Title

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Journal

BMJ Open, 13(8)

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Publication Date

2023-08-17

DOI

10.1136/bmjopen-2023-071976

Peer reviewed

BMJ Open

Effect of no cost sharing for paediatric care on healthcare usage by household income levels: regression discontinuity design

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To cite: Fukuma S, Kato H, Takaku R, *et al*. Effect of no cost sharing for paediatric care on healthcare usage by household income levels: regression discontinuity design. *BMJ Open* 2023;**13**:e071976. doi:10.1136/bmjopen-2023-071976

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2023-071976).

Received 18 January 2023
Accepted 04 August 2023

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ABSTRACT

Objectives To investigate the impact of no cost sharing on paediatric care on usage and health outcomes, and whether the effect varies by household income levels.

Design Regression discontinuity design.

Setting Nationwide medical claims database in Japan.

Participants Children aged younger than 20 years from April 2018 to March 2022.

Exposure Co-insurance rate that increases sharply from 0% to 30% at a certain age threshold (the threshold age varies between 6 and 20 years depending on region).

Primary outcome measures The outpatient care usage (outpatient visit days and healthcare spending for outpatient care) and inpatient care (experience of any hospitalisation and healthcare spending for inpatient care).

Results Of 244 549 children, 49 556 participants were in the bandwidth and thus included in our analyses. Results from the regression discontinuity analysis indicate that no cost sharing was associated with a significant increase in the number of outpatient visit days (+5.26 days; 95% CI, +4.89 to +5.82; p<0.01; estimated arc price elasticity, −0.45) and in outpatient healthcare spending (+US$369; 95% CI, +US$344 to +US$406; p<0.01; arc price elasticity, −0.55). We found no evidence that no cost sharing was associated with changes in inpatient care usage. Notably, the effect of no cost-sharing policy on outpatient healthcare usage was larger among children from high-income households (visit days +5.96 days; 95% CI, +4.88 to +7.64, spending +US$511; 95% CI, +US$440 to +US$627) compared with children from low-income households (visit days +2.64 days; 95% CI, +1.54 to +4.23, spending +US$154; 95% CI, +US$80 to +US$249).

Conclusions No cost sharing for paediatric care was associated with a greater usage of outpatient care services, but did not affect inpatient care usage. The study found that this effect was more pronounced among children from high-income households, indicating that the no cost sharing disproportionately benefits high-income households and may contribute to larger disparities.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Implementation of the quasi-experimental regression discontinuity design, allowing us to investigate the causal effect of no cost sharing for paediatric care.
⇒ Usage of the nationwide medical claims database in Japan, with a robust sample size (n=244 549).
⇒ The inclusion of household income data, enabling the investigation of the interaction between no cost sharing and socioeconomic status.
⇒ Limitation of inability to examine the effect on health outcomes other than hospitalisations due to data unavailability.
⇒ Analysis not including children from unemployed households, who typically face greater economic disadvantages.

INTRODUCTION

The goals of health insurance include improving the financial risk protection from large medical bills and improving health outcomes through better access to healthcare services. However, even those individuals with health insurance coverage may restrain themselves from using healthcare services if the cost sharing amount is not affordable. To ensure children's access to healthcare regardless of their households' ability to pay, many countries implement policies to subsidise children's out-of-pocket healthcare spending. For example, in the USA, the Children's Health Insurance Program provides several million children with low-cost health coverage. Also, some countries with a universal health insurance system provide children with free healthcare; households with children younger than 18 years of age in Germany and the Netherlands,[1 2] and children younger than 3 years of age in Taiwan[3] are exempt from cost sharing. Given that children are a particularly vulnerable population whose access to healthcare is largely determined by their parents' preferences and abilities to pay, and that childhood health has a long-standing impact on children's health and economic outcomes,[4 5] it is critically important to understand how cost sharing affects their usage of healthcare services and health outcomes.

Evidence is limited as to how cost sharing on healthcare for children affects usage and health outcomes. Existing studies conducted in the USA (the RAND Health Insurance Experiment,[3] the New York Child Health Plus insurance plan,[4 5] and Massachusetts healthcare reform[6]) found that a lower cost sharing amount for children was associated with an increase in healthcare usage. Outside of the USA, studies that focused on children in Sweden, Japan or Taiwan also reported that a lower cost sharing amount was associated with an increase in healthcare usage.[3 6–11] Yet, little is known as to whether the impact of the cost sharing on usage and cost of care varies by household income levels.[6 12 13] If affordability plays an important role in patients' decisions to use healthcare, the impact of cost sharing on healthcare usage may vary based on the household income levels. In addition, low-income individuals—who are on average less informed than the high-income population—may be more likely to curtail their healthcare usage because of their limited ability to gain access to the information regarding the reduced cost sharing for paediatric care.[13–15]

Despite the central importance of understanding the heterogeneity of price elasticity across different income levels, a lack of access to household-level income data hindered the researchers' ability to examine this topic. Our results have important policy implications as our findings suggest that providing subsidies for healthcare cost sharing can have varying impacts on disparities depending on whether high-income or low-income households receive more benefits from such policies.

To address this important knowledge gap, we linked and analysed two databases: the nationwide insurance claim database in Japan and the data on Japanese household income levels acquired directly from insurers (the accuracy of the data were validated by individual employers). We sought to achieve two aims by applying a quasi-experimental regression discontinuity (RD) design to this novel database: (1) to investigate the effect of no cost sharing for paediatric care on healthcare usage, and (2) to examine whether the effect of no cost sharing for paediatric care varies by household income levels. We took advantage of the age thresholds for cost sharing for paediatric care in Japan (the co-insurance rate is eliminated for children under the age threshold, and sharply increases to 30% above that threshold). We used the quasi-experimental RD design, with additional adjustments for children's age, to disentangle the effects of cost sharing from that of age.

METHODS

Data source and participants

We analysed a nationwide medical claims database between April 2018 and March 2022 from one of the largest health insurers in Japan (the national sample of employees of civil engineering and construction companies), which includes employees and their family members. The medical claims database includes complete information on healthcare usage. We extracted ZIP Code and annual income information from the insurer and linked it with the claims database. Information on subsidies for healthcare spending among children, which varies from region-to-region, was extracted from the websites of the Japanese government and each local government. We analysed 244 549 insured individuals, aged younger than 20 years. Figure 1 shows the selection process of participants.

Cost sharing of healthcare spending for children

The cost-sharing rate is set to zero (or to a small fixed amount) until children reach a certain age threshold. This no cost-sharing policy does not end on the child's birthday, but instead, it ends on 31 March (the last day of the school year in Japan) of the previous year when the child's age reaches the specified age threshold (online supplemental figure S1). We calculated the difference in days from the cut-off to be subsidised for each insured individual based on her/his birthdate.

Healthcare usage

Healthcare usages were defined as outpatient visit days, healthcare spending for outpatient treatment, hospitalisation and healthcare spending for inpatient treatment by medical claims data during the fiscal year from 2018 to 2021. The conversion from Japanese yen to US dollars was calculated using the rate on 22 September 2022 (US$1=144.99 Japanese yen).

Statistical analysis

To estimate the effect of no cost sharing on healthcare usage in children, we used an RD design in which the difference from the cut-off age for medical subsidy was the assignment variable and healthcare usage was the outcome variable. We assume that just below and just above the cut-off age determines whether there is 0% or 30% cost sharing. Further, we assume that near the cut-off, the population will have similar characteristics (even unmeasured factors) except for the presence of cost sharing. Therefore, RD design allows us to estimate the causal effect of cost sharing by the discontinuity of outcomes at the cut-off.

In our RD analysis, we selected the data-driven bandwidth from the cut-off of age, using a local linear RD estimation with robust bias-corrected CIs to avoid overfitting of the data.[16] To further conduct model-based adjustment for potential confounders, we included age, gender, parent's age, number of children in a family, fiscal year (2018–2021), whether individuals were living in the full-subsidy area and diagnosed diseases in the previous year ('Certain infectious and parasitic diseases', 'Diseases of the eye, adnexa, ear, and mastoid process', 'Diseases of the skin and subcutaneous tissue', 'Injury, poisoning, and certain other consequences of external causes') in the model. Healthcare usage are defined each year between 2018 and 2021, and there are multiple records per child (one to four records per child). To account for the potential correlation of observations within a child, we used

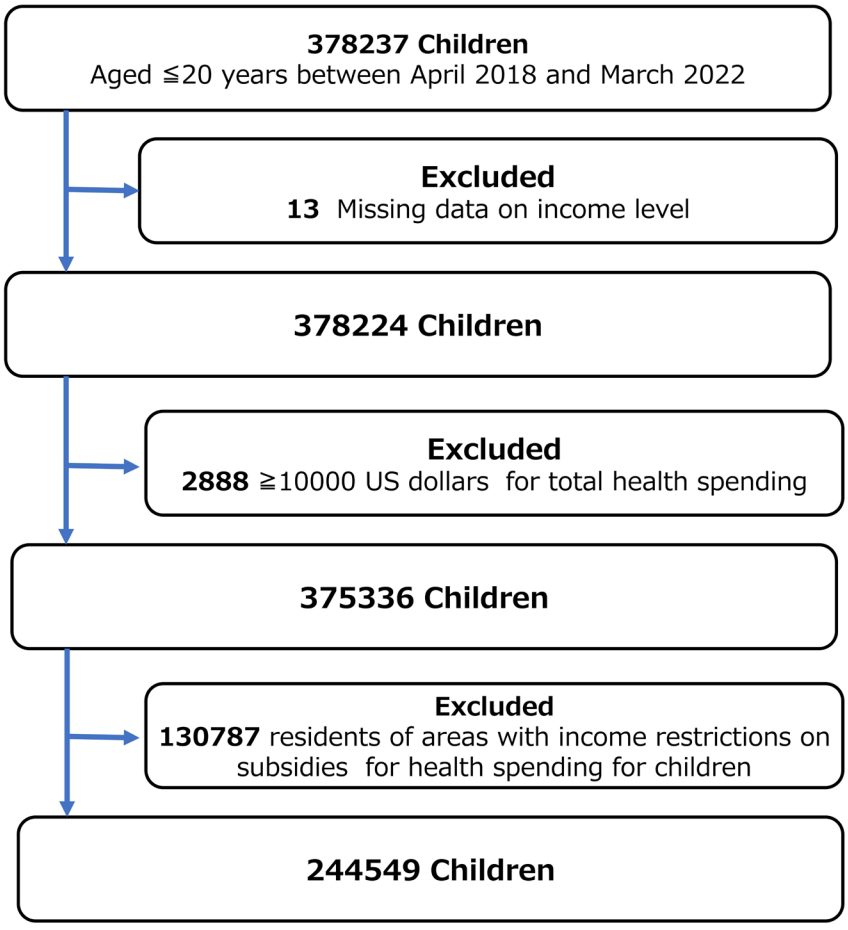

Figure 1 Selection process of study participants. Figure shows selection process of study participants from the database. We excluded 13 children due to missing income level, 2888 children due to very high healthcare spending which is covered by the government and 130 787 children who live in the areas with income restrictions on subsidies. Finally, we analysed 244 549 children for the main analysis.

clustered SEs at the individual child level. In our RD analysis, we used an estimator developed for the RD design by Calonico *et al*.[17] In the RD plots, a range of ±180 days from the cut-off is used, as shown in figure 2 and online supplemental figure S2.

In order to analyse the heterogeneous effects of no cost sharing policy on healthcare usage based on family income, we stratified our data by family income levels (low, mid-low, mid-high and high). For each income category, we estimated the effect of no cost sharing on healthcare usage.

Following previous studies,[3 18] we estimated arc price elasticity, which was defined as follows:

$$arc\ price\ elasticity = \frac{Q2-Q1}{(Q2+Q1)/2} \Big/ \frac{P2-P1}{(P2+P1)/2}$$

where Q1 and Q2 were, respectively, healthcare usage with subsidy and without subsidy (ie, the average healthcare usage before and after the cut-off age), and P1 and P2 were cost sharing with and without subsidy. $Q2-Q1$ was the effect of cost sharing estimated from the RD analysis. Because P1 was 0 in our case, the denominator of the arc price elasticity was 2, meaning that the arc price elasticity reflected only changes in quantity.

To assess the continuity of covariates at the age cut-off (online supplemental figure S2). We described a histogram of age and conducted a manipulation test (McCray test) to assess the continuity of difference in ±360 days from the cut-off age (online supplemental figure S3).

Secondary analysis

We conducted subgroup analyses according to the cut-off age (online supplemental table S1) and the presence of fixed cost sharing (online supplemental table S2).

Patient and public involvement

No patients were involved in setting the research question or the outcome measures, nor were they involved in developing plans for the design or implementation of the study. No patients were asked to advise on interpretation or reporting on results. There are no plans to disseminate the results of the research to study participants or the relevant patient community. Patient consent was not required for the study.

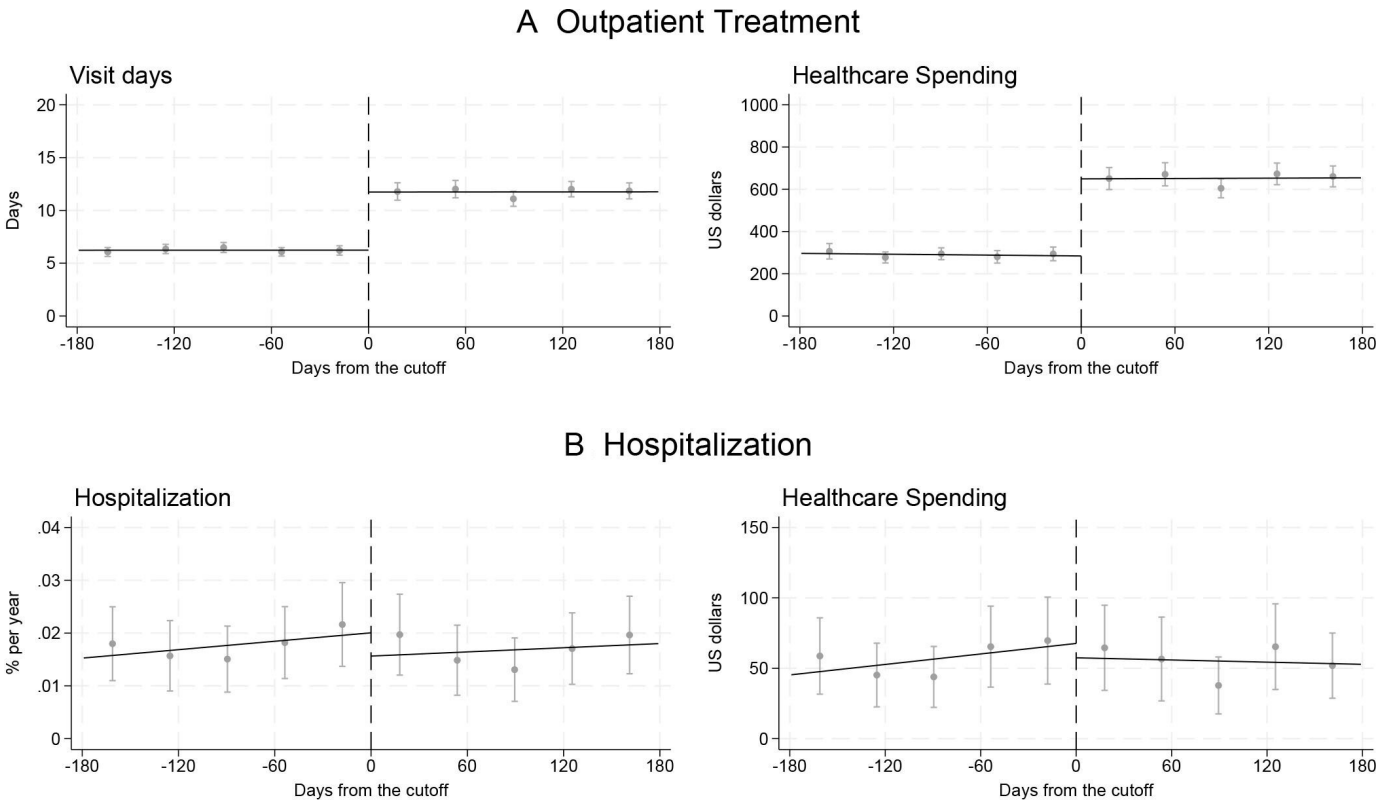

Figure 2 Regression discontinuity plots for outcomes. (A) Outpatient treatment. (B) Inpatient treatment. Figure shows discontinuity in outcomes around the age threshold.

RESULTS

Participant characteristics

We analysed 244 549 children, including 49 556 individuals within the bandwidth (±668 days from the cut-off). As for the individuals within the bandwidth, mean (SD) age was 14.1 (2.3) years, 49.5% were women. Table 1 shows characteristics in total and those within the optimal bandwidth. We found no evidence of discontinuity in days from the cut-off age at cut-off (online supplemental figure S1). We found that observed covariates smoothly changed at the age cut-off (online supplemental figure S3).

Effect of no cost sharing on healthcare usages

Figure 2 shows the discontinuity in outcomes around the age threshold. Figure 3 shows that no cost sharing was associated with higher outpatient visit days (+5.26 days; 95% CI, +4.89 to +5.82; p<0.01) and higher healthcare spending for outpatient treatment (+US$369, 95% CI, +US$344 to +US$406; p<0.01). We found no evidence that no cost sharing was associated with hospitalisation, and healthcare spending for inpatient treatment. The arc price elasticity of demand was −0.45 and −0.55 for outpatient visit days and outpatient healthcare spending, respectively (table 2). The effect of no cost sharing on healthcare usages were not qualitatively affected by the patient's age (online supplemental table S1) and the presence of fixed cost-sharing (online supplemental table S2).

We estimated the effects of no cost sharing on healthcare usages as differences adjusted for age, gender, parent's age, number of children in a family, fiscal year (2018–2021), whether individuals were living in the full-subsidy area and diagnosed diseases in the previous year ('Certain infectious and parasitic diseases', 'Diseases of the eye, adnexa, ear, and mastoid process', 'Diseases of the skin and subcutaneous tissue', 'Injury, poisoning, and certain other consequences of external causes').

We estimated arc price elasticity, which was defined as follows:

$$arc\ price\ elasticity = \frac{Q2-Q1}{(Q2+Q1)/2} \Big/ \frac{P2-P1}{(P2+P1)/2}$$

where Q1 and Q2 were, respectively, healthcare usage with subsidy and without subsidy (ie, the average healthcare usage before and after the cut-off age), and P1 and P2 were cost sharing with and without subsidy. Q2–Q1 was the effect of cost sharing estimated from the RD analysis.

Differential effect of no cost sharing on healthcare usages by family income

In any income level, no cost sharing was associated with higher visit days and higher healthcare spending for outpatient treatment (figure 3). The adjusted effects of no cost sharing for outpatient healthcare usage were greater in the high-income households (visit days +5.96 days; 95% CI, +4.88 to +7.64, spending +US$511; 95% CI, +US$440 to +US$627) compared with the low-income households (visit days +2.64 days; 95% CI, +1.54 to +4.23, spending +US$154; 95% CI, +US$80 to +US$249). The arc price elasticity for outpatient healthcare usage was also greater

Table 1 Characteristics of total participants and participants within optimal bandwidths

	Total	Individuals within age bandwidth (668 days)
	N=244 549	N=49 556
Age, years, mean (SD)	11.6 (5.7)	14.1 (2.3)
Women	119 085 (48.7)	24 554 (49.5)
Annual household income, million yen per year		
<4	17 630 (7.2)	2915 (5.9)
4–7.9	114 043 (46.6)	21 639 (43.7)
8–11.9	97 831 (40.0)	21 468 (43.3)
≥12	15 045 (6.2)	3534 (7.1)
Certain infectious and parasitic diseases	64 157 (26.2)	8407 (17.0)
Neoplasms	43 507 (17.8)	5717 (11.5)
Diseases of the blood and blood-forming organs, and certain disorders involving the immune mechanism	578 (0.2)	130 (0.3)
Endocrine, nutritional and metabolic diseases	11 458 (4.7)	2551 (5.1)
Mental and behavioural disorders	15 879 (6.5)	3074 (6.2)
Diseases of the nervous system	13 446 (5.5)	2785 (5.6)
Diseases of the eye, adnexa, ear and mastoid process	9047 (3.7)	2475 (5.0)
Diseases of the circulatory system	138 517 (56.6)	27 920 (56.3)
Diseases of the respiratory system	6024 (2.5)	1873 (3.8)
Diseases of the digestive system	171 601 (70.2)	32 002 (64.6)
Diseases of the skin and subcutaneous tissue	41 983 (17.2)	8174 (16.5)
Diseases of the musculoskeletal system and connective tissue	123 732 (50.6)	21 375 (43.1)
Diseases of the genitourinary system	30 295 (12.4)	9143 (18.4)
Pregnancy, childbirth and puerperium	11 241 (4.6)	1802 (3.6)
Certain conditions originating in the perinatal period	239 (0.1)	12 (0.0)
Congenital malformations, deformations and chromosomal abnormalities	1500 (0.6)	60 (0.1)
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	8173 (3.3)	1543 (3.1)
Injury, poisoning and certain other consequences of external causes	58 849 (24.1)	10 553 (21.3)
Certain infectious and parasitic diseases	35 029 (14.3)	8964 (18.1)
Neoplasms	46 598 (19.1)	9532 (19.2)
Diseases of the blood and blood-forming organs, and certain disorders involving the immune mechanism	120 (0.0)	20 (0.0)

Numbers are No. (%) unless stated otherwise.

in the high-income households (visit days −0.50, spending −0.65) compared with the low-income households (visit days −0.33, spending −0.36). Across all income levels, we found no evidence that the no cost-sharing policy was associated with hospitalisation, and healthcare spending for inpatient treatment.

Secondary analysis

We found no evidence of discontinuity of observed covariates at the cut-off of birthdate (online supplemental figure S2). These results support the validity of our RD analysis. There was no evidence of manipulation of birthdate at the cut-off (McCray test p=0.98, online supplemental figure S3).

DISCUSSION

Using the nationwide medical claims database in Japan, we found that no cost sharing for paediatric care was associated with an increased outpatient care usage (outpatient visit days and outpatient healthcare spending), with an estimated arc price elasticity of demand for outpatient visits of −0.45. This was little bit larger than the arc elasticities of demand for outpatient care from the RAND

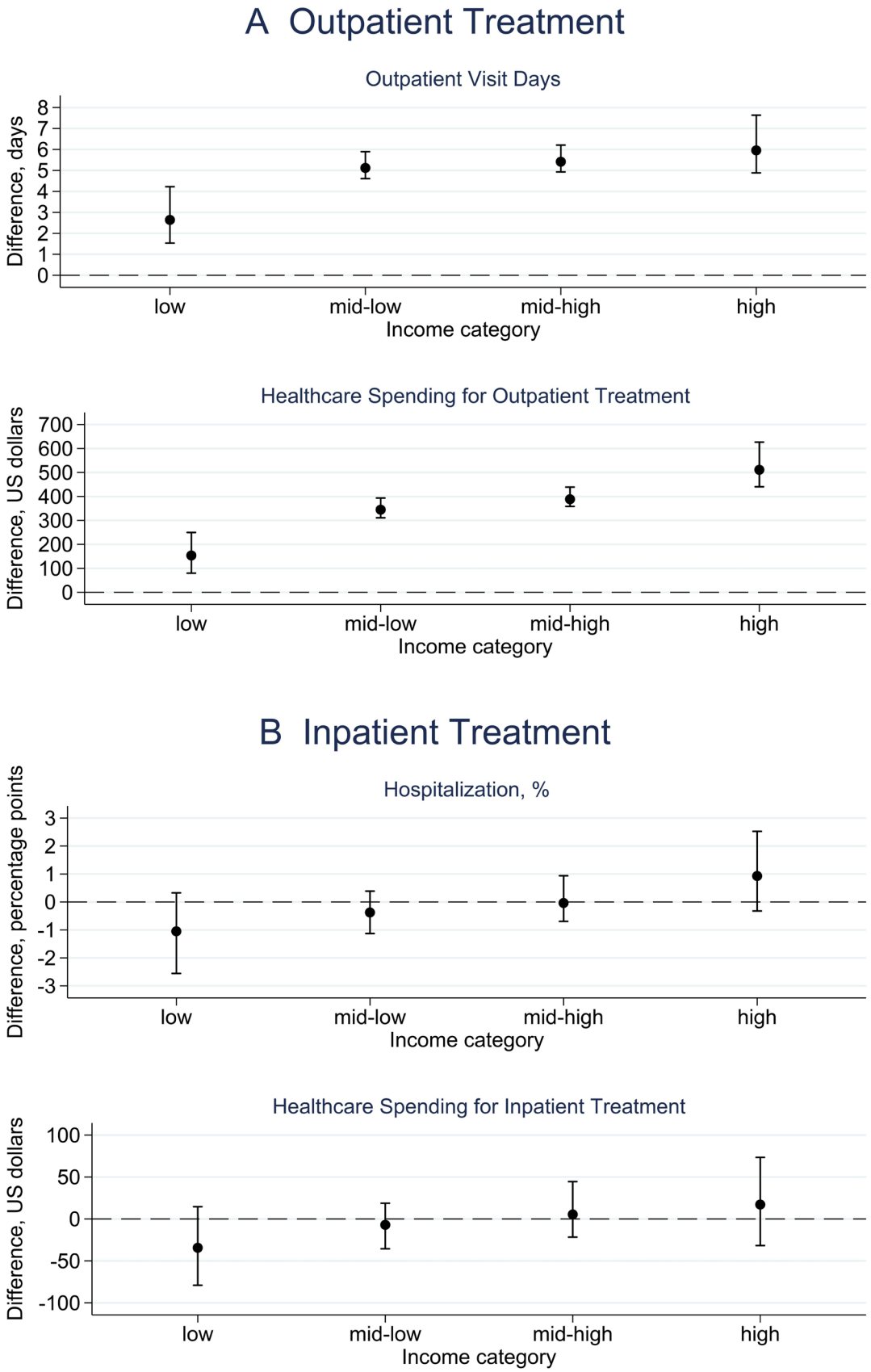

Figure 3 Effect of no cost sharing on healthcare usage by income categories. (A) Outpatient treatment. (B) Inpatient treatment. We estimated the effects of no cost sharing on healthcare usages as differences adjusted for age, gender, parent's age, number of children in a family, fiscal year (2018–2021), whether individuals were living in the full-subsidy area and diagnosed diseases in the previous year ('Certain infectious and parasitic diseases', 'Diseases of the eye, adnexa, ear, and mastoid process', 'Diseases of the skin and subcutaneous tissue', 'Injury, poisoning, and certain other consequences of external causes').

Table 2 Effects of no cost sharing on healthcare usages

Outcomes	Mean values at baseline	Differences (95% CI) p values	Arc price elasticity
Outpatient visit days, days per year	6.36	+5.26 (+4.89 to +5.82) <0.01	−0.45
Healthcare spending for outpatient treatment, US$ per year	US$297	+US$369 (+US$344 to +US$406) <0.01	−0.55
Hospitalisation, % per year	1.8	−0.4 (−0.8 to +0.04) 0.18	−0.29
Healthcare spending for hospitalisation, US$ per year	US$57	−US$11 (−US$24 to +US$6) 0.22	−0.24

Health Insurance Experiment, which ranged from −0.17 to −0.31.[19] In the contrary, we found no evidence that no cost sharing was associated with changes in inpatient care usage (ie, hospitalisations). We also found that the effect of no cost sharing was larger for children of high-income households than for children of low-income households, suggesting that it is disproportionally benefiting the high-income households. Our findings suggest that no cost sharing regardless of household income levels may actually lead to wider disparities, and policymakers should consider redesigning the cost sharing policies so that low-income households benefit the most.

Our study has important policy implications. If their paediatric care affordability is important when parents decide the amount of healthcare services to consume, we expect the effects of no cost sharing to be larger among children of low-income households than among children of high-income households. However, we found that high-income households paradoxically responded more strongly to no cost sharing. This implies that affordability might play a limited role in patients' decisions to use healthcare in settings like Japan, where the universal health insurance system allows everyone access to healthcare with relatively low cost sharing (the pricing for individual healthcare services in Japan is set low by government, making the out-of-pocket spending to be modest even with 30% co-insurance rate). Consistent with the discussion above, one study focusing on older people in Japan found that the effects of reducing the cost sharing on healthcare usage were larger among higher-income people than lower-income ones.[20] Our findings indicate that high-income households benefit more from no cost sharing, suggesting that zero cost sharing policies for paediatric care may be aggravating income disparities in healthcare access and usage.

Several factors may explain why the effect of no cost sharing on usage was stronger among high-income households in our study. First, there is no gatekeeping system in Japan, and patients may visit any physician—including both primary care providers and specialists—as they wish without any approval. When no cost sharing is combined with no gatekeeping, it is possible that children and parents from high-income households increase the usage of elective, discretionary care (including low-value care), which is generally elastic to cost sharing (moral hazard). Second, children from low-income households, on average, maybe sicker than children from high-income households.[21–23] Considering that sicker patients would be less price-sensitive than healthier patients because receiving healthcare is less discretionary for these patients,[24] low-income parents may be less sensitive to cost sharing than high-income parents. Third, it is possible that low-income households may live in communities with worse access to healthcare providers. Even when cost sharing for paediatric care children is set to zero, patients must pay non-medical costs (eg, patients' costs for transport, reduced income due to taking a day off from work), and such non-medical costs may prevent low-income families from frequently using paediatric healthcare. Fourth, high-income individuals, on average, have better access to information and healthcare; therefore, they may be more likely to take advantage of the zero cost sharing policies, and use more healthcare services. Finally, high-income individuals generally consume non-urgent elective healthcare services, such as specialist visits for detailed examinations, more often than low-income individuals. For example, several studies from many developed countries have consistently found that the usage of specialist visits,[25] which is generally elastic to cost sharing, was greater among individuals with higher-income levels.[26 27] Given that healthcare services consumed by different income groups are generally different, it is still natural to expect higher price elasticity among high-income individuals, even though a bit counterintuitive. Consistent with the discussion above, one study from Japan found that the price elasticity of denture usage, which is a typical elective healthcare service, is high among elderly persons with higher socioeconomics backgrounds.[28]

Our study builds on previous studies that examined the effects of no cost sharing for paediatric care. Several studies have examined the effects of zero cost sharing policies for children in Japan. While informative, these studies were limited as they did not use causal designs such as quasi-experimental designs and did not examine heterogeneous effects of the medical subsidies by income.[7–11 29 30] We are aware of only two recent studies that used an RD design to study how no cost sharing for paediatric care affects the healthcare usage and whether the effect of no cost sharing varies by income. Han and colleagues examined the effects of increased cost sharing

at age 3 in Taiwan, and reported mixed evidence of differential responses by income.[3] Nilsson and Paul examined the effects of reduced cost sharing at age 7 and age 20 in one region of Sweden, and reported that low-income households responded more strongly to reduced cost sharing.[6] Both studies found that cost sharing for paediatric care was associated with lower usage of outpatient treatment. In the studies, a single or only two age thresholds were used to determine the cost sharing, and therefore, the authors could not disentangle the effect of cost sharing from that of age (it was possible that healthcare usage may start to increase at a certain age). Our study took advantage of between-region variations in the age thresholds, allowing us to investigate the effect of no cost sharing while adjusting for children's age. Also, in the study conducted by Nilsson and Paul, a telephone triage system was implemented whereby patients must call a gatekeeping nurse to see a healthcare provider and are only provided an appointment if it is deemed necessary by that nurse.[6] Such a gatekeeping system may attenuate the effects of no cost sharing because price-sensitive, discretionally healthcare services patients request may be triaged by a nurse leading to no increase in healthcare usage (patients can receive healthcare services only when there are clinical needs). Our study captured the effects of no cost sharing that is not attenuated by gatekeepers since there is no gatekeeping system in Japan.

Limitation

Our study has limitations. First, we could not examine the effect of cost sharing on health outcomes due to the lack of data. Additional studies are needed to better understand the impact of cost sharing on a variety of outcome measures. Second, we could not examine what types of outpatient treatment were affected by cost sharing. Finally, given that our study focused on children of corporate employees in Japan, the findings may not be generalisable to individuals who are unemployed or to populations of other countries.

Conclusions

Using the nationwide medical claims database in Japan, we found that no cost sharing for paediatric care was associated with increased outpatient visit days and outpatient healthcare spending. The effect of no cost sharing on healthcare usage was larger among children of high-income households compared with children of low-income households, suggesting that high-income households are benefiting more from such policy, potentially leading to wider disparities.

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Contributors SF and YT conceived and designed the study and performed the statistical analyses. SF, HK, RT and YT drafted the initial manuscript. All authors interpreted the data, critically revised the manuscript for important intellectual content and approved the final manuscript. SF is the guarantor and attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. The Health Insurance Association for Architecture and Civil Engineering Companies, Tokyo, support in developing the database, Tatsuyoshi Ikenoue and Mari Ogino, Kyoto University, support in data management.

Funding SF, the Japan Society for the Promotion of Science (Grants-in-Aid for Scientific Research, Grant Number 19H03870). YT, the National Institutes of Health (NIH)/NIMHD Grant R01MD013913 and NIH/NIA Grant R01AG068633).

Competing interests All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: all authors had financial support from the Japan Society for the Promotion of Science for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study was approved by the institutional review board of Kyoto University (IRB No. R2051). Since we analysed only anonymised data, the IRB waived the need for informed consent.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available. The data underlying this article is not shared due to the privacy policy of data providers.

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