
Notes: We convert the KCD (Korean Standard Classification of Disease) codes in the data into the corresponding ICD-9 codes. While most of the KCD codes match the ICD-9 codes, some codes do not have direct matches. In such cases, we select the closest ICD-9 code. We define non-deferrable health conditions as diagnoses with similar visit rates on weekdays and weekends during 2015, following Han et al. (2020). For example, a diagnosis is classified as a non-deferrable health condition if it has a weekend visit rate ranging from 0.28 to 0.30 (around 2/7) and a weekday visit rate ranging from 0.70 to 0.72 (around 5/7).

Table A10. Difference in Discontinuities in Outpatient Care and Emergency Room Care Use in the Quarter of the 16th Birthday

Dependent variable:	Log(total expenditure)	
Type of healthcare:	Outpatient care	Emergency room care
	(1)	(2)
1[age<16]×Post	0.012	-0.013
	(0.008)	(0.026)

Data source: Korean NHIS claims data, 2016–2019.
Notes: We use the number of observations in each age cell as analytical weights. Standard errors are clustered at the age-in-quarter level. *** p<0.01, ** p<0.05, * p<0.1.

Table A11. List of Treatments Classified as Beneficial Care

Diagnoses	ICD-9 Code
Immunization-Related and Preventable Conditions	033, 037, 045, 390, 391
Epilepsy	345
Convulsions	780.3
Severe ENT Infections	382, 462, 463, 465, 472.1
Tuberculosis	011-018
Bacterial Pneumonia	481, 482.2, 482.3, 482.9, 483, 485, 486
Asthma	493
Cellulitis	681, 682, 683, 686
Diabetes	250.0, 250.1, 250.2, 250.3, 250.8, 250.9
Hypoglycemia	251.2
Gastroenteritis	558.9
Kidney/Urinary Infections	590, 599.0, 599.9
Dehydration/Volume Depletion	276.5
Nutrition Deficiencies	260, 261, 262, 268.0, 268.1

Source: Agency for Healthcare Research and Quality (2004).

Table A12. Difference in Discontinuities in Household Total Healthcare Expenditure and Private Health Insurance Coverage

Dependent variables:	Log(Total Expenditure) (1)	Log(Expenditures for uncovered treatment) (2)	Private HI coverage (3)
1[age<16]×Post	0.101	0.052	-0.035
	(0. 278)	(0.446)	(0.056)

Data source: Korean Health Panel Survey, 2016–2018

Notes: We aggregate data into age-year cell. We use +/-10 age-in-year bandwidth around the year of the 16th birthday. We exclude observations in the year of the 16th birthday from estimation. 1[age<16] indicates 1 if age in year is less than 16 years. Post is 1 if the survey year is 2018. To approximate age profiles of outcome variables, we use quadratic function of age in year, and its interactions with 1[age<16], Post, and 1[age<16]×Post. For dependent variables, we use the logarithm value of annual other household members' healthcare expenditure. We do not include control variables. We use the number of observations as a weight. Standard errors are clustered at the age-in-year level. *** p<0.01, ** p<0.05, * p<0.1.