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Effect of a medical subsidy on health service utilization among schoolchildren: A community-based natural experiment in Japan

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ABSTRACT

Reducing out-of-pocket medical payments for children can reduce financial barriers to healthcare, but may increase health service expenditure. Efficient schemes of patient cost-sharing are needed to address this. We explored the impacts of a medical subsidy for children (MSC), which contained two schemes for cost-sharing of medical expenditure and health service utilization. The first is a monthly stop-loss policy, or caps on out-of-pocket payments, for outpatient/inpatient services; this reduces out-of-pocket payments for those who use greater amounts of health services. The second is a free prescription policy, which eliminates out-of-pocket payments regardless of the amount of drug expenditure. Expansion of the MSC was used as a natural experiment in a Japanese prefecture. We analyzed Japanese National Health Insurance claims data covering April 2013 to January 2017, and found no significant effect of the stop-loss policy on outpatient/inpatient service expenditures, regardless of the children's baseline health status. The free prescription policy, however, significantly increased prescription drug expenditure to 116% in the total sample and 121% among children with good health status, but not among children with poor health status. Increased health expenditure among healthy, low-volume users was found to cause increased overall expenditure. The stop-loss policy for children is potentially efficient because it selectively reduced out-of-pocket payments in high-volume users and did not increase overall expenditure.

1. Introduction

Children's health is not only important in and of itself, but also essentially tied to children's education and their future health and social status [1–3]. Securing access to healthcare services is necessary for improving children's health. When finances are an obstacle to parents pursuing sufficient level of healthcare for their children, alleviation of out-of-pocket (OOP) medical payments may encourage them to seek care. Such measures can also help households with children facing financial difficulties induced by health-related shocks [4]. Thus far, several countries have expanded policies that reduce OOP payments for children's healthcare [5–9]. However, such measures can cause unnecessary healthcare utilization through ex-post moral hazard, especially in low-value care [10]. Some studies also show that better access to healthcare services does not necessarily result in a notable improvement in children's health [11,12]. These findings suggest that reducing OOP payments for children's healthcare at a uniform rate may not be efficient.

To resolve these problems, policymakers have looked to patient cost-sharing schemes, rather than uniform reductions in OOP payments. One example is stop-losses—upper limits on OOP payments. These can reduce payments selectively for those who use high-cost care or greater amounts of health services. Those who have comparatively mild conditions will not be incentivized to use more health service. Despite widespread implementation of this approach [13–16], however, few empirical studies have assessed the impact of stop-loss policies on health service expenditure and utilization.

In the present study, we therefore aimed to simultaneously evaluate and compare the impact of (1) a stop-loss policy particularly in high-volume users and (2) a policy that uniformly reduces OOP payments regardless of the volume of health services used. Japan has recently expanded financial support available to households with children, in the form of a medical subsidy for children (MSC). We used the situation wherein an MSC has been gradually introduced across municipalities in a prefecture (hereinafter Prefecture N) in Japan as a natural experiment (prefectures and municipalities are respectively the first- and the second-level administrative divisions

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in Japan). In Prefecture N, the MSC introduced (1) a monthly stop-loss policy (caps on OOP payments) for outpatient and inpatient services and (2) a free prescription policy that covered 100% of OOP payments at pharmacies, regardless of the amount. On average, the MSC reduced OOP payments for outpatient service, inpatient service, and prescription drugs by 55.4%, 98.5%, and 100%, respectively. We hypothesized that the stop-loss policy may not create as notable of an increase in health expenditure for children compared with that from the free-prescriptions policy. This was because most of the expenditure would be attributed to milder conditions for which treatment costs were accordingly lower.

2. Materials and methods

2.1. Setting

Japan provides its citizens with unrestricted access to medical providers through its universal health coverage [17]; this is achieved through public health insurance. Residents of Japan <75 years old are legally required to be enrolled in the Japanese National Health Insurance (NHI) scheme, unless they are covered under another form of public health insurance such as employment-based [17]. Scopes of the benefits provided under all public health insurance options are common and wide: inpatient and outpatient care, dental services, physical rehabilitation, home health, and prescriptions (although preventive care, such as vaccinations, is not covered).

Each municipality manages its own NHI system, mainly covering self-employed people, unemployed people, part-time workers, pensioners, and these people's family members living in the municipality. During the study period, the coinsurance rate for schoolchildren covered under public health insurance, including the NHI, was 30% without deductibles or copayments, and including a catastrophic coverage provision [16]. Aside from this, each municipality independently offers an MSC subsidy program. Under the MSC policy, for households with children, municipalities pay part or all of the OOP payments not reimbursed by the public health insurance. The MSC does not reimburse OOP payments for healthcare services excluded from the public health insurance benefit coverage. The number of municipalities that have introduced MSCs has been increasing over the past decade because of competition with surrounding municipalities for attracting younger parents [12].

Prefecture N, the site of the present study, is in southwestern Japan. In 2012, it had a population of 1.4 million and a land area of 4,093 km^2. It ranks 27th, 18th, and 39th among Japan's 47 prefectures for total population, proportion of the population <15 years old, and average per capita income, respectively. As of April 2013, 19 of the 21 municipalities in Prefecture N provided no MSC for schoolchildren (in grades 1–9). Since then, several municipalities have introduced such MSCs at different times (Fig. A1 and Table A1). We considered this situation a natural experiment. Students in grades 1–9 were eligible for the MSC in each municipality that had introduced one, except for two municipalities where only those in grade 1–6 were subsidized. There were no eligibility conditions for the MSC other than children's residence in the municipality and their school grade across the municipalities. The allowance amount was also identical across the municipalities, and the MSC had a stop-loss policy for outpatient and inpatient services, and a free prescription policy. The former subsidized part of the OOP payments so they were capped at 1,600 yen (JPY; 100 JPY = around US$1) per month for one medical institution, regardless of the utilization frequency (OOP payments were capped at 800 JPY per month only if the child used a medical institution for just one day per month). The two policies were introduced in the same manner within a municipality.

2.2. Data

Under a research agreement between Prefecture N's NHI organization and our research group, we obtained access to de-identified enrollment and monthly claims data. We then used a unique and anonymous identification number to combine all claims for each subject from April 2012 through January 2017. The University of Tokyo approved the study protocol after ethical consideration (approval no. 11092). NHI data from all 21 municipalities in the prefecture were used. Enrollment files included information on enrollees' residence municipalities, birth year and month, sex, and the date enrollment started or ended. Claims data included monthly individual-level information on health service utilization. Data from April 2012 through March 2013 were used to assess subjects' health conditions at baseline. During the study period, between April 2013 and January 2017, we extracted information on the claims data in the form of person-month data. From enrollment files, we extracted data on children who were in grades 1–6 (i.e., 6–11 years old) on April 1, 2013 (baseline) and were continuously enrolled in the same form of NHI during the study period. The participants were, accordingly, in grades 4–9 at the end of the study period; i.e., they were students throughout the study period. None used an alternative publicly funded health system.

2.3. Outcomes

Among the outcomes, (1) outpatient service expenditure (JPY) per month, (2) inpatient service expenditure (JPY) per month, and (3) prescription drug expenditure (JPY) per month were used as primary outcomes. Eight types of person-month level indicators of health utilization were used as secondary outcomes to evaluate potential pathways of the subsidy's effects on health services expenditure and to assess possible health outcomes: (4) monthly outpatient visit dummy variable, (5) number of outpatient visits per month, (6) outpatient service expenditure (JPY) per visit, (7) monthly admission dummy variable, (8) monthly inpatient days, (9) monthly prescription dummy variables, (10) quantity of drugs per month (unit), and (11) proportion of generic drug quantity in a month. Outcomes 1–3, 5, 8, and 10 were calculated by summing all claims for each child in each month. The health service expenditures—1–3, and 6—indicate the total cost that medical providers claimed for payers, including the NHI, municipalities, and patients. The "unit" for outcome 10 indicates a unit by which the Japanese government regulates drug prices. Prescription drug expenditure is the total cost of drugs provided at pharmacies and excludes dispensing fees. The monthly outpatient visit dummy, admission dummy, or prescription dummy was 1 if a child used outpatient service, inpatient service, or pharmacy service once or more in a month. The outpatient service expenditure (JPY) per visit or proportion of generic drug quantity in a month was not defined in months in which no service was used.

2.4. Exposures

Exposure was eligibility for the MSC, which was determined based on the child's residence municipality, school grades (corresponding to age at the start of the fiscal year when utilizing health services), and the month in which health services were used.

2.5. OOP payment reductions owing to the MSC

Fig. A2 plots the OOP payments reduction rate via the MSC and the outpatient service expenditure (Panel A), inpatient service expenditure (Panel B), or prescription drug expenditure (Panel C) per month for all person-month observations with eligibility for the MSC and that used each health service at least once in a month.

Each plot represents 100 person-month observations for outpatient service and prescription drug expenditure, and 10 person-month observations for inpatient service expenditure. Expenditure for each plot indicates the geometric mean across the observations the plot includes. The OOP payment reduction rate for each plot was defined as the sum of the benefits the MSC provided, divided by the sum of the expenditure within the observations the plot includes. The MSC for outpatient service employed a stop-loss policy, wherein the OOP payment reduction rate was 0% until expenditure per month reached 2,667 JPY (corresponding to 800 JPY of OOP payments when public insurance is offered but an MSC is not). The OOP payment reduction rate gradually increased once the expenditure exceeded 2,667 JPY. Meanwhile, the MSC for pharmacy services was a free prescription policy, wherein OOP payments were offset 100% regardless of the prescription drug expenditure per month. As inpatient service was costly, the OOP payment reduction rate was above 80% overall. The OOP payments for outpatient service, inpatient service, and prescriptions were reduced an average of 55.4%, 98.5%, and 100%, respectively; calculated by dividing the sum of the MSC benefits by the sum of the OOP payments for all person-month observations.

2.6. Estimation

We applied a difference-in-differences (DID) approach regarding the gradual rollout of an MSC, illustrated in Fig. A1, as a natural experiment. We first supposed the following equation:

$$\begin{aligned} Y_{iajt} &= \beta_0 + \beta_1 Subsidy_{ajt} + All\ age\ dummies_a \\ &+ All\ monthly\ dummies_t + All\ municipality\ dummies_j \\ &+ Age \times Municipality\ dummies_{aj} + \boldsymbol{\gamma_a} t + \boldsymbol{\delta_j} t + \boldsymbol{\beta_2 X_i} + \varepsilon_{iajt} \end{aligned} \quad (1)$$

where Y_{ijt} is an individual-level monthly outcome variable mentioned above, i indexes children, j indexes municipalities, t indexes year-months, and a indexes children's ages at month t. The main exposure, $Subsidy_{ajt}$ is 1 if a child aged a residing in municipality j is eligible for the MSC in month t, and 0 otherwise. $\boldsymbol{X_i}$ consists of sex and a time-invariant comorbidity dummy (mentioned below). ε_{iajt} is an idiosyncratic error term. To improve the robustness of our DID identification strategy, we added $Age \times Municipality\ dummies_{aj}$, which allowed municipality-specific age effects, to covariates. A municipality-specific monthly trend, $\gamma_a t$, and age-specific monthly trend, $\delta_j t$, were also included. These allowed the outcomes in different municipalities or ages to follow different monthly trends.

Because the health service expenditure, number of outpatient visits, and quantity of drugs were expected to be right-skewed, we applied a generalized linear models (GLM) estimation with a log-link function in the main analyses, following earlier studies [18,19]:

$$\begin{aligned} \ln E(Y_{iajt}|covariates) &= \beta_0 + \beta_1 Subsidy_{ajt} + All\ age\ dummies_a \\ &+ All\ monthly\ dummies_t + All\ municipality\ dummies_j \\ &+ Age \times Municipality\ dummies_{aj} + \boldsymbol{\gamma_a} t + \boldsymbol{\delta_j} t + \boldsymbol{\beta_2 X_i} \end{aligned} \quad (2)$$

Here, $Var(Y covariates)$ is supposed to depend on $E(Y|covariates)$. Exponentiated β_1 means the multiplicative effects of the MSC on outcomes. We can also apply this form of GLM for the monthly outpatient visit/prescription dummy as an outcome variable [20]. Standard errors were clustered by postal-code level area (there were 1,380 such areas in Prefecture N) because the outcomes of individual residents were supposed to be correlated with each other.

We also conducted analyses stratified by a comorbidity dummy variable (included in $\boldsymbol{X_i}$) to evaluate the heterogeneity in the impact of the MSC on outcomes across children's health status at baseline. The comorbidity dummy is 1 if a child was diagnosed with at least one of the conditions listed in Appendix 1, which were identified as per the International Classification of Diseases 10th Revision (ICD-10) code [21] in the record of insurance claims data in the year preceding the study period (April 2012 to March 2013). These conditions were reported as predictive of death for children within 1 year of hospital discharge [22], similar to the conditions in the commonly used Charlson Comorbidity Index [23]. A child with a comorbidity was quite unlikely to be misclassified as not having a comorbidity because all subjects could be observed for at least 3 months before the baseline. However, as the diagnoses included suspected cases, a child who had no comorbidity might be misclassified as having one. We also repeated analyses when the equation (1) was estimated using ordinary least squares (OLS) estimations to evaluate the additive effects of the MSC instead of multiplicative effects. All analyses were performed using Stata 14 (StataCorp, College Station, TX, USA). $P < 0.05$ was considered statistically significant.

2.7. DID assumption

The DID approach assumed the trends in the outcomes of municipalities that introduced an MSC ("treatment group") were similar to those of municipalities that did not ("control group") until the point of the intervention. This common trend assumption should still be checked, even though we adjusted for the linear monthly trend peculiar to each municipality. Thus, we visually compared the trends of outpatient service and prescription drug expenditures across the groups classified by the MSC period. Additionally, to check whether or not the amount of the medical expenditure in the current year affected subsidy introduction in subsequent years (e.g., 1 or 2 years later), we added lead ($Subsidy_{ajt+12}$, $Subsidy_{ajt+24}$) and lag ($Subsidy_{ajt-12}$) exposure variables in equation (2) and repeated the analyses (Granger causality test) for outcomes 1–3.

3. Results

3.1. Descriptive statistics

Column 1 in Table 1 shows the characteristics of the total observations. We followed up 8,581 children aged 6–11 at baseline. The sex ratio was balanced. About one-fifth of the children had been identified as "with comorbidity" at baseline. In the follow-up period of 46 months, 394,726 (8,581 persons x 46 months) person-months of data were observed (289,796 not eligible for an MSC and 104,930 eligible for an MSC). Panel C in Table 1 shows the outpatient service, inpatient service, and prescription drug expenditures per month standardized both across year-months and municipalities. These expenditures were right-skewed. Compared with the person-months observations not eligible for an MSC, those eligible for an MSC showed slightly lower outpatient service expenditure per month, lower inpatient service expenditure per month, and higher prescription drug expenditure per month.

Columns 2–5 compare the characteristics of the observations across four municipality groups classified by the period of MSC introduction: "always subsidizers" were municipalities that already had implemented an MSC at baseline (April 2013), "early reformers" had started an MSC by September 2015, "late reformers" started an MSC between October 2015 and January 2017, and "never subsidizers" did not introduce an MSC during the study period. Macro-level information was extracted from the Survey of Physicians, Dentists and Pharmacists, 2014 [24]; Population Census, 2015 [25]; and System of National Accounts, 2014 [26]. The percentage of the child population, average per capita income, mean age, and sex ratio were balanced across four groups, while

Table 1
Observed characteristics.

	1 Total	2 Always subsidizers	3 Early reformers	4 Late reformers	5 Never subsidizers
A: Macro-level information					
Pediatricians per 1000 children <15 years old	1.7	1.3	1.3	1.7	1.8
Percentage of population <15 years old, %	12.9	12.1	12.4	12.9	13.5
Average per capita income (million JPY)	2.4	2.0	2.1	2.4	2.3
B: Individual data					
Number of observations	8,581	852	1,318	4,878	1,533
Age at baseline, mean (SD)	8.6 (1.7)	8.6 (1.7)	8.6 (1.7)	8.6 (1.7)	8.6 (1.7)
Boys, %	51.0	50.2	50.8	51.5	50.4
With diagnosed comorbidity at baseline, %	20.9	26.2	18.5	19.6	23.9
C: Person-month data					
(i) Not eligible for MSC (subsidy = 0)					
Number of observations	289,796	0	25,104	194,174	70,518
Outpatient service expenditure/month, mean (SD)	3139 (10,989)	–	3122 (5726)	3141 (12,099)	3139 (9028)
Inpatient service expenditure/month, mean (SD)	1932 (37,312)	–	1675 (21,053)	1965 (41,920)	1932 (26,923)
Prescription drug expenditure/month, mean (SD)	1707 (10,658)	–	1894 (3223)	1683 (12,650)	1708 (4741)
(ii) Eligible for MSC (subsid y = 1)					
Number of observations	104,930	39,192	35,254	30,214	0
Outpatient service expenditure/month, mean (SD)	2977 (7220)	2977 (6299)	2989 (6114)	2963 (9253)	–
Inpatient service expenditure/month, mean (SD)	1334 (40,007)	1334 (53,938)	1516 (26,570)	1120 (30,898)	–
Prescription drug expenditure/month, mean (SD)	2089 (12,854)	2089 (7760)	1957 (3573)	2244 (21,923)	–

SD: standard deviation; MSC: medical subsidy for children. Municipalities were classified by period of the MSC introduction into four groups: "always subsidizers," which already had implemented an MSC at baseline (April 2013); "early reformers," which started an MSC by September 2015; "late reformers," which started an MSC between October 2015 and January 2017; and "never subsidizers," which did not introduce an MSC during the study period. Macro-level information was calculated from Japanese governmental statistics (Survey of Physicians, Dentists and Pharmacists, 2014; Census, 2015; and System of National Accounts, 2014). Outpatient, inpatient, and prescription drug expenditures shown in Panel C were standardized both across year-months and municipalities (the base municipality is the capital city and the base period is April 2013).

the number of pediatricians per population was slightly higher in late reformers and never subsidizers than in always subsidizers and early reformers. The percentage of children with a diagnosed comorbidity was also slightly unbalanced but did not substantially differ. Thus, the observable characteristics of municipalities at baseline did not differ widely by timing of MSC introduction.

Fig. 1 compares the trends of the outpatient service and prescription drug expenditures across the groups classified by period of MSC introduction (early reformers, late reformers, and never subsidizers). The vertical lines show the point where municipalities in the "treatment group" started an MSC. To the left of the leftmost vertical line, each panel shows similar trends before the interventions and appears to support the common trend assumption.

3.2. Main results

Table 2 shows the MSC's impacts on health service expenditures. Among the total sample (panel A), the MSC did not significantly affect either outpatient or inpatient service expenditure per month, but increased prescription drug expenditure to 116% (95% confidence interval [CI] 103%, 131%). In stratified analyses by baseline health status (panels B and C in Table 2), the MSC had no significant effects on outpatient and inpatient service expenditure, both among children with and without diagnosed comorbidities. Meanwhile, the prescription drug expenditure significantly increased to 121% (95% CI 105%, 141%) only among children without diagnosed comorbidities. The ratio of MSC effects between children with and without diagnosed comorbidities was not statistically significant (panel D in Table 2).

Table 3 shows the effects of the MSC on outcomes 4–11. The MSC did not affect the probability and numbers of outpatient service utilization on the whole or among children with or without diagnosed comorbidities. Meanwhile, the MSC significantly decreased outpatient service expenditure per visit to 93% (95% CI 87%, 99%) on the whole and to 82% (95% CI 71%, 95%) among children with diagnosed comorbidities, but not among those without them (the ratio of MSC effects between children with and without diagnosed comorbidities was statistically significant). The MSC did not have a significant effect on the probability of admission/inpatient days on the whole or among children with or without diagnosed comorbidities. The MSC increased the probability of prescriptions to 107% (95% CI 103%, 112%) among the total sample and to 109% (95% CI 103%, 114%) among children without diagnosed comorbidities, and decreased the proportion of generic drug quantity to 95% (95% CI 91%, 100%) among the total sample, and to 94% (95% CI 90%, 99%) among children without diagnosed comorbidities. The quantity of medication increased to 135% (95% CI 107%–172%) among children without diagnosed comorbidities. No significant effects of the MSC were observed among children with diagnosed comorbidities.

In Appendix 1, we estimated Eq. (1) using OLS. Tables A2 and A3 correspond to Tables 2 and 3. The statistical significance of the coefficients barely changed compared with the main analyses. Tables A4 shows the results of a Granger causality test. The lead exposures ($Subsidy_{ajt+12}$, $Subsidy_{ajt+24}$) were not significantly associated with the expenditure for outpatient service, inpatient service, or prescription drugs, suggesting such expenditures in the current year did not affect introduction of an MSC in the subsequent years.

4. Discussion

In this quasi-experimental study in a Japanese prefecture that introduced an MSC that had two different schemes of patient cost-sharing, we found the stop-loss policy had no significant effects on outpatient or inpatient service expenditure on a monthly basis, but the free prescriptions policy significantly increased prescription drug expenditure on a monthly basis. The stop-loss policy offered a greater rate of reduction in OOP payments for outpatient service to those who used more of this type of service (Fig. A2). Thus, children who use outpatient service comparatively more often would be the main targets of the stop-loss policy in this prefecture. As these children were more likely to have poor health status and higher demand for health services (children with diagnosed comorbidities had 1.6 times higher outpatient service expenditure in the main analyses), they might have already received necessary health service even without the MSC (i.e., 30% coinsurance rate), as demonstrated in some previous studies [27,28]. Consequently,

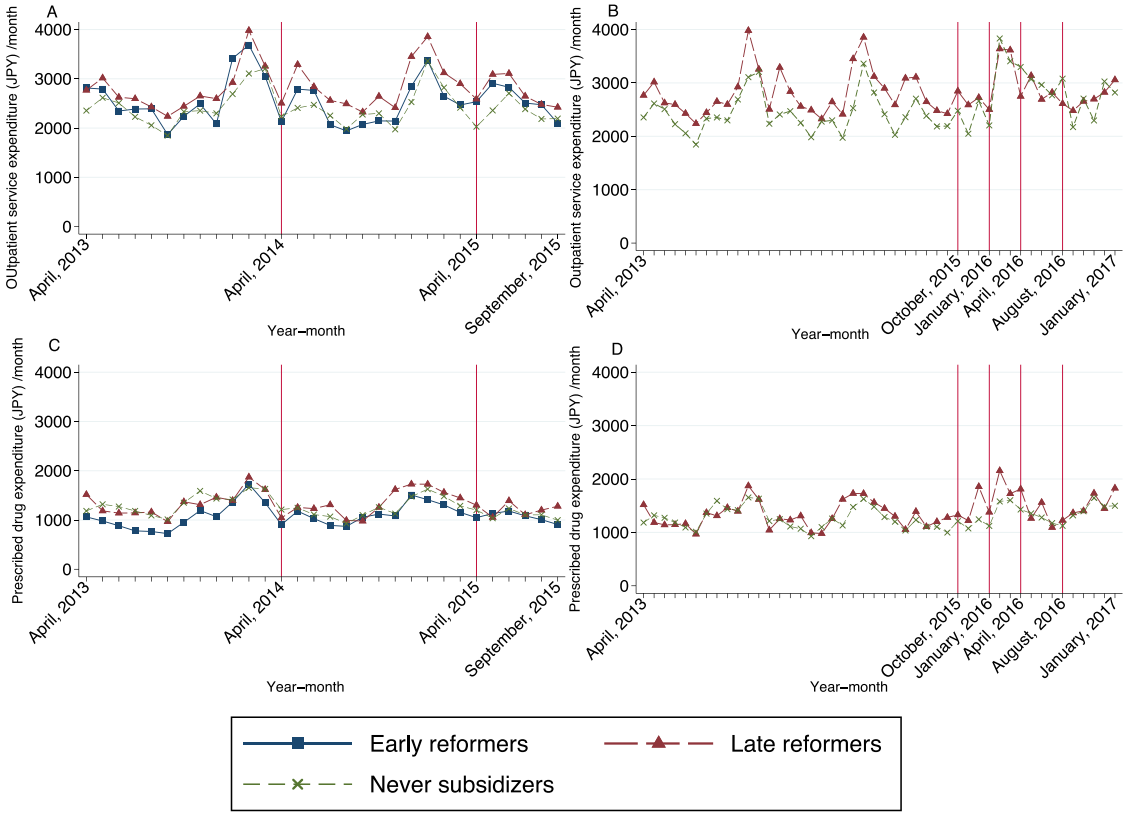

Fig. 1. Trends of outpatient service and prescription drug expenditures.
Notes: This graph compares the trends of outpatient service and prescription drug expenditures across the groups classified by the period of MSC introduction. "Early reformers" are municipalities that started an MSC by September 2015. "Late reformers" are municipalities that started an MSC between October 2015 and January 2017. "Never subsidizers" are municipalities that did not introduce an MSC during the study period. Panels A and B regard outpatient service expenditure. Panels C and D regard prescription drug expenditure. Vertical lines show the point when the municipalities among the "treatment group" (i.e., early reformers in Panels A and C or late reformers in Panel B and D) started an MSC.

Table 2
Effect of the medical subsidy on health service expenditures.

		Outpatient service expenditure (JPY)/month	Inpatient service expenditure (JPY)/month	Prescription drug expenditure (JPY)/month
A (total sample)	Subsidy	0.95	0.70	1.16*
	(95% CI)	(0.87, 1.03)	(0.39, 1.25)	(1.03, 1.31)
B (comorbidity = 0)	Subsidy	1.00	0.73	1.21**
	(95% CI)	(0.93, 1.08)	(0.38, 1.41)	(1.05, 1.40)
C (comorbidity = 1)	Subsidy	0.82	0.68	1.04
	(95% CI)	(0.65, 1.03)	(0.29, 1.60)	(0.86, 1.25)
D (ratio of the two subsidy effects)	Ratio	0.82	0.94	0.86
	(95% CI)	(0.64, 1.04)	(0.32, 2.74)	(0.68, 1.08)
Observation (individuals)	Total sample	8,581	8,581	8,581
	Comorbidity = 0	6,792	6,792	6,792
	Comorbidity = 1	1,789	1,789	1,789
Observation (person-months)	Total sample	394,726	394,726	394,726
	Comorbidity = 0	312,432	312,432	312,432
	Comorbidity = 1	82,294	82,294	82,294

* $p < 0.05$, ** $p < 0.01$. Null hypothesis: coefficient = 1.00. 95% CI: 95% confidence interval. JPY: Japanese yen (100 JPY ≒ 1 US dollar). Panels A, B, and C show the exponentiated βs of the estimated results for the total sample, children with diagnosed comorbidities (comorbidity = 0), and children with at least one diagnosed comorbidity (comorbidity = 1), respectively. Panel D shows the ratios of the estimator in Panel C to the estimator in Panel B.

their demand for outpatient service might already reach a plateau and not be affected by the MSC. However, the free prescription policy eliminated the OOP cost regardless of monthly prescription drug expenditure. The increasing effect on the expenditure on prescription drugs was observed among children with no diagnosed comorbidities, but not among children with at least one diagnosed comorbidity. This finding would support the argument that children with good health status responded to the free prescription policy more substantially than those with poor health status. The arc elasticity for prescriptions calculated using the coefficient shown in Table 3 was −0.07. This value was closer to zero than that for outpatient service among children in previous studies: −0.10 to −0.13 [9,29]. This might be because while prescription privilege belongs to medical providers, patients make the choice to visit hospitals.

We also found a modest but significant reduction in outpatient service expenditure per visit, especially among children with diagnosed comorbidities at baseline. We hypothesized patient-side and provider-side explanations for this phenomenon. First, with the MSC available, patients with health issues might visit hospitals

Table 3
Effect of the medical subsidy on monthly level health service usage indicators.

		Visits dummy/ month	Number of visits/ month	Outpatient service expenditure/ visit (JPY)	Admission dummy/ month	Inpatient days/ month	Prescription dummy/ month	Quantity of medication/ month (unit)	Proportion of generic drug quantity/ month
A (total sample)	Subsidy	1.01	1.01	0.93*	0.92	0.73	1.07**	0.98	0.95*
	(95% CI)	(0.98, 1.05)	(0.97, 1.06)	(0.87, 0.99)	(0.62, 1.36)	(0.41, 1.31)	(1.03, 1.12)	(0.66, 1.43)	(0.91, 1.00)
B (comorbidity = 0)	Subsidy	1.02	1.01	0.97	1.18	0.98	1.09**	1.35*	0.94*
	(95% CI)	(0.98, 1.06)	(0.95, 1.06)	(0.91, 1.04)	(0.74, 1.88)	(0.53, 1.81)	(1.03, 1.14)	(1.07, 1.72)	(0.90, 0.99)
C (comorbidity = 1)	Subsidy	1.00	1.03	0.82**	0.65	0.64	1.03	0.53	0.98
	(95% CI)	(0.95, 1.06)	(0.94, 1.13)	(0.71, 0.95)	(0.36, 1.19)	(0.32, 1.26)	(0.95, 1.11)	(0.25, 1.13)	(0.89, 1.07)
D (ratio of the two subsidy effects)	Ratio	0.98	1.02	0.84*	0.55	0.65	0.95	0.39*	1.03
	(95% CI)	(0.92, 1.05)	(0.92, 1.14)	(0.72,0.99)	(0.26, 1.18)	(0.26, 1.62)	(0.86, 1.04)	(0.18, 0.87)	(0.93, 1.15)
Observation (individuals)	Total sample	8,581	8,581	8,534	8,581	8,581	8,581	8,581	8,020
	Comorbidity = 0	6,792	6,792	6,752	6,792	6,792	6,792	6,792	6,300
	Comorbidity = 1	1,789	1,789	1,782	1,789	1,789	1,789	1,789	1,720
Observation (person-months)	Total sample	394,726	394,726	122,128	394,726	394,726	394,726	394,726	69,995
	Comorbidity = 0	312,432	312,432	89,210	312,432	312,432	312,432	312,432	50,465
	Comorbidity = 1	82,294	82,294	32,918	82,294	82,294	82,294	82,294	19,530

* $p < 0.05$, ** $p < 0.01$. Null hypothesis: coefficient = 1.00. 95% CI: 95% confidence interval. JPY: Japanese yen (100 JPY ≒ 1 US dollar). Panels A, B, and C show the exponentiated βs of the estimated results for the total sample, children with no diagnosed comorbidities (comorbidity = 0), and children with at least one diagnosed comorbidity (comorbidity = 1), respectively. Panel D shows the ratios of the estimator in Panel C to the estimator in panel B.

earlier and before conditions worsen, which would result in less-expensive medical examinations and treatment. Second, physicians might prescribe medication more frequently in place of medical examinations or other treatments because of the free prescription policy. However, because the number of prescribed drugs declined (but not significantly) among children with diagnosed comorbidities, the second explanation should be rejected.

The prescription drug expenditure can be decomposed into probability of prescription, number of prescribed drugs, and drug price per unit. It is important to explore which factor or factors account for the increased drug cost. In the present study, the probability of prescription and quantity of prescribed drugs significantly increased among children without diagnosed comorbidities. Moreover, the MSC significantly decreased the proportion of generic drugs; this contrasted the findings in RAND Health Insurance Experiment, which did not find the generosity of insurance significantly affected the proportion of generic drugs used among children [30]. Drug price per unit should increase because generic drugs are priced much lower than those of original drugs [31]. Thus, all three of the above factors would account for the increased prescription drug expenditure. It is hard to identify if the subsidies' effects derived from providers or patients, because prescription privilege belongs to providers but Japanese patients tend to ask providers to prescribe more drugs than necessary. Nevertheless, as patients in Japan make the final choice between generic and brand-name drugs, a patient-initiated increase in prescription drug expenditure seems possible.

Finally, although the children had considerable reductions in OOP payments for inpatient service expenditure, we found no increasing effects of the MSC on inpatient service expenditure, probability of admission, or inpatient days per month, either among the children with or without diagnosed comorbidities. Instead, decreasing trends were observed especially among those with diagnosed comorbidities, but our results could not statistically demonstrate this.

4.1. Strengths and limitations

In the present study, by accurately using quasi-experimental approach, we were able to quantify and compare the effect of an MSC that had two schemes for patient cost-sharing in health service utilization. A significant increasing effect of the MSC on prescription drug expenditure sharply contrasted with insignificant effects of the MSC on outpatient/inpatient health service expenditure and utilization. This difference may derive from the difference between the stop-loss policy and free prescription policy. Our findings suggest the increased health expenditure caused by a policy that uniformly reduces OOP payments may primarily be explained by increased health service utilization by households with relatively healthy children.

Some limitations should be mentioned. First, this study only examined schoolchildren in one Japanese prefecture; therefore, generalizability to the entire Japanese population cannot be ensured. Nevertheless, some observable characteristics in Prefecture N were similar to those nationwide regarding number of pediatricians per 1000 children <15 years old (1.7 in Prefecture N vs. 1.9 nationwide); percentage of the population <15 years old (12.9% vs. 12.5%); average per capita income (million JPY; 2.4 vs. 2.9); and distribution of the distance to the closest medical institution (37% vs. 34% for <250 m, 19% vs. 29% for 250–500 m, 20% vs. 23% for 500–1000 m, and 24% vs. 15% for >1000 m [chi-square test: p = 0.99]) [24–26,32]. Second, we restricted our sample to children who had been enrolled in the same municipality's NHI throughout the study period. This restriction excluded children who moved from their original residence municipality to another within N Prefecture or enrolled in another type of public insurance scheme, which may cause selection bias. For example, if some households with children living in a municipality without an MSC move to one with an MSC, a type of "forum shopping," part of the MSC's effects on health service utilization stemmed from the difference in the attenuation rate of NHI enrollees among municipalities. To explore this problem, we compared the attenuation rate of enrollees across four groups determined by their period of MSC introduction. We followed up the enrollment status of children in grades 1–6 enrolled in Prefecture N's NHI at baseline. Fig. A3 illustrates the trends were parallel across the groups over the years, both in children with or without diagnosed comorbidities. Thus, the forum shopping problem would not be substantial in this study.

5. Conclusions

This quasi-experimental study evaluated and compared the impacts of an MSC that had two schemes of patient cost-sharing for health service expenditure and utilization among schoolchil-

dren in a Japanese prefecture. Reduced OOP payments for healthy, low-volume users would explain the increase in overall expenditure among schoolchildren covered under the MSC. The stop-loss policy that selectively reduces OOP payments in high-volume users is a potentially efficient scheme for patient cost-sharing.

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Conflict of interest

None.

CRediT authorship contribution statement

Atsushi Miyawaki: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data curation, Writing - original draft, Visualization, Funding acquisition. **Yasuki Kobayashi:** Validation, Resources, Data curation, Writing - review & editing, Supervision, Project administration, Funding acquisition.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.healthpol.2019.02.003.

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