博士論文

A Study on Patient Cost Sharing and Health Service Utilization among Children: A Difference-in-Differences Analysis in an Urban City, Japan

（小児における患者自己負担と医療サービス利用についての研究：ある都市における差分の差解析）

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List of abbreviations

NHI: National Health Insurance

HIE: Health Insurance Experiment

DID: Difference-in-Differences

MSC: Medical Subsidy for Children

AY: Academic Year

JPY: Japanese Yen

ICD10: International Classification of Disease, Tenth Edition

NB: Negative Binomial

OLS: Ordinary Least Squares

Abstract

Financial support for children's medical expenses has been introduced in many countries. Limited work has been done on price elasticity in children's healthcare demand, especially in countries other than the United States. I investigated the impact of an increase in the cost-sharing rate on medical service utilization among elementary school children, exploiting medical subsidy disqualification at the end of the third grade as an exogenous shock. A difference-in-differences approach was applied. National health insurance claims data in an urban city were used. I found that an increase in the cost-sharing rate reduced outpatient service utilization as a whole. Also, I did not observe an increase in inpatient service utilization. The effect of an increase in the cost-sharing rate on outpatient service utilization was prominent among middle-income households compared to among high-income households. The reductions in outpatient service were heterogeneous across medical conditions; declines were sharper for mild conditions. These findings may help to characterize how a change in cost-sharing rate affects health service utilization and health outcomes in children.

1. INTRODUCTION

Health status in childhood is important for learning, prospective health, and future human resources (Case et al., 2005; Condliffe and Link, 2008; Currie and Stabile, 2003; Glass et al., 2010). Multiple countries have introduced policies to reduce medical expenditures for children and households with children, including Egypt, Japan, the Philippines, the United States, and Vietnam (Bessyo, 2012; Palmer et al., 2015; Quimbo et al., 2011; Racine, 2014; Yip and Berman, 2001). However, budgetary constraints preclude inexhaustible financial support. Additionally, excessive financial support may lead to a “moral hazard” (Arrow, 1963). To set an appropriate rate of cost-sharing, the effects of a change in cost sharing rate on medical demand and health outcomes need to be quantified.

Most studies on the effects of sharing rate on medical demand focus on adult healthcare demand (Chandra et al., 2010; Manning et al., 1987; Shigeoka, 2014) rather than on children’s healthcare. So far, a few studies have investigated the effects of a change in cost-sharing rate on children’s medical demand experimentally or quasi-experimentally. Although these studies demonstrated an increase in outpatient service usage as a whole along with insurance enrollment, most of these studies focused only on observations in the United States.

In Japan, in addition to public health insurance, a medical subsidy for children (MSC) is offered by municipalities, which reimburse out-of-pocket expenses that public insurance does not cover for children younger than a designated age. In other words, once a child’s age exceeds the designated age, the out-of-pocket expense increases drastically. In the present study, I regarded this drastic change in out-of-pocket expenses as an exogenous shock and aimed to investigate the effects of a change in the rate of cost sharing on health service utilization among elementary school-age children in a Japanese urban setting. I implement this strategy using health insurance claims data of National Health Insurance (NHI) beneficiaries from 2012 to 2014 of an urban city located in Greater Tokyo Area.

Moreover, I investigated the heterogeneity of the effect of the change in cost sharing rate. Prior studies have scarcely reported whether the effects of a change in sharing rate differed by income level or medical issues. Firstly, I stratified the analytic sample by income level and investigated the effect of the change in cost-sharing rate on health service utilization for each income group. I presumed that the effect of the change in cost-sharing rate on health service utilization should appear more prominently in children whose household is in lower income level. This is because the same amount of change in out-of-pocket cost would have larger utility for lower income households compared to for higher income households.

Secondly, I also investigated the effects of a change in the sharing rate on health service utilization by commonly diagnosed conditions in the total sample. This attempt may clarify the pathway through which a change in outpatient service utilization induced by a change in the rate of cost sharing affects children's health outcomes. For example, refraining from utilizing outpatient services when children have a possibly severe disease may lead to aggravation of the condition, while an increase in outpatient service usage for mild cases may not lead to children's health improvement.

1.1. Prior literature for adults

Most studies on the effects of sharing rate on medical demand focus on adult healthcare demand rather than on children's healthcare. The first study in this line was the RAND Health Insurance Experiment (HIE), which evaluated the effect of the difference in cost-sharing rate on medical service utilization and health status through a randomized controlled trial (RCT), where participating households were randomly assigned to health insurance plans that had different coinsurance rate (Manning et al., 1987; Newhouse, 1993). In RAND HIE, lower coinsurance rate was primarily associated with increased number of outpatient visits and outpatient service expenditure. The estimated arc-elasticity for outpatient medical spending was in the range of -0.2 (-0.17 for the total, -0.20 for the chronic diseases, and -0.16 for the acute diseases) (Keeler et al., 1988). An empirical study is often not feasible because of budgetary constraints and ethical issues. Recently, therefore, a natural experiment approach has been used. Chandra et al. applied a difference-in-differences (DID) approach using increased patient cost-sharing in the retired public employees in California. Their study suggested the arc-elasticities for physician visits ranged from -0.07 to -0.10 and those for drug prescriptions ranged from -0.08 to -0.15 (Chandra et al., 2010). Shigeoka (2014) applied a regression discontinuity approach using the drastic decrease in cost-sharing rate among Japanese elderly at the age of 70. The elasticity of outpatient visits ranged from -0.14 to -0.18. Fukushima et al. (2016) also used this situation and demonstrated the price elasticity differed by health services (overall elasticity for outpatient service was -0.16). Besides, some studies evaluated the effect of health insurance enrollment on medical service utilization or health outcomes but did not address the elasticity for medical service utilization (Baicker et al., 2013; Card et al., 2008; DeVoe et al., 2015; Finkelstein et al., 2012; Loehrer et al., 2018; Sommers et al., 2016, 2015; Taubman et al., 2014).

1.2. Prior literature for children

Children's healthcare seeking behavior may be different from adults' cases because guardians rather than children usually decide to visit physicians. Therefore, the effect of a change in cost-sharing rate on medical service utilization may also differ. So far, a few studies have investigated the effects of a change in cost-sharing rate on children's medical demand experimentally or quasi-experimentally. The RAND HIE found an increase in outpatient service usage per year both in acute episodes and chronic episodes among children aged less than 14 as the cost-sharing rate declined (Leibowitz et al., 1985). When the state of New York introduced its Child Health Plus insurance plan, the effects were measured using the DID approach (Holl et al., 2000; Zwanziger et al., 2000). More recently, Miller (2012) reported the impact of the Massachusetts health care reform program on health care usage among children. De La Mata (2012) reported the effects of eligibility change near the income threshold for Medicaid on children's health service utilization using a regression discontinuity design. Although these quasi-experimental studies demonstrated an increase in outpatient service usage as a whole along with insurance enrollment, all of these studies focused only on observations in the United States. Few studies have investigated the effect of a change in the cost-sharing rate in other countries (Skinner and Mayer, 2007).

In Japan, in addition to public health insurance, a medical subsidy for children (MSC) is offered by municipalities, which reimburse out-of-pocket expenses that public insurance does not cover for children younger than a designated age. Some studies focused on the effect of the subsidy; they were limited to cross-sectional designs or using self-reported data on service utilization (Bessyo, 2012; Higashi et al., 2016; Takaku, 2016). Recently, the health service utilization has been measured more precisely through health insurance claims data. For example, Takaku (2017) and Yuda et al. (2015) quantified the effect of MSC on health service utilization in rural areas. Kato and Goto (2017) investigated the effect of reducing cost-sharing for outpatient service on hospital admission. Iizuka and Shigeoka (2018) also investigated the effect of the variations in the subsidies at the municipality-age-time level across Japan on health service utilization among children whose parent(s) worked for large corporations.

1.3. Financial support for children's out-of-pocket payments

1.3.1. Public health insurance in Japan

In Japan, all citizens are covered by public health insurance and have unrestricted access to medical providers (Kobayashi, 2009). Public health insurance underwriters reimburse patients for a portion of the cost of outpatient services, inpatient services, drug prescriptions, and dental services without any deductible. The co-insurance rate is fixed by beneficiaries' age. Between elementary school and the age of 69, the co-insurance rate was 30% across all official insurance underwriters, with a catastrophic coverage provision (i.e., no co-payments once the monthly expenditure exceeds a certain amount) (Ikegami et al., 2011).

1.3.2. Medical subsidy for children in Japan

In addition to public health insurance, each municipality offers MSC under different conditions. MSC is not a national uniform policy. In MSC, municipalities subsidize part or all of the out-of-pocket cost not reimbursed by public health insurance (i.e., 30% of the total medical expenditure for elementary school children). Each municipality independently decides the beneficiaries, the amount, and the method of administering the subsidy. MSC has been offered as financial support for child-rearing since MSC started for newborns and infants in some municipalities in the Tohoku region (northernmost area of Honshu mainland) in the 1960s. For example, Sawauchi village in Iwate prefecture has offered MSC since 1961 (Bessyo, 2012) and have experienced a decrease in infant mortality (Kuwada et al., 2012). After the 2000s, mainly in affluent municipalities, MSC has been introduced, and the target age groups were expanded. Recently, municipalities offer MSC in expectation of immigration of younger generation such as families with children, which results in competition in the MSC coverage among neighboring municipalities (Adachi and Saito, 2016). Consequently, MSC is now offered by almost all the municipalities in Japan and covers lower/upper secondary school students in many municipalities (Adachi and Saito, 2016).

Meanwhile, some issues are discussed along with the roll-out of MSC (Sawano, 2013). First, the reduction in out-of-pocket expenses leads to an increase in medical service utilization, which results in a financial burden for the insurer (public insurers paid 70% of the cost of increased medical service). Demand exceeding the supply in pediatric medical service, especially in emergency medical service, may also lead to overwork of the healthcare providers. Finally, it remains questionable whether MSC for school children, who are on average less likely to be sick than infants, do improve health status.

1.4. Aims

In summary, I aimed to explore the impact of an increase in the cost-sharing rate on medical service utilization among elementary school children in an urban city. The heterogeneity of the effect on medical service utilization by income level and the effect on health service utilization by each medical condition was also investigated.

2. METHODS

2.1 Settings

In the present study, I used data from a city within the Tokyo metropolitan area (hereafter, C city), which had a population of approximately 1 million in 2016. In C city, MSC eligibility depended on children's grade level (Table 1). All children enrolled in the 3rd grade or below, who were 9 years old or younger at the end of the academic year (AY), were eligible for MSC for outpatient service during the study period (April 1, 2012, to March 30, 2014). MSC reimburses the out-of-pocket medical expenses not covered by public health insurance. By offering MSC in the form of immediate reimbursement, all outpatient services cost patients at most 300 Japanese yen (JPY; 100 JPY = approximately 1 US dollar in 2013) out of pocket per visit. Children living under the poverty line are entitled to free services. When children were promoted to the 4th grade (typically in April), they were disqualified from receiving MSC for outpatient services and had to pay 30% of medical expenditure out of pocket. Consequently, in our main analyses, I defined children who became promoted to the 2nd or the 3rd grade in April 2013, aged 7 or 8 at the end of March 2013, as a control group, and children who were promoted to the 4th grade, aged 9 at the end of March 2013, as a treatment group.

2.2. Data source

All data were extracted from NHI claim files in C city. NHI is community-based public insurance managed by each municipality in Japan, which is offered to citizens who do not have regular employment; these include the self-employed, farmers, part-time workers, temporary workers, contract workers, and the unemployed or retired (Ikegami et al., 2011). The NHI system covered one-third of the total population in Japan in 2012. Participants in this study were elementary school children who were enrolled in C city's NHI at least for one month during the study period (April 1, 2012, to March 30, 2014), and who were promoted to the 2nd, 3rd, or 4th grade in April 2013. I extracted data on insured medical outpatient and inpatient service utilization during the study period. I did not include claims for prescription and dental services so that I could determine the pure effects on medical care use.

2.3. Ethical considerations

Under the research agreement between C city and our group, I obtained the above claim data in an anonymous format. Because claims are issued by each medical institution on a monthly basis, I combined all the claims for each patient during the study period by using a unique but anonymous identification number. The Institutional Review Board of the University of Tokyo approved this study protocol (approval no. 10834).

2.4. Exposure

MSC disqualification was a major exposure when children were promoted to the 4th grade. Other independent variables included dummy variables for the treatment group, gender, month, and residential area. In our dataset, I regarded children aged 8, 9, and 10 years old at the end of the AY 2013 as 2nd, 3rd, and 4th grade elementary school students, respectively, because grade almost always follows age in Japan.

2.5. Outcomes

Our main measured outcomes in this study were the following: (1) total expenditure on outpatient services per person per month, (2) number of outpatient visits per person per month, (3) dummy of outpatient service received per month (1 if a child received service; 0 if not), (4) average expenditure for outpatient services per visit, (5) total expenditure for inpatient service per person per month, (6) inpatient days per person per month, and (7) dummy of admission per month (1 if a child stayed in hospital; 0 if not). The number of outpatient visits and the total expenditure for receiving outpatient/inpatient services were calculated by summing all the claims for each individual in each month. For inpatient service, I excluded a small number of children who were hospitalized for an infeasible number of days in a month (e.g., hospitalization for more than 31 days); the exclusions accounted for less than 0.1% of the total.

I investigated the outcomes (1)–(4) for each of the following medical conditions: (a) acute lower respiratory infection (except for influenza), (b) acute upper respiratory infection, (c) injury, (d) intestinal infectious diseases, (e) allergic rhinitis, (f) asthma, (g) conjunctivitis, (h) dermatitis/eczema, and (i) disorders of refraction and accommodation (e.g., myopia, hypermetropia, and astigmatism). Our preliminary research revealed that these conditions were the nine most common medical conditions among subject children during the study period. Outpatient service by each particular diagnosed condition listed above was identified by International Classification of Disease, Tenth Edition (ICD10) code; namely, (a) J12–22, (b) J00–06, (c) S00–S99 and T00–T14, (d) A00–09, (e) J30, (f) J45, (g) H10, (h) L20–L30, and (i) H52 (World Health Organization, 2016). With regard to acute conditions such as lower respiratory infections, upper respiratory infections, injuries, and intestinal infectious diseases, I considered outpatient service for the medical condition only when the consultation start month corresponded to the month when medical service was actually provided, because already treated and completed diagnoses were often left on the claim data sheets, and these acute conditions are typically treated successfully within one month.

2.6. Covariates

Children’s gender, grade, income level of the children’s households and residential area were included as covariates. Income level was categorized into four groups according to the equivalized income (pre-tax) in 2013: income missing; less than 1.5 million JPY (low-income); 1.5 million to 4.5 million JPY (middle-income); more than 4.5 million JPY (high-income). Equivalized income was calculated by the gross (pretax) income divided by square root of the number of household members (In this study, those who had the same insurance identification number (*hihokensya bango*) were defined as being the same household.) Residential areas were identified based on zip code in the enrollment file.

2.7. Statistical analyses

A DID approach was employed in this study. Our treatment group consisted of children who were promoted to the 4th as of April 2013 (denoted below as treatment group). The children were disqualified from MSC when they entered 4th grade. Our control group consisted of children who were promoted to the 2nd or 3rd grade in April 2013 (denoted below as control group). The latter remained eligible for MSC. For the DID approach, I first posited the following equation:

(1) $Y_{it} = \beta_0 + \beta_1 Grade\ 4_i + \beta_2 Grade\ 4_i \cdot 1[Month\ is\ April\ 2013\ or\ later] + all\ monthly\ dummies + \beta_3 \mathrm{X}_i + \varepsilon_{it}$

, where Y_{it} is an outcome variable for an *i*-th child at month *t*; $Grade\ 4_i$ takes 1 if an *i*-th child's grade in the AY 2013 is grade 4, and 0 otherwise; $1[Month\ is\ April\ 2013\ or\ later]$ is an indicator function that takes 1 if month is April 2013 or later, and 0 otherwise; X_i are dummy variables for an *i*-th child's gender, grade in AY2013, income level, and residential area, which are time-invariant. These covariates were added for estimates to be more efficient. ε_{it} is an *i*-th child error term at time *t*. In Equation (1), I exclude a dummy variable for post-event which takes 1 if Month is April 2013 or later and 0 otherwise, because it should obviously be perfectly collinear with *all monthly dummies*.

Here, the distributions of dependent variables, such as the number of outpatient visits, inpatient days and outpatient/inpatient expenditure, were non-negative and potentially skewed to the right in the present study. Hence, in the main analyses, I applied a negative binomial (NB) regression model for every outcome except the dummy of outpatient service received per month and the dummy of admission per month (Cameron and Trivedi, 1986). I estimated the following equation:

(2) $LnE(Y_{it}) = \beta_0 + \beta_1 Grade\ 4_i + \beta_2 Grade\ 4_i \cdot 1[Month\ is\ April\ 2013\ or\ later] + all\ monthly\ dummies + \beta_3 \mathrm{X}_i$

, where the variance-mean ratio of conditional Y_{it} is allowed to be linear in the mean of conditional Y_{it}. I reported exponentiation of β_2, which indicated the multiplicative effect of MSC disqualification on the outcomes. For binary outcomes, such as dummy of outpatient service received per month and dummy of admission per month, I applied a logistic regression model, where I replaced $E(Y_{it})$ in the equation (2) with $P(Y_{it} = 1)/\{1 - P(Y_{it} = 1)\}$. In these cases, exponentiation of β_2 indicated the odds ratio of outpatient service /admission utilization when a child is disqualified with MSC compared with when he/she is eligible for MSC. Standard errors were clustered on the individuals to allow serial correlations (Bertrand et al., 2004). I excluded medical service utilization data on March 2013 in the analyses because "rush in demand" was observed. In Equation (2), I exclude a post-event dummy, because of the same reason as Equation (1), like I previously mentioned.

An ordinary least squares (OLS) regression model was also used to assess additive marginal effects. Since I had a relatively large number of observations, using OLS as a linear probability model could be justified even for a dichotomous variable such as receiving outpatient service in a given month, of which distribution would asymptotically be normal (Angrist and Pischke, 2008). In equation (1), β_2 indicated the additive effect of MSC disqualification on the outcomes. Moreover, a Poisson regression model was applied to the equation (2) as another sensitivity analysis following the literature (Chandra et al., 2014). A Poisson regression model is justified for the model with a binary outcome (Zou, 2004). I show the results in the Appendix. These analyses were repeated for each income level to check the heterogeneity of the effect of MSC disqualification by income level. Furthermore, I replicated the analysis for outpatient service usage by the nine most common medical conditions. *P* values below 0.05 were interpreted as statistically significant. Analyses were conducted using Stata version 14 (StataCorp., 2015).

2.8. DID assumption

In a DID approach, the average treatment effects for the treated are estimated by comparing the outcome values observed in the treatment group with counterfactual outcome values that would have been taken without the intervention in the treatment group, which are estimated referring to the outcome values observed in the control group (Figure A1). Therefore, a DID approach needs that the outcomes show parallel trends between the control group and the treatment group ("parallel trend assumption") (Angrist and Pischke, 2009). There were some reasons to support this assumption. First, since children in both groups lived and attended schools in the same city C, they should be having a common lifestyle and a living environment. Second, children's ages of the control group and the treatment group were close within 8 to 10 years old. In addition, most of them usually have yet to develop secondary sexual characteristics. Third, and most importantly, the parallel trends of outpatient service utilization in both control and treatment groups before and after the intervention (April 2013) were confirmed (displayed in the Results section). This also underpinned the comparability.

A DID approach also needs a "common shock assumption," which rules out that systematic factors other than a change in cost-sharing rate influenced the service use and expenditure of each group separately (Angrist and Pischke, 2009). For example, the hours that children spent in school may have affected healthcare-seeking behavior. However, I may ignore the effect, because the hours that children spent in school did not change much among the three grades, according to the Japanese government's curriculum guidelines (Ministry of Education, Culture, Sports, Science and Technology, 2008). Furthermore, there was no change in the MSC and cost-sharing rate for children's inpatient service use. The other major policies for children that could have influenced demand for child health care, such as child allowances and tax credits, did not change either at the municipal level or the national level during the study period.

3. RESULTS

The data included 90,293 person-month observations, and I followed 5,921 children over 24 months (unbalanced panel). Table 2 displays descriptive statistics for gender, service usage, and expenditures for both outpatient and inpatient services from April 2012 to February 2013 by the groups. The control group and the treatment group were similar in gender proportion and residential areas. Both groups visited around 0.8 times per month and paid around 5000 JPY per visit in average for outpatient service, while inpatient service utilization was quite rare. These results supported the comparability of the treatment group and the control group. The distributions of service utilization were right-skewed as expected.

Table 3 shows the main results for outcomes (1)–(7). I analyzed 86,632 person-month observations except those on March 2013. MSC disqualification significantly reduced outpatient expenditure per person per month by 26% (95% confidence interval (CI): 19 to 32%), and it also reduced the overall number and odds of outpatient visits per person per month by 22% (95% CI: 17 to 27%) and 25% (95% CI: 19 to 30%). However, it did not have a statistically significant impact on outpatient expenditure per visit. MSC disqualification did not significantly affect the number of inpatient days, inpatient expenditure per person per month, or the odds of admission per person per month.

Figure 1 and 2 displays the outpatient service expenditure and the number of outpatient service utilization per person per month for both treatment and control groups, which show similar trends for 11 months until February 2013. The expenditure and the number of outpatient visits for the treatment group appeared to jump up in March 2013 just before they were disqualified with MSC, which appeared to be consistent with a hypothesis of “rush in demand.” In April 2013, however, they turned to show a steeper decline than the ones for the control group. The treatment group’s expenditure and the number of outpatient visits remained lower and its transition was parallel in subsequent months compared to the control group. This trend seemed to be consistent with a "parallel trend assumption" in DID approach. Figure 3 and 4 show the inpatient expenditure and the days of admission per person per month. The treatment group and the control group displayed similar trends until March 2013. Inpatient expenditure and days jumped up in October 2013 but did not show a clear change in trends after it.

Figure 5 shows the effects of the MSC disqualification on medical service utilization for each group stratified by income levels. The outpatient service expenditure per person per month significantly declined by 19%, 30%, or 19% for low income, middle-income, or high-income group, respectively. The number of outpatient visits per person per month significantly declined by 26% only for the middle-income group. The effects on the number of outpatient visits significantly differed between for the middle-income group and the high-income group (p = 0.02).

Table 4 shows the main results for outpatient service expenditure per person per month, the number and odds of outpatient visits per person per month, and outpatient expenditure per visit by the diagnosed condition. MSC disqualification significantly reduced outpatient service expenditure per month for acute lower respiratory infection, acute upper respiratory infection, intestinal infectious diseases, allergic rhinitis, dermatitis/eczema, and disorders of refraction and accommodation by 32%, 28%, 26%, 25%, 35%, and 43%, respectively. The number and odds of outpatient visits significantly declined for each medical condition except the number of outpatient visits for injury. Outpatient expenditure per visit did not change significantly for either medical condition except for acute upper respiratory infection.

Figure 6 and 7 illustrate the outpatient service expenditure per person per month and the number of outpatient visits per person per month by the diagnosed condition. The differences between the treatment group and the control groups appeared to widen after April 2013 for acute lower respiratory infection, acute upper respiratory infection, intestinal infectious diseases, and dermatitis/eczema. For disorders of refraction and accommodation, the treatment group utilized outpatient services more frequently than the control groups before March 2013, but after April 2013, the groups utilized outpatient services at almost the same frequency. Other medical conditions did not show apparent differences in the trends after April 2013.

In the Appendix, I present the results of the OLS model and the Poisson model. Table A1 shows the additive effects of MSC disqualification for outcomes (1)–(7). Corresponding to the main results, while MSC disqualification significantly decreased the total expenditure per month, the number of outpatient visits, and the probability of outpatient visits by 1094 JPY, 0.18 times, and 7% points, it did not have a notable effect on outpatient expenditure per visit. MSC disqualification did not significantly affect the inpatient service expenditure per month, the inpatient days per month, or the probability of admission. Table A2 shows the additive effects of MSC disqualification by the medical condition. For each diagnosed condition, the statistical significance of a reduction in outpatient service usage was observed similarly to the main results (but the statistical significance of the effects on the outpatient service expenditure for intestinal infectious diseases and allergic rhinitis disappeared). Table A3 and Table A4 show the results of the Poisson model. Similarly to the main results shown in Table 3, MSC disqualification significantly decreased total expenditure per month and the number and probability of outpatient visits by 25%, 22%, and 16%, respectively while it had no notable effect on outpatient expenditure per visit, inpatient service expenditure per month, inpatient days per month, or the probability of admission per month. In table A4, the magnitudes of the impacts and the statistical significance were almost similar to the main results shown in Table 4, but the statistical significance of the reduction effects disappeared for the outpatient service expenditure by intestinal infectious diseases and allergic rhinitis.

4. DISCUSSION

4.1 Total healthcare utilization

Our study found that MSC disqualification for outpatient service in a Japanese urban city caused statistically significant reductions in the expenditure and number of outpatient service visits among NIH-insured children in elementary school. Let us suppose an average out-of-pocket cost between 0 and 300 JPY after April 2013. Based on our estimate, the arc-elasticity value calculated in accordance with the RAND HIE fell between −0.22 and −0.15. In comparison with the results of the RAND HIE, our estimates were comparable to those for adults' total outpatient service expenditure and inpatient service expenditure in the range from 0% to 25% coinsurance rate (= −0.17 and −0.17, respectively), but larger than that for adults' dental service expenditure in the range from 0% to 25% coinsurance rate (= −0.12) (Keeler et al., 1988). Our estimate was also comparable to the price elasticity of outpatient service for older adults reported in previous Japanese studies (−0.14 to −0.18) (Fukushima et al., 2016; Shigeoka, 2014).

The odds or the probability of outpatient service utilization declined significantly following MSC disqualification. This finding certainly suggests that MSC disqualification raised the threshold for outpatient service usage among consumers (children or their guardians), because supplier-induced demand was less likely to influence decision-making by those who did not seek outpatient service. Additionally, in the present study, outpatient expenditure per visit did not change after MSC disqualification. Because outpatient expenditure per visit is considered to mainly reflect health providers' decisions on the intensity of medical care utilization, MSC disqualification in the treatment group would be unlikely to lead to an increased supplier-induced demand to compensate hospital income loss derived from a decrease in the number of patients. Nevertheless, I cannot exclude the possibility that MSC disqualification discouraged physicians from aggressive follow-up for children who sought outpatient service at least once (e.g., if a patient was not eligible for MSC and had only a mild acute disease, a physician may not request a follow-up appointment, considering the patient's financial burden). This effect may have strengthened the reduction in outpatient service utilization.

In this study, MSC disqualification did not exert notable effects on inpatient service utilization. This finding suggests that reduced outpatient service utilization was not offset by an increase in inpatient service utilization, at least in the short run, because there were no changes in either subsidy or policy for inpatient service during the study period. This finding is consistent with that of previous studies (Kiil and Houlberg, 2013).

4.2. Healthcare utilization by income levels

Our analyses by income levels showed that the reducing effect of MSC disqualification on outpatient service utilization was more substantial for the middle-income group than the high-income group as expected. Given the findings that the level of outpatient service utilization was almost equal between the middle-income group and the high-income group in AY 2012, MSC disqualification would increase the disparity in outpatient service utilization between the middle-income group and the high-income group (Figure A2). I did not find any significant difference in the reducing effect of MSC disqualification on outpatient service utilization between the low-income group and the middle/high-income group (Figure A3 and A4). This finding suggests the other factors than price (out-of-pocket payments) of outpatient visits might substantially affect the decision for low-income households to use outpatient service. That is, for the low-income group, the opportunity cost of the outpatient visit might be larger than for the middle/high-income group (because of the difficulty in leave of absence from work or duty), and as a result, the effect of the increase in the price of the outpatient visit might be weakened. Another likely explanation for it is that the other subsidies such as the medical subsidies for single-parent households might alleviate the reducing effect of MSC disqualification on outpatient service utilization in the low-income group compared to the middle/high-income group because single-parent households generally tend to be in the low-income group.

4.3. Healthcare utilization by diagnosed conditions

In children, only limited research has investigated the effect of a change in cost-sharing rate on medical demand stratified by particular diagnosed conditions. Our results suggested that the effects of MSC disqualification varied by condition. In particular, MSC disqualification reduced the outpatient service expenditure where children were diagnosed with acute lower/upper respiratory infection, intestinal infectious diseases, allergic rhinitis, dermatitis/eczema, or disorders of refraction and accommodation ($p<0.05$). In contrast, MSC disqualification did not affect the outpatient service expenditure where injury or asthma was diagnosed. For children in developed countries like Japan, most acute lower/upper respiratory infection, intestinal infectious diseases, dermatitis/eczema, and disorders of refraction and accommodation are considered relatively mild cases which rarely lead to severe conditions. Therefore, children's guardians can easily employ alternative remedies, such as purchasing over-the-counter drugs, without seeing a physician or extend the interval of each consultation. However, children's guardians would be more concerned with possibly severe conditions such as injuries or asthma (Liu et al., 2015), and would tend to select outpatient services.

4.4. Strengths and limitations

The present study has contributed useful information on the impact of a change in cost-sharing rate on healthcare utilization. For example, prior quasi-experimental studies that looked at the impact of price on children's healthcare demand in the United States focused on the effects of insurance enrollment. I examined the impact of a change in cost-sharing rate from practically nothing to 30% on children's health service utilization in Japan, where public health insurance already covers all children. The impact of a change in cost-sharing rate could differ depending on the original rate. Therefore, our study's setting could complement the prior studies in the United States. Besides, this study is the first study that investigated the impact of a change in cost-sharing rate on outpatient service utilization by each medical condition common in children. Characterizing the change in medical demand for treating particular conditions may help to evaluate the mechanism by which a change in the cost-sharing rate affects health.

Despite these strengths, there were some limitations to this study. First, this study was an observational study that used a DID approach, which assumed a "parallel trend" and a "common shock" between the control group and the treatment group. Nevertheless, the parallel trend assumption appeared to be valid as explained in the Methods section and supported by Figure 1. The common shock assumption also seems to be plausible as explained in the Methods section, but if there should unobserved changes peculiar to the treatment group except for the change in cost-sharing rate, our estimates would be affected. Second, I identified each medical condition by the ICD10 codes recorded in medical claims, although those may have differed from the actual conditions the children had. For example, if a child who did not have specific symptoms except for acute fever saw a doctor and was otherwise in relatively good health, the child may be diagnosed with acute upper respiratory infection at that time; other symptoms may emerge later, and the child would be re-diagnosed with an intestinal infectious disease. Therefore, I could not exclude the possibility of misclassification. Additionally, the present way of counting episodes with each acute condition may lead to undercounting. However, it seemed plausible that the degree of undercounting did not differ by school grade, and hence, the results would not be affected by undercounting. Third, this study's participants were NIH-insured children whose guardians were self-employed or irregular employees. They had relatively lower income in average compared with regular employees, and as a result, the effect of the increase in cost sharing rate was amplified in this study's participants. Fourth, this study was conducted in one urban city in Japan, where physical access to medical resources might not representative. Nevertheless, the distribution of the dwellings by the distance to the nearest medical facility in C City was almost similar to that across Japan (under 250 m, 34% in C City vs. 33% across Japan; 250 to 500 m, 38% vs. 28%; 500 to 1000 m, 21% vs.22%; over 1000 m, 7% vs. 18%; chi-squared test, $p = 0.99$) (Ministry of Internal Affairs and Communications Japan, 2008). The number of pediatricians was also similar (1.93 in C City vs. 1.88 across Japan per thousand children aged under 15) (Ministry of Health Labour and Welfare Japan, 2014). At least in the perspective of physical access to medical resources, C City might be nationally representative. Fifth, Japan ensures universal access to health providers. This universal access is considered to increase the number of children's outpatient service utilization (Ishida et al., 2012), and therefore, may mitigate the decline in outpatient service utilization compared with countries that offer only restricted access to health providers. Sixth, I could not identify persons eligible for another subsidy provided by the Injury and Accident Mutual Aid Benefit system, which is common in Japanese schools and covers injuries or diseases occurring at the school (Japan Sport Council, 2018). This subsidy provides co-insurance that aids in coverage when the MSC does not apply and may have mitigated reductions in outpatient service usage during the study period. Finally, indicators of health outcomes, such as laboratory data, numbers of absences from school, and mortality, were not available as outcomes except for the information on inpatient service utilization.

4.5. Conclusions

Health in childhood plays an important part in realizing future good health (Currie, 2009), while excessive cost-sharing reduction without improvement in health outcomes can cause social welfare loss resulting from a “moral hazard.” Besides, budgetary constraints require the assessment of policy effects on healthcare utilization. I found that MSC disqualification for outpatient service reduced outpatient service utilization among elementary school children. The reduction in outpatient service utilization was heterogeneous across medical conditions; notable declines were observed in relatively mild conditions. These findings may indicate that at least in Japan, a 30% increase in the cost-sharing rate from almost zero may reduce outpatient service utilization for mild conditions, which do not necessarily lead to adverse health outcomes in the short term (as represented by no significant change in inpatient service utilization). Nevertheless, our study did not investigate the long-term effects of MSC disqualification on health service utilization. It has been reported that health insurance eligibility exerts positive effects on future health (Currie et al., 2008). As our study period was one year, it did not sufficiently include the cumulative effects of a change in the cost-sharing rate on adolescents’ or adults’ health. Further studies should be conducted.

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Figure and tables

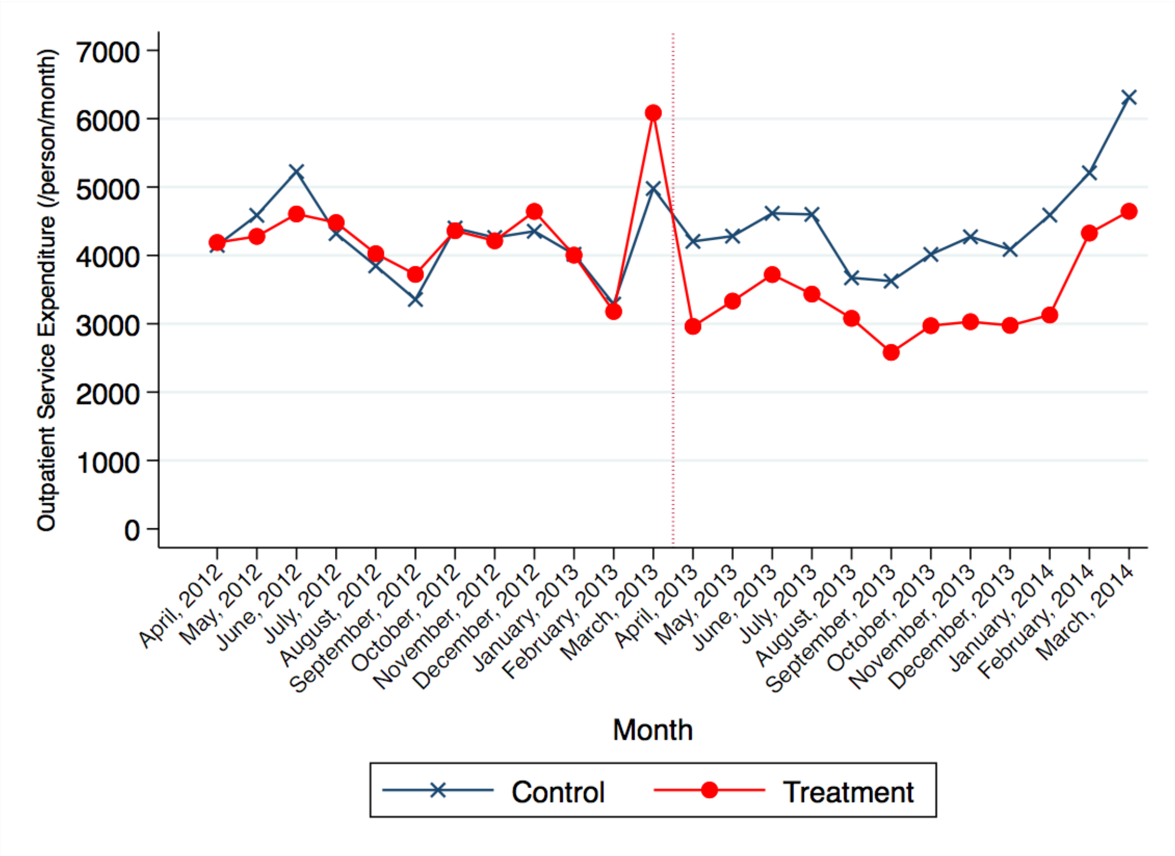

Figure 1. Monthly outpatient service expenditure. The unit of the expenditure is Japanese yen. The red vertical line shows when the treatment group was disqualified the medical subsidy.

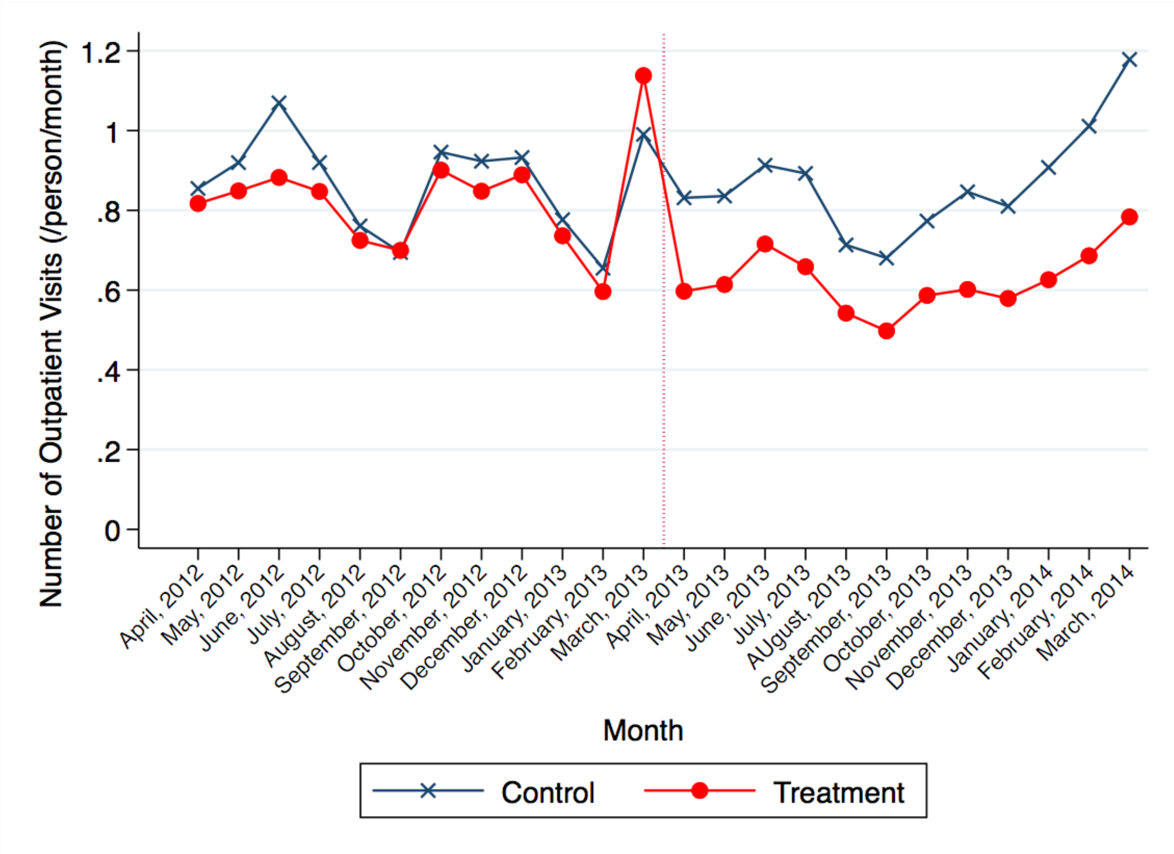

Figure 2. Number of monthly outpatient visits. The red vertical line shows when the treatment group was disqualified the medical subsidy.

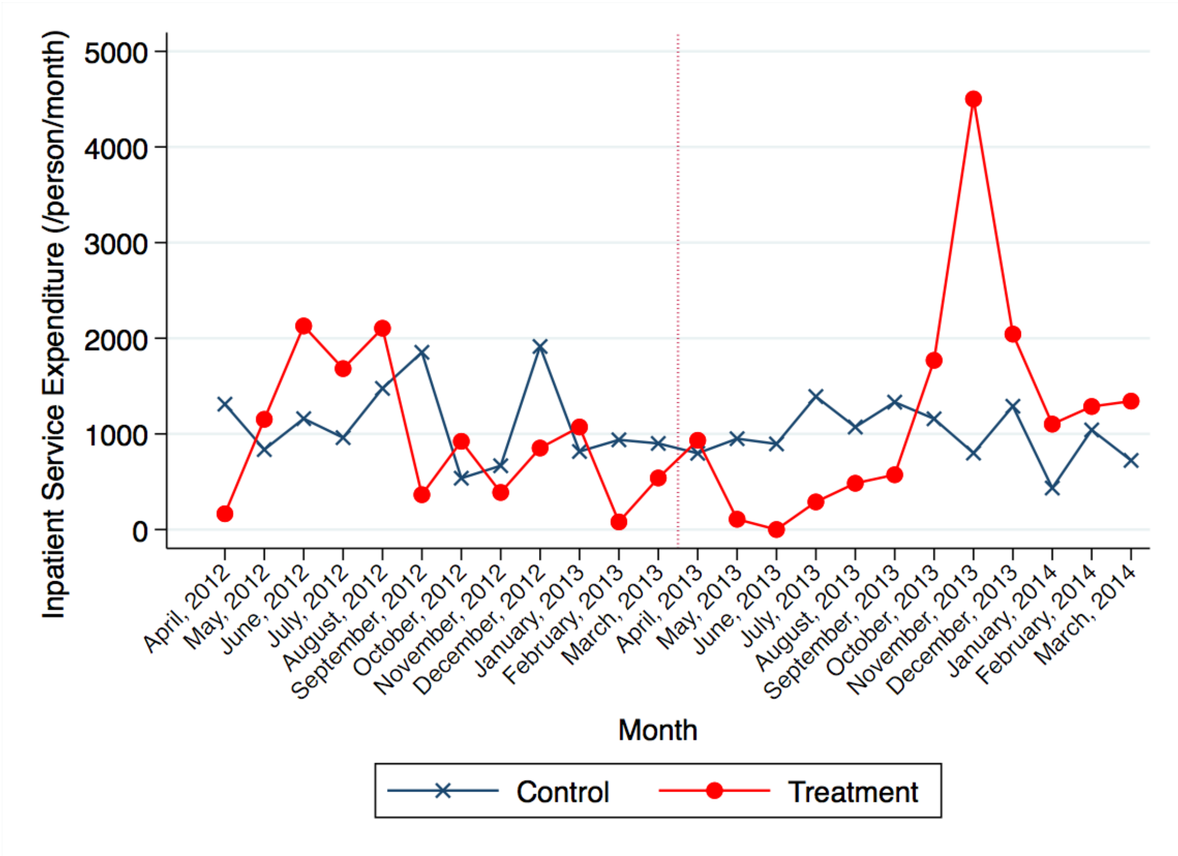

Figure 3. Monthly inpatient service expenditure. The unit of the expenditure is Japanese yen. The red vertical line shows when the treatment group was disqualified the medical subsidy.

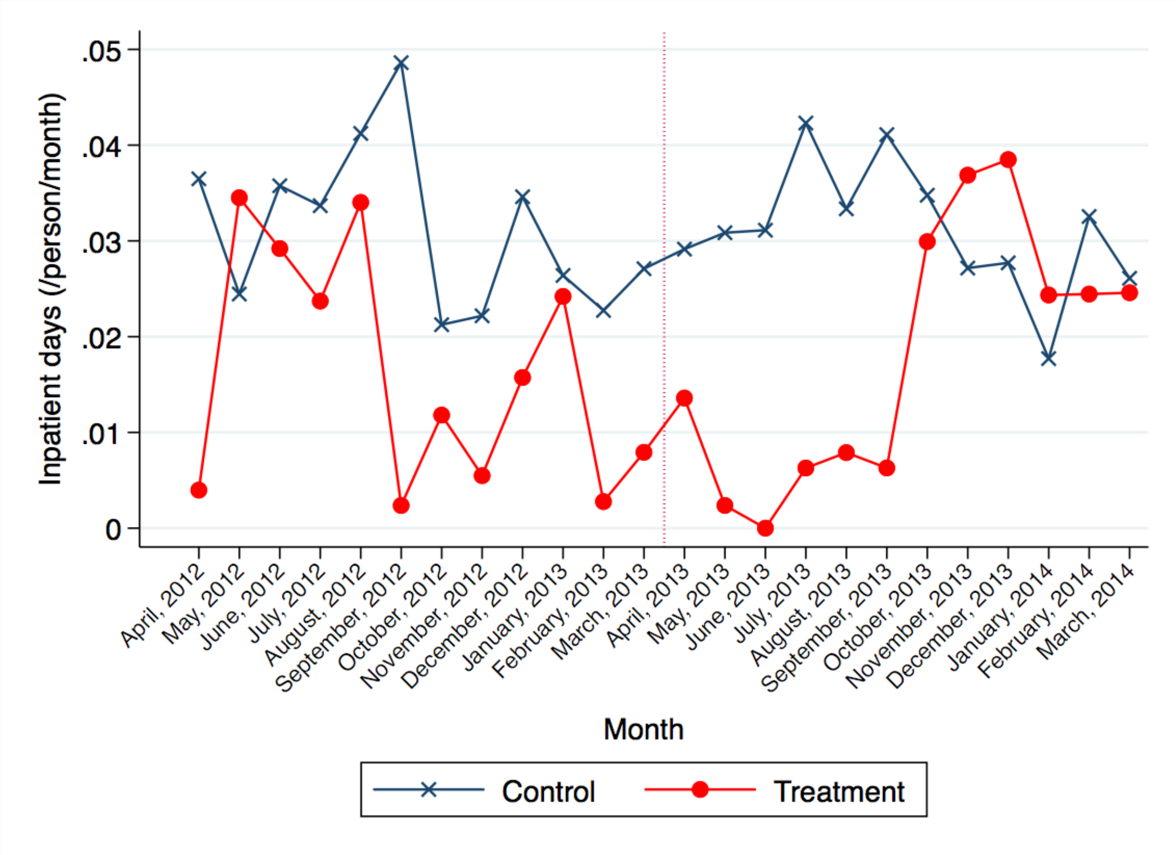

Figure 4. Monthly inpatient days. The red vertical line shows when the treatment group was disqualified the medical subsidy.

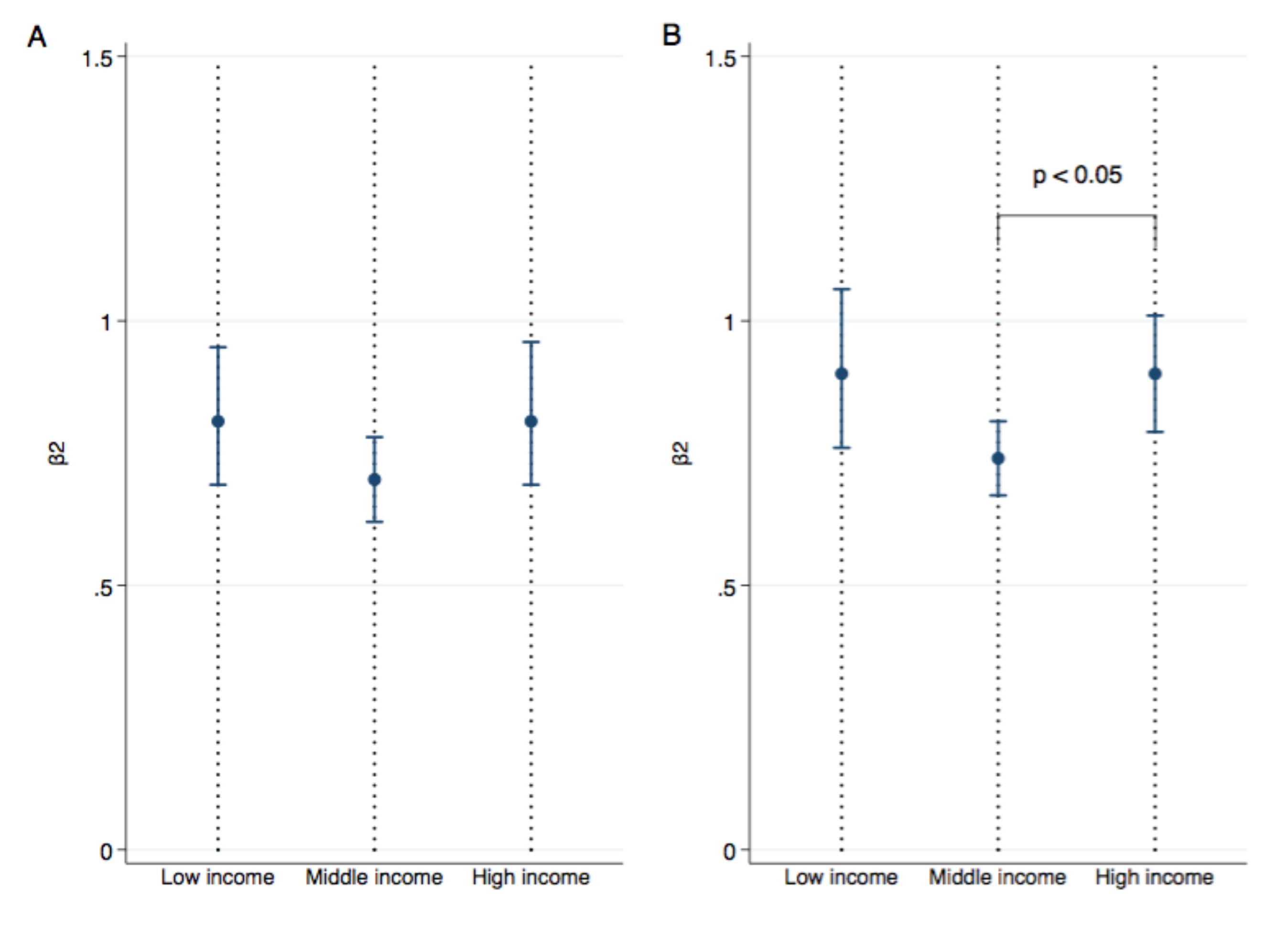

Figure 5. Effect of MSC disqualification on outpatient service expenditure per month (Panel A) and number of outpatient visits (Panel B) by income levels. MSC: medical subsidy for children.

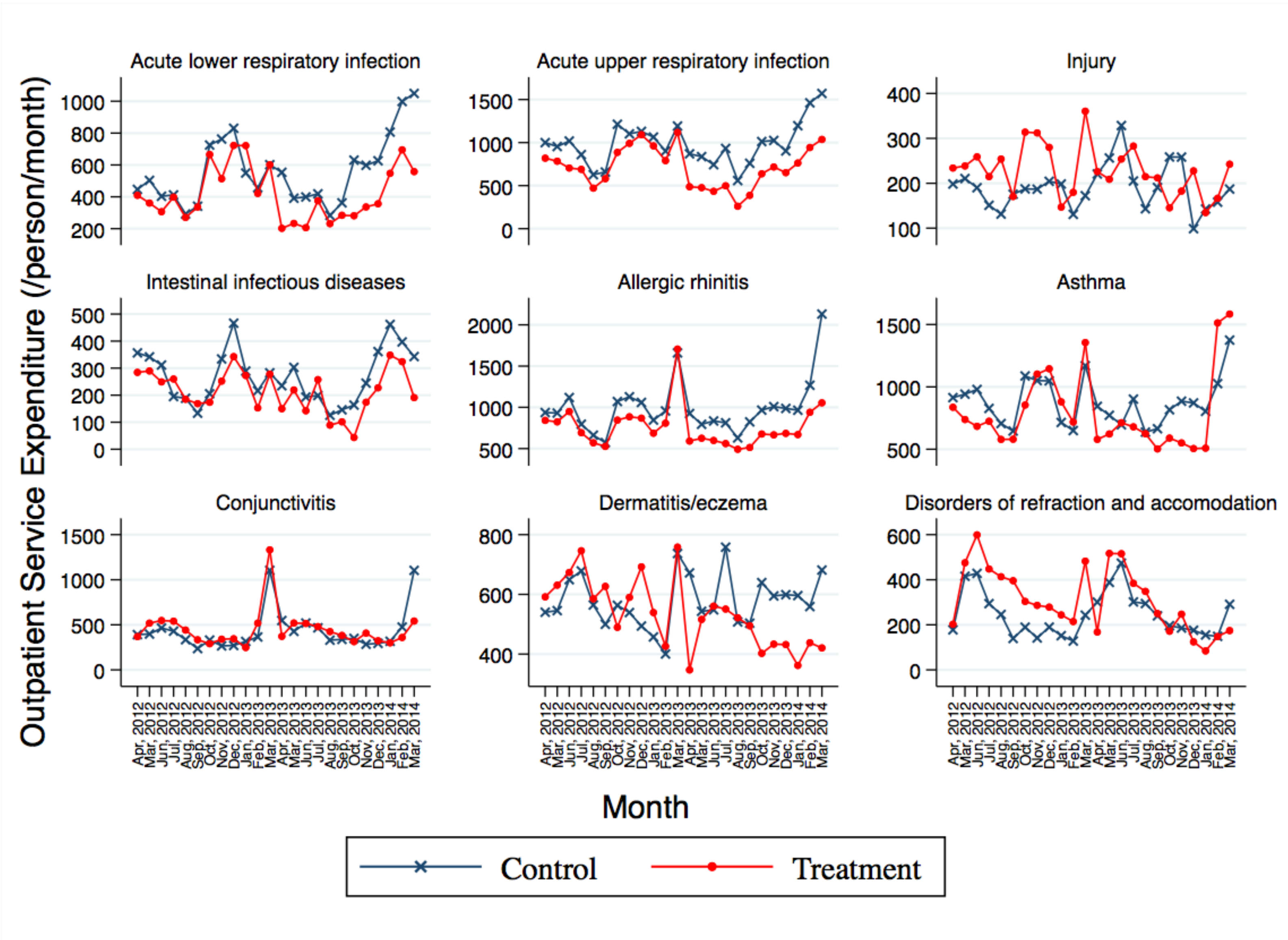

Figure 6. Monthly outpatient service expenditure by medical condition

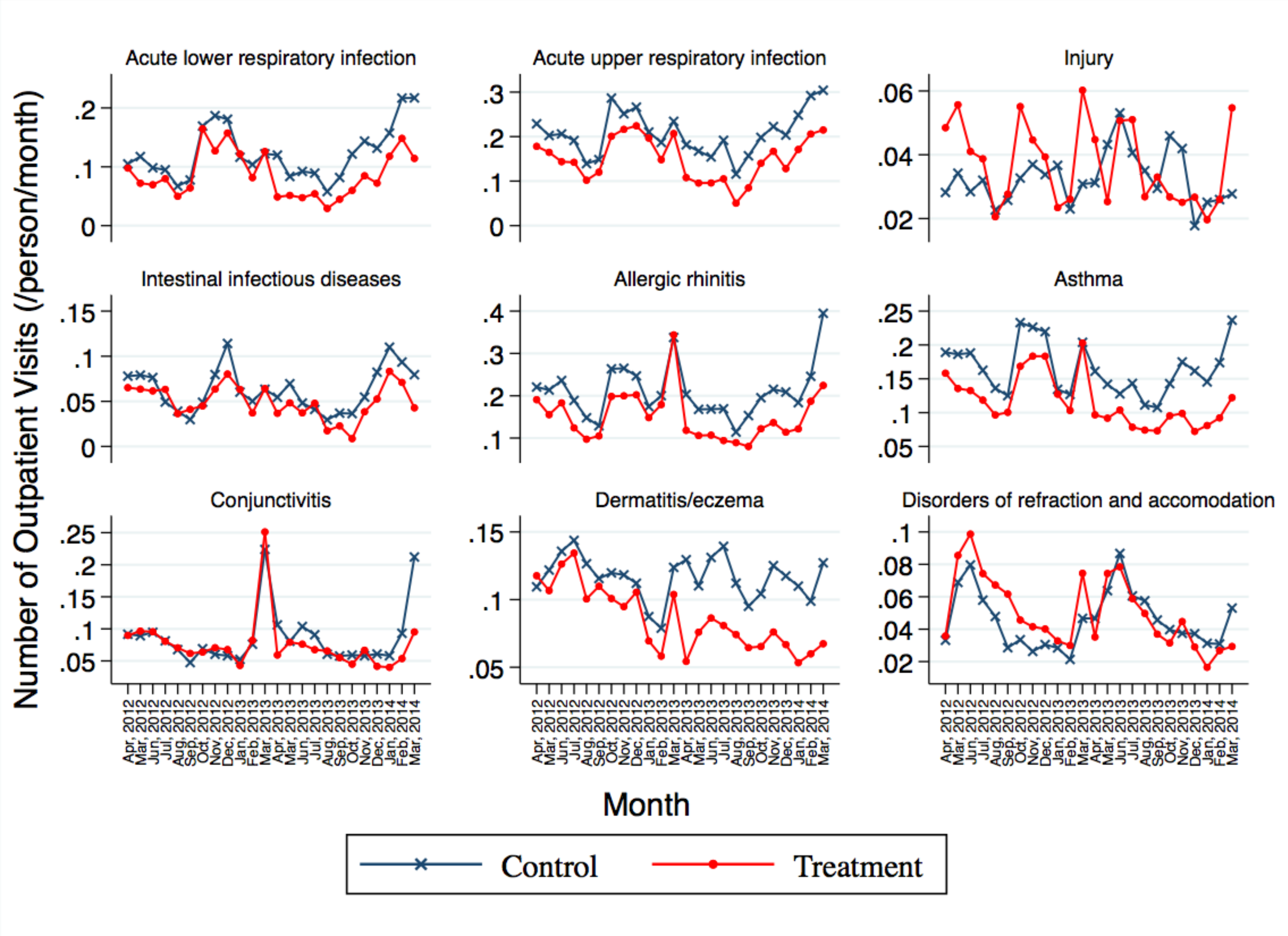

Figure 7. Number of monthly outpatient visits by medical condition

Table 1. Change in copayment for outpatient service by grade between April 2012 and March 2014 in C city

	Copayment for outpatient service	
	AY 2012 [a]	AY 2013 [a]
2nd grade in AY 2013	300 JPY maximum/visit[b]	300 JPY maximum/visit[b]
3rd grade in AY 2013	300 JPY maximum/visit[b]	300 JPY maximum/visit[b]
4th grade in AY 2013	300 JPY maximum/visit[b]	30% co-insurance

Notes: During the study period, a medical subsidy for children (MSC) was offered to children enrolled in 3rd or lower grade in elementary school. Thus, during AY 2012, all the analytic schoolchildren were eligible for MSC. In April 2013, children promoted to 4th grade were disqualified from MSC.

[a] Academic year (AY) 2012/2013 is from April 2012/2013 to March 2013/2014. Schoolchildren was promoted at the end of AY 2012.

[b] No charge was imposed on children living under the poverty line. JPY, Japanese yen.

Table 2. Descriptive statistics in the control group and the treatment group

	Control group[a]	Treatment group[b]
Individual observations		
Number	3954	1967
Males (%)	50.6	49.3
Residential area[c]		
District A (%)	18.4	17.9
District B (%)	12.1	11.0
District C (%)	15.8	17.8
District D (%)	16.5	14.2
District E (%)	18.8	20.2
District F (%)	12.8	13.5
Others (%)	5.5	5.3
Equivalized income (%)		
Income missing	57.7	53.2
＜1.5 million JPY	8.2	9.3
1.5 to 4.5 million JPY	22.7	24.1
≧4.5 million JPY	11.3	13.4
Person-month observations		
Number	59326	30967
Number of outpatient visits (/person/month)[d], Mean (SD)	0.851 (1.374)	0.792 (1.371)
Outpatient visit dummy (/person/month)[d], Mean (SD)	0.425 (0.494)	0.400 (0.490)
Outpatient service expenditure (/person/month)[d], Mean (SD)	4130 (7941)	4119 (9845)
Outpatient service expenditure (/visit)[d], Mean (SD)	5088 (5366)	5467 (7613)
Inpatient days (/person/month)[d], Mean (SD)	0.031 (0.808)	0.017 (0.477)

Admission dummy (/person/month)[d], Mean (SD)	0.003 (0.055)	0.002 (0.050)
Inpatient expenditure (/person/month)[d], Mean (SD)	1125 (25880)	958 (26411)

[a] Control group consisted of children enrolled to grade 2 or 3 in April 2013. [b] Treatment group consisted of children enrolled to grade 4 in April 2013. SD: standard deviation. Residential area showed administrative districts within C city. [d] Mean of the data between April 2012 and February 2013; all participants qualified for a medical subsidy during that period. Expenditure unit is Japanese yen.

Table 3. Impact of medical subsidy for children (MSC) disqualification on medical service utilization

	Difference-in-differences estimates (95% confidence interval)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variables	Outpatient service expenditure (/person/month)	Number of outpatient visits (/person/month)	Outpatient visit dummy (/month)	Outpatient service expenditure (/visit)	Inpatient service expenditure (/person/month)	Inpatient days (/person/month)	Admission dummy (/month)
MSC disqualified (ref: MSC qualified)	0.74*** (0.68, 0.81)	0.78*** (0.73, 0.83)	0.75*** (0.70, 0.81)	1.00 (0.89, 1.12)	0.49 (0.19, 1.29)	0.54 (0.22, 1.34)	0.88 (0.45, 1.72)
Observations (persons)	5921	5921	5921	4485	5921	5921	5921
Observations (person-months)	86632	86632	86632	35754	86632	86632	86632
Pseudo R^2	0.0004	0.0058	0.0114	0.0024	0.0022	0.0235	0.0402

Negative binomial regression methods were applied. Exponentiated β_2s were shown. Estimates refer to the multiplicative effects of medical subsidy for children (MSC) disqualification on the dependent variables for the column (1), (2), (4), (5), or (6) and on the odds that the dependent variable takes 1 for the column (3) or (7). Standard errors were clustered on individuals. ***, $p<0.001$.

Table 4. Impact of medical subsidy for children (MSC) disqualification on outpatient service utilization by particular common condition

	Difference-in-differences estimates (95% confidence interval)			
	(1)	(2)	(3)	(4)
Dependent variables	Outpatient service expenditure (/person/month)	Number of outpatient visits (/person/month)	Outpatient visit dummy (/month)	Outpatient service expenditure (/visit)
Acute conditions				
Acute lower respiratory infection	0.68*** (0.57, 0.81)	0.70** (0.61, 0.80)	0.74** (0.65, 0.83)	0.97 (0.90, 1.04)
Acute upper respiratory infection	0.72*** (0.64, 0.81)	0.80*** (0.72, 0.89)	0.80*** (0.72, 0.88)	0.92** (0.86, 0.98)
Injury	0.83 (0.61, 1.12)	0.80 (0.60, 1.06)	0.77* (0.62, 0.95)	1.00 (0.86, 1.15)
Intestinal infectious diseases	0.74** (0.59, 0.92)	0.75** (0.63, 0.91)	0.75** (0.64, 0.88)	1.04 (0.96, 1.12)
Chronic conditions				
Allergic rhinitis	0.75* (0.56, 0.99)	0.79*** (0.69, 0.91)	0.78*** (0.69, 0.89)	0.98 (0.69, 1.38)
Asthma	0.82 (0.64, 1.05)	0.77*** (0.66, 0.89)	0.77*** (0.66, 0.89)	1.21 (0.88, 1.67)
Conjunctivitis	0.75 (0.51, 1.12)	0.72** (0.58, 0.88)	0.68*** (0.57, 0.82)	1.09 (0.72, 1.65)
Dermatitis/eczema	0.65*** (0.52, 0.82)	0.67*** (0.55, 0.83)	0.69*** (0.59, 0.82)	0.99 (0.82, 1.20)
Disorders of refraction and accommodation	0.57*** (0.45, 0.72)	0.63*** (0.52, 0.77)	0.65*** (0.55, 0.78)	0.94 (0.79, 1.11)

Exponentiated β2s are shown. Estimates refer to the multiplicative effects of medical subsidy for children (MSC) disqualification on the dependent variables for the column (1), (2), and (4) and on the odds that the dependent variable takes 1 for the column (3). *, p<0.05, **, p<0.01. ***, p<0.001.

Appendix

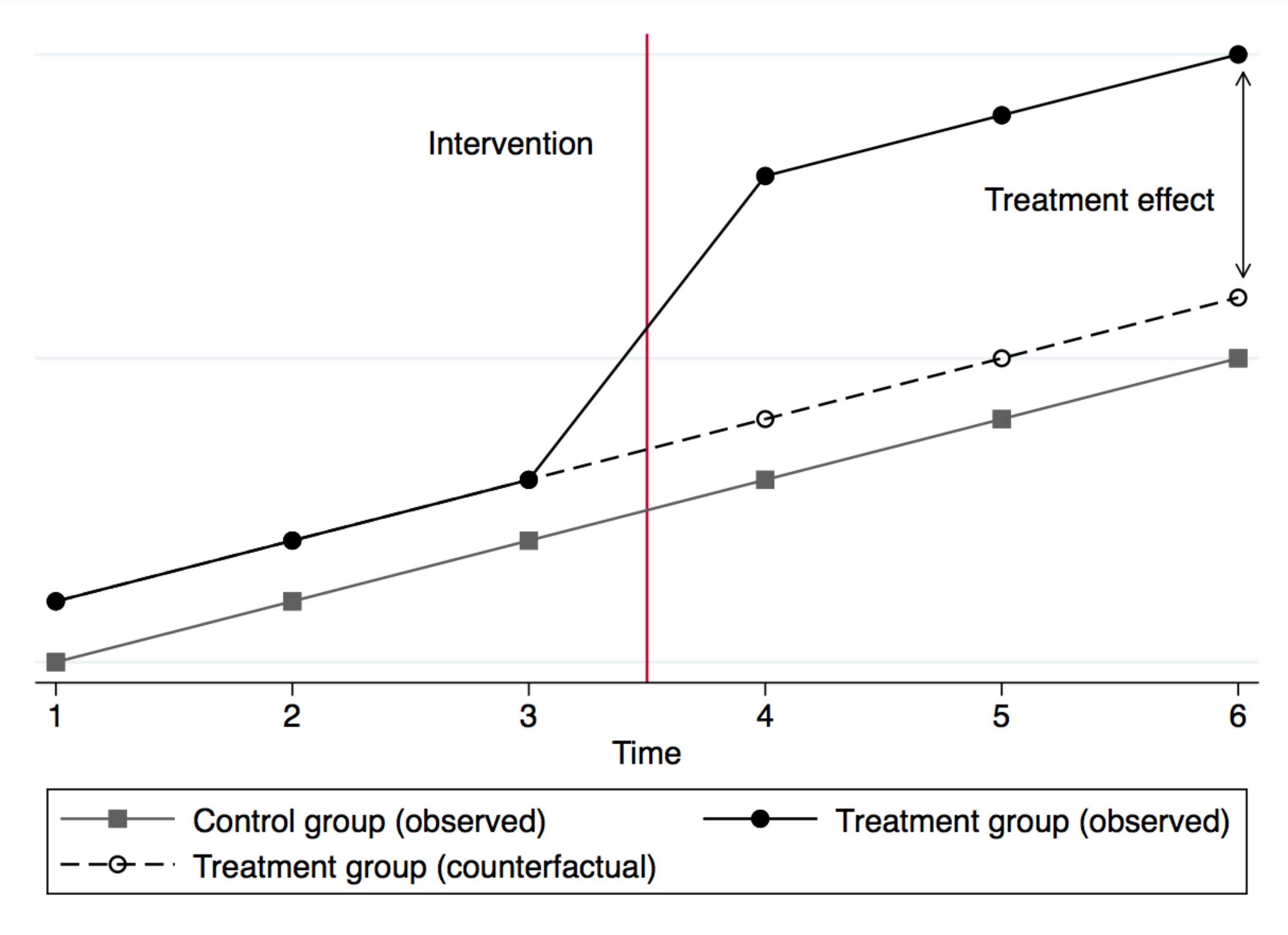

Figure A1. Concept of a difference-indifferences approach.

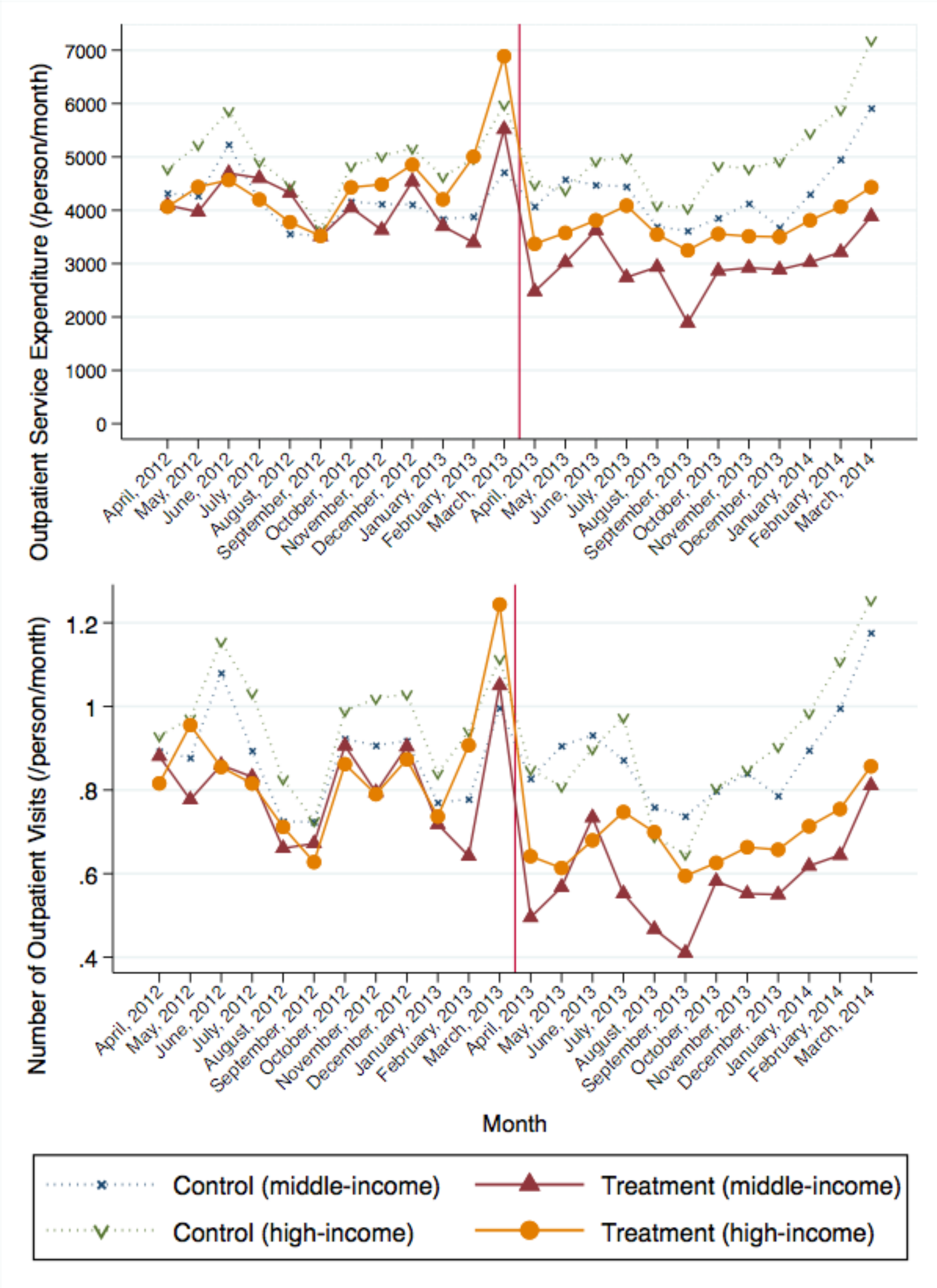

Figure A2. Monthly outpatient service expenditure and number of monthly outpatient visits among the middle-income group and the high-income group. The red vertical line shows when the treatment group was disqualified the medical subsidy. The unit of the expenditure is Japanese yen.

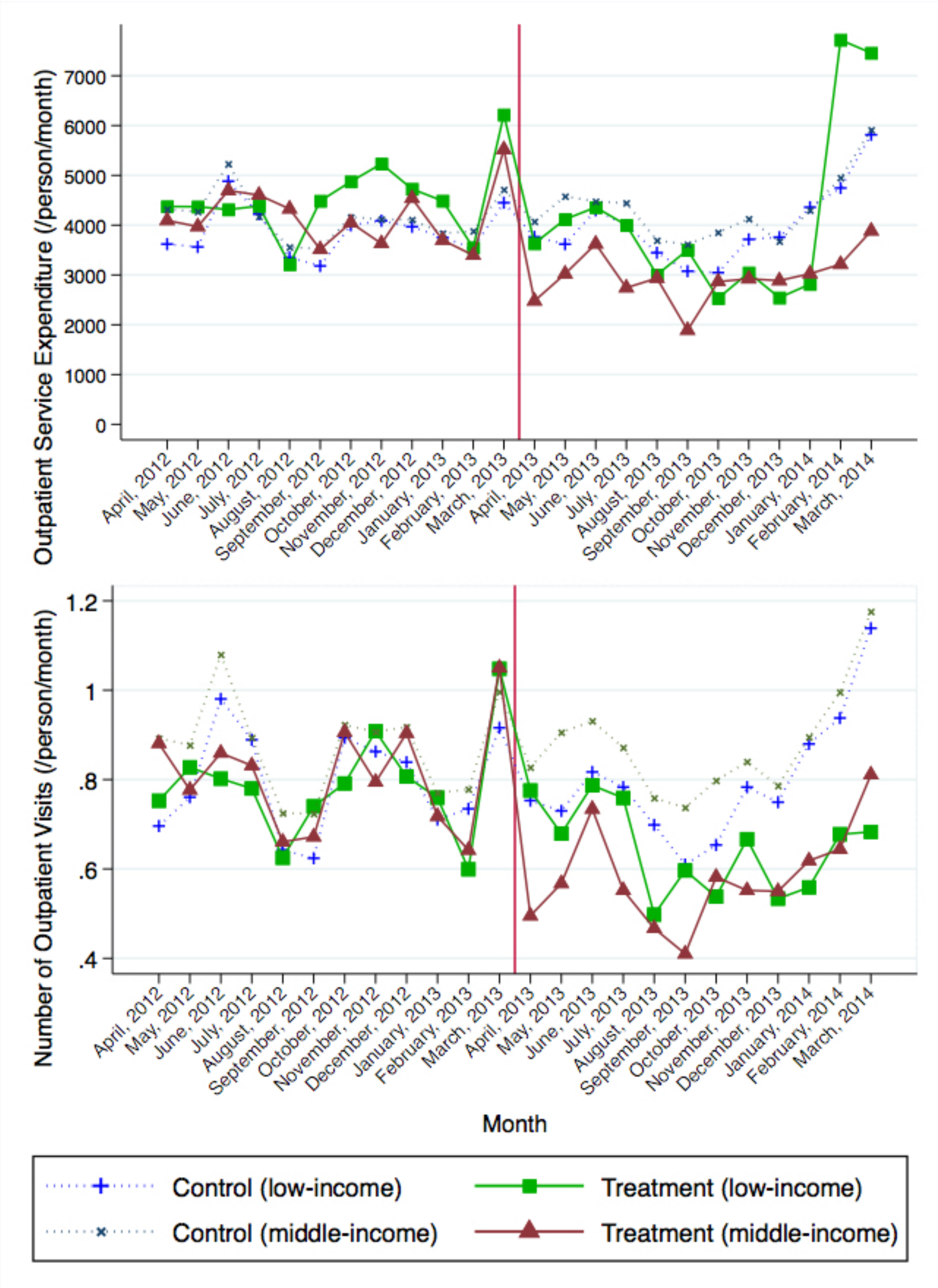

Figure A3. Monthly outpatient service expenditure and number of monthly outpatient visits among the low-income group and the middle-income group. The red vertical line shows when the treatment group was disqualified the medical subsidy. The unit of the expenditure is Japanese yen.

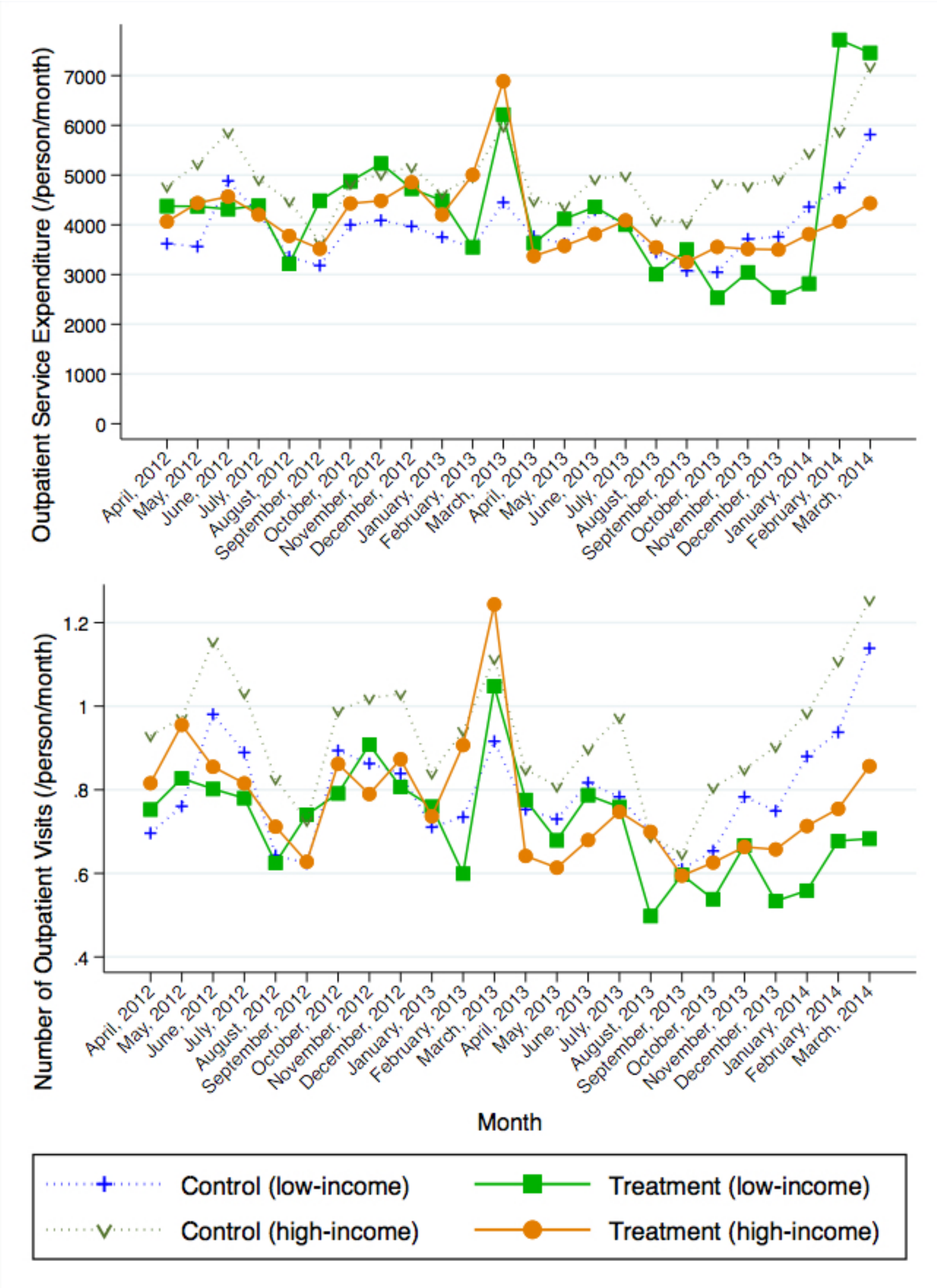

Figure A4. Monthly outpatient service expenditure and number of monthly outpatient visits among the low-income group and the high-income group. The red vertical line shows when the treatment group was disqualified the medical subsidy. The unit of the expenditure is Japanese yen.

Table A1. Impact of medical subsidy for children (MSC) disqualification on medical service utilization, analyzed by an OLS model

	Difference-in-differences estimates (95% confidence interval)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variables	Outpatient service expenditure (/person/month)	Number of outpatient visits (/person/month)	Outpatient visit dummy (/month)	Outpatient service expenditure (/visit)	Inpatient service expenditure (/person/month)	Inpatient days (/person/month)	Admission dummy (/month)
MSC disqualified (ref: MSC qualified)	-1094*** (-1494, -694)	-0.182*** (-0.229, -0.134)	-0.066*** (-0.083, -0.050)	129 (-810, 1069)	385 (-931, 1700)	0.002 (-0.023, 0.026)	0 (-0.002, 0.001)
Observations (persons)	5921	5921	5921	4485	5921	5921	5921
Observations (person-months)	86632	86632	86632	35754	86632	86632	86632
R-squared value	0.0067	0.0136	0.0154	0.034	0.0015	0.0024	0.0501

Expenditure unit is Japanese yen. Ordinary least squares estimation was applied. The other adjusted covariates were a treatment group dummy, month dummies, sex, income level, and living area dummies. Estimates refer to how much MSC disqualification would change outcomes if other conditions were unchanged. MSC: Medical subsidy for children. Standard errors were clustered on individuals. ***, $p<0.001$.

Table A2. Impact of medical subsidy for children (MSC) disqualification on outpatient service utilization by common condition, analyzed by an OLS model

	Difference-in-differences estimates (95% confidence interval)			
	(1)	(2)	(3)	(4)
Dependent variables	Outpatient service expenditure (/person/month)	Number of outpatient visits (/person/month)	Outpatient visit dummy (/month)	Outpatient service expenditure (/visit)
Acute conditions				
Acute lower respiratory infection	-181***	-0.032***	-0.017***	-151
	(-253, -108)	(-0.045, -0.019)	(-0.024, -0.010)	(-519, 217)
Acute upper respiratory infection	-223***	-0.029**	-0.019***	-444*
	(-343, -131)	(-0.047, -0.011)	(-0.029, -0.010)	(-782, -106)
Injury	-54	-0.008	-0.004*	-83
	(-115, 7)	(-0.019, 0.002)	(-0.008, -0.001)	(-1155, 989)
Intestinal infectious diseases	-37	-0.011*	-0.008**	185
	(-84, 9)	(-0.021, -0.002)	(-0.014, -0.003)	(-162, 533)
Chronic conditions				
Allergic rhinitis	-196	-0.032**	-0.022***	121
	(-480, 88)	(-0.055, -0.009)	(-0.033, -0.010)	(-2568, 2810)
Asthma	-51	-0.025*	-0.015**	2910
	(-412, 310)	(-0.043, -0.006)	(-0.026, -0.004)	(-2698, 8518)
Conjunctivitis	-109	-0.028**	-0.018***	1158
	(-351, 133)	(-0.043, -0.013)	(-0.026, -0.010)	(-3567, 5883)
Dermatitis/eczema	-202***	-0.034***	-0.019***	494
	(-317, -87)	(-0.053, -0.015)	(-0.029, -0.010)	(-2150, 3138)
Disorders of refraction and accommodation	-123***	-0.021***	-0.015***	-428
	(-192, -54)	(-0.030, -0.011)	(-0.022, -0.009)	(-1707, 851)

Expenditure unit is Japanese yen. Ordinary least squares estimates are shown, and refer to how much medical subsidy for children (MSC) disqualification would change outcomes if other conditions were unchanged. Standard errors were clustered on individuals. *, $p<0.05$. **, $p<0.01$. ***, $p<0.001$.

Table A3. Impact of medical subsidy for children (MSC) disqualification on medical service utilization, analyzed by a Poisson model

	Difference-in-differences estimates (95% confidence interval)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variables	Outpatient service expenditure (/person/month)	Number of outpatient visits (/person/month)	Outpatient visit dummy (/month)	Outpatient service expenditure (/visit)	Inpatient service expenditure (/person/month)	Inpatient days (/person/month)	Admission dummy (/month)
MSC disqualified (ref: MSC qualified)	0.75*** (0.67, 0.84)	0.78*** (0.73, 0.83)	0.84*** (0.81, 0.88)	1.02 (0.87, 1.19)	1.43 (0.50, 4.09)	1.08 (0.36, 3.27)	0.88 (0.45, 1.72)
Observations (persons)	5921	5921	5921	4485	5921	5921	5921
Observations (person-months)	86632	86632	86632	35754	86632	86632	86632

Poisson models were applied. The other adjusted covariates were a treatment group dummy, month dummies, sex, income level, and living area dummies. Exponentiated β_2s were shown. Estimates refer to the multiplicative effects of medical subsidy for children (MSC) disqualification on the dependent variables. Standard errors were clustered on individuals. ***, $p<0.001$.

Table A4. Impact of medical subsidy for children (MSC) disqualification on outpatient service utilization by common condition, analyzed by a Poisson model

	Difference-in-differences estimates (95% confidence interval)			
	(1)	(2)	(3)	(4)
Dependent variables	Outpatient service expenditure (/person/month)	Number of outpatient visits (/person/month)	Outpatient visit dummy (/month)	Outpatient service expenditure (/visit)
Acute conditions				
Acute lower respiratory infection	0.68*** (0.58, 0.79)	0.70*** (0.61, 0.81)	0.75*** (0.67, 0.84)	0.97 (9.89, 1.05)
Acute upper respiratory infection	0.74*** (0.66, 0.83)	0.81*** (0.73, 0.90)	0.82*** (0.75, 0.89)	0.91* (0.85, 0.98)
Injury	0.77 (0.58, 1.02)	0.78 (0.58, 1.06)	0.77* (0.62, 0.95)	0.99 (0.85, 1.15)
Intestinal infectious diseases	0.83 (0.68, 1.02)	0.79* (0.65, 0.94)	0.76** (0.65, 0.88)	1.04 (0.96, 1.13)
Chronic conditions				
Allergic rhinitis	0.79 (0.53, 1.18)	0.79*** (0.69, 0.91)	0.80*** (0.72, 0.90)	1.01 (0.64, 1.60)
Asthma	0.94 (9.58, 1.51)	0.75*** (0.65, 0.88)	0.78*** (0.68, 0.89)	1.44 (0.80, 2.58)
Conjunctivitis	0.76 (0.42, 1.37)	0.68** (0.56, 0.84)	0.70*** (0.59, 0.83)	1.16 (0.64, 2.13)
Dermatitis/eczema	0.69* (0.52, 0.91)	0.67*** (0.55, 0.82)	0.71*** (0.61, 0.83)	1.05 (0.77, 1.41)
Disorders of refraction and accommodation	0.64*** (0.52, 0.80)	0.64*** (0.53, 0.79)	0.67*** (0.56, 0.79)	0.93 (0.76, 1.14)

Exponentiated β_2s are shown. Estimates refer to the multiplicative effects of medical subsidy for children (MSC) disqualification on the dependent variables. *, p<0.05. **, p<0.01. ***, p<0.001.