Research Square

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# Evaluating the impact of Japan's #7119 emergency telephone consultation service on ambulance use: synthetic control and synthetic difference-in-differences analyses

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## Abstract

Background. To reduce ambulance dispatches resulting from non-urgent calls, several Japanese local governments have introduced an emergency telephone consultation service (#7119), which provides real-time medical advice on whether an ambulance should be called. This study examined whether #7119 reduced ambulance use across Japanese prefectures.

Methods. The effects of #7119 on ambulance dispatches per 1,000 people were estimated for each intervention prefecture using the synthetic control method (SCM) and synthetic difference-in-differences (SDID) frameworks. Publicly available, aggregated data from local governments were used for the analyses. The study period spanned from 1989 to 2022.

Results. Among the 47 prefectures in Japan, five with unique measures to reduce ambulance use were excluded. A total of 16 treated and 26 control prefectures were identified. Except for three prefectures, including Tokyo and Osaka, SCM estimates were feasible. No significant reduction in ambulance dispatches was observed in any treated prefecture in the SCM analyses. The SDID analyses yielded results largely consistent with those of SCM. For Tokyo, the SDID analysis estimated a significant decrease in ambulance use. However, the event-study plots for Tokyo showed declining pretreatment trends relative to the control group, suggesting that this estimate should be interpreted with caution.

Conclusion. Using SCM and SDID, this study found no clear evidence that Japan's emergency telephone consultation service (#7119) reduced ambulance dispatches in most prefectures. Additional measures may therefore be required to address the continuing increase in ambulance use.


## Background

Ambulance dispatch services play a crucial role in transporting individuals with severe medical conditions who require immediate treatment at appropriate emergency medical facilities. A persistent and widely recognized challenge facing these services is the misuse of emergency ambulances by patients with non-serious conditions, which can lead to delays in care for patients with truly urgent needs (1). Although this issue has been acknowledged for several decades (2), it has become increasingly prominent in recent years, driven by an increasing demand for ambulance services, largely due to population aging and the growing burden of chronic diseases (3, 4).

One approach to addressing this challenge is the use of emergency telephone consultation services. In Japan, several local governments operate a telephone consultation service known as #7119, which is primarily staffed by trained medical professionals (mostly nurses). Individuals who believe they may require ambulance transport due to acute illness or injury are instructed to call 119, Japan's national emergency medical number (5). In practice, ambulances are generally dispatched by local fire departments upon receiving a 119 call, even when the clinical urgency of the reported symptoms is unclear. This operational principle may contribute to the overuse of ambulance services for non-urgent conditions.

The #7119 service was established to mitigate unnecessary ambulance utilization by providing medical guidance to individuals who are uncertain whether ambulance transport is warranted. Callers to #7119 receive symptom-based advice from medical professionals and, when ambulance use is considered necessary, are either transferred to 119 or advised to contact 119 directly. Overall, #7119 is intended to reduce unnecessary ambulance

use without assigning ambulance dispatch authorities the responsibility to deny ambulance dispatch at the time of the initial emergency call.

Although the #7119 service is designed to reduce ambulance dispatches by avoiding non-urgent calls, its impact on ambulance dispatches has not been thoroughly studied (6). One peer-reviewed study was conducted one year after the #7119 service was first introduced in Tokyo and was limited to the city (7). Another examined #7119`s effect on unnecessary ambulance use, focusing on Osaka City (6). To our knowledge, no peer-reviewed studies have evaluated the impact of the #7119 service at the prefecture-wide level.

This study examines whether implementing the #7119 reduced ambulance dispatches at the prefectural level in Japan. Advances in causal inference methodology now enable the estimation of intervention effects using observational data, rather than relying solely on randomized controlled trials (8). Specifically, the synthetic control method (SCM) and synthetic difference-in-differences (SDID) frameworks allow for the analysis of treatment effects using publicly available aggregated data from local governments (9–11).

## Methods

# Aim, design, and setting of the study

This study examines the impact of introducing the #7119 service on ambulance dispatches per 1,000 people across all prefectures that implemented the service by 2022, using SCM and SDID.

## Data Sources and Study Outcomes

This study requires annual ambulance counts and population data for each prefecture.

Annual ambulance dispatch counts for each prefecture were extracted from “K1210_Frequency of dispatches of ambulances [number of occurrences]” available on e-Stat, the official portal site for Japanese Government Statistics (13). Population data for each prefecture were obtained from “A1101_Total population (Both sexes) [person]” on the same site (14). The outcome variable was the annual number of ambulance dispatches per 1,000 people, calculated by dividing each prefecture’s annual number of ambulance dispatches by its population in the preceding year. Data from 1989 to 2022 were used for the analyses.

## Identification of the intervention and control groups

The units in both the intervention and control groups were drawn from Japan's 47 prefectures, based on Table 1 (compiled from the Fire and Disaster Management Agency’s webpage [12]). The intervention group comprised prefectures that introduced the #7119 service in or before 2022. For three prefectures with partial coverage—Hokkaido, Kanagawa, and Hyogo—only the largest cities and their adjacent municipalities adopted #7119: Sapporo City in Hokkaido, Yokohama City in Kanagawa, and Kobe City in Hyogo. Given that these cities constitute a substantial share of each prefecture's total population (Sapporo: approximately 38% of Hokkaido; Yokohama: approximately 41% of Kanagawa; Kobe: approximately 27% of Hyogo), these three prefectures were classified as treated. In contrast, Wakayama Prefecture had #7119 adoption limited to Tanabe City and Kamitonda Town, whose combined population represents only 9% of Wakayama's total. Similarly, Okayama Prefecture had adoption

restricted to Kasahara City and Ibara City, accounting for just 4% of the prefecture's population. Consequently, both Wakayama and Okayama were classified as control prefectures.

Since four prefectures (Yamagata, Tochigi, Chiba, and Kagawa) had their own emergency telephone consulting services (15), they were excluded from the control group. Similarly, Saitama Prefecture had its own service in place before the introduction of #7119 and was excluded from the intervention group. As a result, the intervention group included 16 prefectures: Tokyo, Osaka, Nara, Hokkaido, Kanagawa, Fukuoka, Miyagi, Hyogo, Niigata, Tottori, Ibaraki, Hiroshima, Yamaguchi, Tokushima, Kyoto, and Kochi. The control group consisted of 26 prefectures.

Table 1
Implementation status of the #7119 service by Japanese local governments as of July 2024.

| Year of Introduction | Local Government(s) |
|---|---|
| 2007 | Tokyo Metropolitan Government (June)[a] |
| 2009 | Osaka Prefecture (October), Nara Prefecture (October) |
| 2013 | Tanabe City and Kamitonda Town in Wakayama Prefecture (April), Sapporo City in Hokkaido (October)[b] |
| 2016 | Yokohama City in Kanagawa Prefecture (January), Fukuoka Prefecture (June) |
| 2017 | Miyagi Prefecture (October), Saitama Prefecture (October), Kobe City in Hyogo Prefecture (October)[c], Niigata Prefecture (December) |
| 2018 | Tottori Prefecture (September), Ibaraki Prefecture (October) |
| 2019 | Hiroshima Prefecture (January)[d], Yamaguchi Prefecture (July), Tokushima Prefecture (December) |
| 2020 | Kyoto Prefecture (October) |
| 2022 | Kochi Prefecture (August) |
| 2023 | Fukushima Prefecture (April), Ehime Prefecture (July), Yamanashi Prefecture (October), Nagano Prefecture (October), Gifu Prefecture (October), Chiba Prefecture (November) |
| 2024 | Yamagata Prefecture (April), Tochigi Prefecture (April), Kagawa Prefecture (April), Toyama Prefecture (May), Kumamoto Prefecture (May), Nagoya City, Aichi Prefecture (July) |
| **Notes.** [a] Islands in Tokyo were excluded. [b] Ishikari City, Shinshinotsu Village, Kuriyama Town, Tobetsu Town, Nanpo Town, and Shamamaki Village were added later. [c] Ashiya City and Himeji City were added later. [d] 22 municipalities including Hiroshima City, were covered. Iwakuni City and Waki Town in Yamaguchi Prefecture and Kasahara City and Ibara City in Okayama Prefecture were covered under a cooperative agreement. | |
| Source: Fire and Disaster Management Agency (12) | |

# Statistical analysis

SCM was used for our main analyses (7). The basic idea of SCM is to construct a synthetic version of the treated unit as a weighted average of the outcomes of the control units (hereafter referred to as “donors”). Donor weights, which are constrained between zero and one and sum to one, are determined to minimize the discrepancy in

predictors between the treated unit and the weighted average of the donors. In this study, the predictors were ambulance dispatches per 1,000 people in four pretreatment years: the year immediately before treatment initiation, 1989, and two additional years chosen so that the four years were approximately equally spaced over the pretreatment period. For target years that did not correspond to an integer calendar year, we used the nearest integer year. For example, in Nara Prefecture, where #7119 was introduced in 2009, the predictors were ambulance dispatches per 1,000 people in 1989, 1995, 2002, and 2008.

Using the difference between the treated unit's outcome and the synthetic control outcome in each pretreatment year, the pretreatment root mean squared prediction error (RMSPE) was calculated. Similarly, the posttreatment RMSPE was calculated. For each treated unit, placebo SCM estimations were conducted for all control units. Based on the SCM analyses, the "proportion of placebos that have a ratio of posttreatment RMSPE over pretreatment RMSPE at least as large as the average ratio for the treated units" (16) was defined as a standardized p-value, referred to as the "joint post standardized p-value" (17). The joint post standardized p-values were used to judge the effectiveness of each treatment following Magness and Makovi (17). The SCM analysis results are displayed graphically to examine the effects of the treatment. All SCM analyses were implemented in Stata 17 (Stata Corp, College Station, TX, USA) using the synth (18) and synth_runner packages (16). We used the *nested allopt* option in the synth package following Magness and Makovi (17).

To check the robustness of the main analyses and estimate the effect of the #7119 service across prefectures, we conducted analyses based on the SDID method (10), which was developed by integrating the features of SCM and traditional difference-in-differences (DID) approaches. SDID accommodates a staggered DID analysis, enabling the estimation of overall treatment effects when the timing of initiation varies across treated units. Accordingly, the overall effect was analyzed, in addition to separate estimations for each treated unit. For SDID, available inference procedures include bootstrapping, jackknife, and placebo-based methods. As bootstrap and jackknife cannot be used when there is only one treated unit, placebo-based inference was employed in this study, except for the overall effect estimation, for which bootstrap inference was applied. Event-study plots for treated and control units after applying SDID weights were also included, following the approach of Clarke et al. (11). All analyses for SDID were performed using the 'sdid' command (11) with Stata 17. Statistical significance was set at $p < 0.05$.

## Results

# Basic statistics

Table 2 presents basic statistics for all 47 prefectures. Figure 1 shows trends in ambulance dispatches per 1,000 people for all prefectures from 1989 to 2022. Tokyo had the highest ambulance dispatches until 2005, but was surpassed by Osaka in 2006, one year before the first implementation of #7119 in Tokyo (Table 1). In 2022, Osaka continued to record the highest number of ambulance dispatches, with Tokyo ranking fifth (74.2 and 62.7 per 1,000 people, respectively). From 2006 to 2022, Tokyo experienced the smallest increase (13.4%), while Osaka saw a larger rise (31.3%).

Table 2
Basic statistics for each prefecture.

| Prefecture | #7119 initiation (year) | Annual ambulance dispatches per 1,000 people | | |
|---|---|---|---|---|
| | | 2006 | 2022 | 2022/2006 (percent change) |
| Hokkaido | 2013 | 39.0 | 57.1 | 46.4 |
| Aomori | | 28.7 | 46.0 | 60.0 |
| Iwate | | 31.0 | 46.0 | 48.1 |
| Miyagi | 2017 | 35.7 | 53.5 | 49.8 |
| Akita | | 31.8 | 48.6 | 52.8 |
| Yamagata | | 31.3 | 45.1 | 43.9 |
| Fukushima | | 33.6 | 49.8 | 48.0 |
| Ibaraki | 2018 | 35.3 | 52.3 | 48.5 |
| Tochigi | | 33.4 | 47.6 | 42.6 |
| Gunma | | 36.4 | 52.6 | 44.5 |
| Saitama | 2017 | 38.2 | 56.6 | 48.4 |
| Chiba | | 42.4 | 60.9 | 43.8 |
| Tokyo | 2007 | 55.3 | 62.7 | 13.4 |
| Kanagawa | 2016 | 43.8 | 61.5 | 40.5 |
| Niigata | 2017 | 33.8 | 51.6 | 52.5 |
| Toyama | | 29.7 | 48.6 | 63.6 |
| Ishikawa | | 29.1 | 45.4 | 55.6 |
| Fukui | | 28.5 | 42.4 | 48.5 |
| Yamanashi | | 37.4 | 54.3 | 45.1 |
| Nagano | | 35.9 | 51.9 | 44.6 |
| Gifu | | 34.8 | 50.6 | 45.6 |
| Shizuoka | | 36.0 | 50.9 | 41.5 |
| Aichi | | 38.7 | 52.7 | 36.2 |
| Mie | | 37.7 | 61.0 | 61.9 |
| Shiga | | 37.2 | 50.6 | 35.9 |
| Kyoto | 2020 | 44.4 | 62.0 | 39.8 |
| Osaka | 2009 | 56.5 | 74.2 | 31.3 |
| Hyogo | 2017 | 39.9 | 59.5 | 49.3 |

| Prefecture | #7119 initiation (year) | Annual ambulance dispatches per 1,000 people | | |
|---|---|---|---|---|
| | | 2006 | 2022 | 2022/2006 (percent change) |
| Nara | 2009 | 39.4 | 65.7 | 66.8 |
| Wakayama | | 43.7 | 61.0 | 39.5 |
| Tottori | 2018 | 35.8 | 53.3 | 49.0 |
| Shimane | | 34.4 | 51.3 | 49.1 |
| Okayama | | 36.6 | 52.9 | 44.4 |
| Hiroshima | 2019 | 39.0 | 53.4 | 36.9 |
| Yamaguchi | 2019 | 42.1 | 56.2 | 33.6 |
| Tokushima | 2019 | 34.5 | 53.4 | 54.7 |
| Kagawa | | 40.9 | 54.1 | 32.4 |
| Ehime | | 39.1 | 56.9 | 45.5 |
| Kochi | 2022 | 44.5 | 66.5 | 49.3 |
| Fukuoka | 2016 | 41.1 | 57.0 | 38.6 |
| Saga | | 34.3 | 52.0 | 51.5 |
| Nagasaki | | 35.3 | 56.6 | 60.4 |
| Kumamoto | | 38.5 | 57.1 | 48.3 |
| Oita | | 35.9 | 54.0 | 50.3 |
| Miyazaki | | 30.3 | 48.8 | 61.2 |
| Kagoshima | | 38.1 | 59.9 | 57.0 |
| Okinawa | | 39.9 | 63.0 | 58.1 |
| (Source) Portal Site of Official Statistics of Japan e-Stat (11, 12) | | | | |

Table 2. Basic statistics for each prefecture

[Table 2 here]

(Source) Portal Site of Official Statistics of Japan e-Stat (13, 14).

## Effects of #7119 on ambulance dispatches for each prefecture

In the main analyses using SCM, treatment effects could not be estimated for Tokyo, Osaka, and Kochi using the synth_runner procedure. This was likely due to Tokyo and Osaka being outliers with respect to ambulance dispatch volumes (Fig. 1), and to Kochi introducing the #7119 service in the final year of the observation period (Table 1). Estimation results for the remaining treated prefectures are shown in Table 3. The donor prefecture weights for each treated prefecture are presented in Supplementary Table 1. The joint post standardized p-values were not statistically significant for any treated prefecture (Table 3). Graphical comparisons indicate that treated

units and their synthetic controls were closely aligned during the pretreatment period and continued to show similar trajectories after treatment (Figs. 2 and 3). Overall, the SCM analyses provided no evidence of a reduction in ambulance dispatches associated with the introduction of the #7119 service.

Table 3. Effects of the #7119 service on ambulance dispatches per 1,000 people.

| Prefecture | Intervention Year | SCM | SDID | |
|---|---|---|---|---|
| | | joint post standardized p-value | ATT | 95% CI |
| Tokyo | 2007 | Not available | -6.58 | (-9.15 to -4.00) |
| Osaka | 2009 | Not available | 0.43 | (-1.50 to 2.36) |
| Nara | 2009 | 0.12 | 3.23 | (1.18 to 5.29) |
| Hokkaido | 2013 | 0.33 | 1.01 | (-0.51 to 2.54) |
| Kanagawa | 2016 | 1.00 | 1.91 | (0.73 to 3.09) |
| Fukuoka | 2016 | 1.00 | -0.46 | (-1.74 to 0.81) |
| Niigata | 2017 | 0.50 | -0.01 | (-1.36 to 1.33) |
| Miyagi | 2017 | 0.88 | -0.04 | (-1.47 to 1.38) |
| Hyogo | 2017 | 0.69 | 1.10 | (-0.25 to 2.45) |
| Ibaraki | 2018 | 0.68 | 0.68 | (-0.65 to 2.01) |
| Tottori | 2018 | 0.36 | 0.57 | (-0.87 to 2.01) |
| Hiroshima | 2019 | 0.48 | -0.42 | (-1.90 to 1.06) |
| Yamaguchi | 2019 | 0.76 | 0.08 | (-1.48 to 1.64) |
| Tokushima | 2019 | 0.40 | 0.57 | (-0.93 to 2.06) |
| Kyoto | 2020 | 0.67 | -0.61 | (-2.29 to 1.06) |
| Kochi | 2022 | Not available | 1.02 | (-0.80 to 2.85) |
| Overall | Not available | Not available | -0.27 | (-2.48 to 1.93) |

The joint post standardized p-values are placebo-based p-values derived from SCM (16, 17). “Not available” indicates that SCM estimation was infeasible for the corresponding prefecture.

SCM, synthetic control method; SDID, synthetic difference-in-differences; ATT, average treatment effect on the treated; CI: confidence interval.

SCM, synthetic control method.

The SDID estimation results are summarized in Table 3. A statistically significant decrease in ambulance dispatches was estimated for Tokyo (− 6.58; 95% confidence interval [CI]: −9.15 to − 4.00). Statistically significant increases were estimated for Nara (3.23; 95% CI: 1.18 to 5.29) and Kanagawa (1.91; 95% CI: 0.73 to 3.09). The overall staggered SDID estimate, shown in the bottom row of Table 3, indicated no statistically significant difference between treated and control units (− 0.27; 95% CI: −2.48 to 1.93).

The event-study plots for the SDID analyses (Figs. 4 and 5) indicate that pretreatment trends for Tokyo and Osaka diverged from those of their SDID control groups, suggesting an imperfect pretreatment fit for these prefectures. In particular, the event-study plots for Tokyo showed declining pretreatment trends relative to the control group, suggesting that the SDID estimate for Tokyo should be interpreted with caution. For the remaining prefectures, pretreatment trends appeared broadly similar between treated units and their SDID control groups, particularly in the periods immediately preceding the treatment, indicating an acceptable pretreatment fit.

SDID, synthetic difference-in-differences; CI, confidence interval.

## Discussion

This study examined the effects of #7119, an emergency telephone consultation service intended to reduce ambulance use in Japan, on ambulance dispatches per 1,000 people at the prefectural level using SCM and SDID. Overall, neither analysis provided evidence of a significant reduction in ambulance dispatches following implementation of #7119, with the exception of Tokyo in the SDID analysis. Although a significant decrease in ambulance use was estimated for Tokyo in the SDID analysis, the corresponding event-study plots showed declining pretreatment trends relative to the control group, suggesting that this estimate should be interpreted with caution.

The analytical framework and results of this study differ from those of the previous studies conducted in Japan. Morimura et al. (5) reported a significant drop in ambulance use in 2007, the first year when #7119 was introduced in Tokyo, compared to the previous year. However, the study by Morimura et al. has important limitations. First, it did not include a control group to compare trends in Tokyo against. Second, the decreasing trend in Tokyo's ambulance use started before the introduction of #7119. These limitations preclude a strong claim regarding the causal impact of #7119 on reducing ambulance use in Tokyo. Katayama et al. (4) examined the association between #7119 and unnecessary ambulance use in Osaka City. Their analyses differed from ours in that their outcome was unnecessary ambulance use instead of overall ambulance use and in that the study used propensity score matching with individual-level data.

The results of this study suggest that the #7119 telephone consultation service has little to no measurable impact on reducing ambulance use in most prefectures in Japan. One possible explanation is that individuals experiencing illness or injury can directly call 119, thereby bypassing #7119. In addition, ambulance transportation in Japan is free of charge, even for non-serious conditions. Although #7119 is intended to reduce inappropriate ambulance use, there is no requirement for individuals to consult #7119 prior to calling 119, which may limit incentives to use the consultation service rather than the emergency line.

Given the limited observed impact of #7119, additional measures may be needed to address the continuing increase in ambulance use. In this context, some Japanese regions, including Matsusaka City and Ibaraki Prefecture, have recently begun introducing fees for non-urgent ambulance use. While such measures may be more effective in curbing unnecessary ambulance dispatches, they may also risk deterring individuals from seeking necessary emergency care. Careful evaluation of both the potential benefits and unintended consequences of these policies will therefore be required.

This study has several strengths. First, newly developed causal inference methods, namely SCM and SDID, were employed, enabling the estimation of treatment effects using aggregated government data rather than individual-level data. Second, the use of publicly available data enhances transparency, accountability, and reproducibility.

Third, the graphical presentation of the estimation results facilitates interpretation of the findings by policymakers and other stakeholders.

This study had several limitations. First, prefectures in the control group may have implemented their own strategies to reduce ambulance dispatches that were not identified in this analysis. If such strategies did exist, the estimated effects of the #7119 intervention in this study may be underestimated. Second, although #7119 may provide additional benefits—such as free medical consultation for callers—beyond any reduction in ambulance dispatches, these outcomes were not evaluated in this study. Third, changes in the characteristics of patients transported by ambulance were not assessed. If #7119 led to a higher proportion of severe cases being transported to emergency medical facilities, this would represent an important benefit even if the overall number of ambulance dispatches was not reduced.

## Conclusions

Using SCM and SDID, this study found no clear evidence that Japan's emergency telephone consultation service (#7119) reduced ambulance dispatches in most prefectures. Additional measures may therefore be required to address the continuing increase in ambulance use.

## Declarations


# Declarations


**Ethics approval and consent to participate:**

Since this study used only publicly available data, ethical approval was not required.

**Consent for publication:**

Not applicable.

# Competing Interests:

The authors declare that they have no competing interests.


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This study was funded by the Research Institute of Economy, Trade and Industry, Japan. The institute played no role in the study design, data analysis, decision to publish, or manuscript preparation.


# Author Contribution

Y.S. designed the study, drafted the manuscript, performed the analyses, and interpreted the results.


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Not applicable.

**Use of artificial intelligence**: During the preparation of this manuscript, the authors used Copilot and Perplexity AI to improve language clarity and readability. All content was reviewed and edited by the authors, who take full responsibility for the final manuscript.

# Data Availability

The dataset supporting the conclusions of this study is shown in Supplementary Data (Additional File 2).

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## Figures

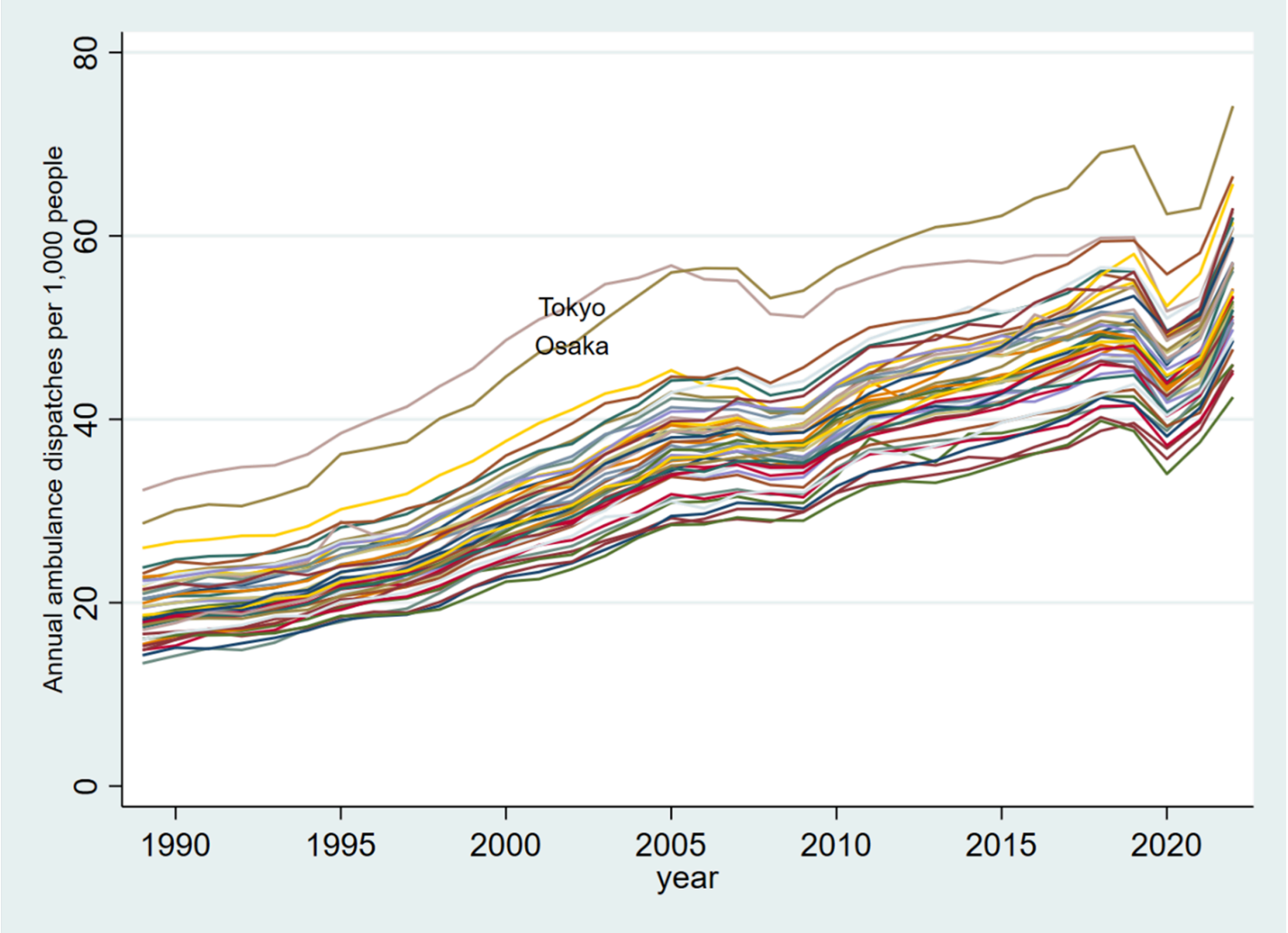



**Figure 1**

Annual ambulance dispatches per 1,000 people for all 47 prefectures.

(Source) Portal Site of Official Statistics of Japan e-Stat (13, 14).

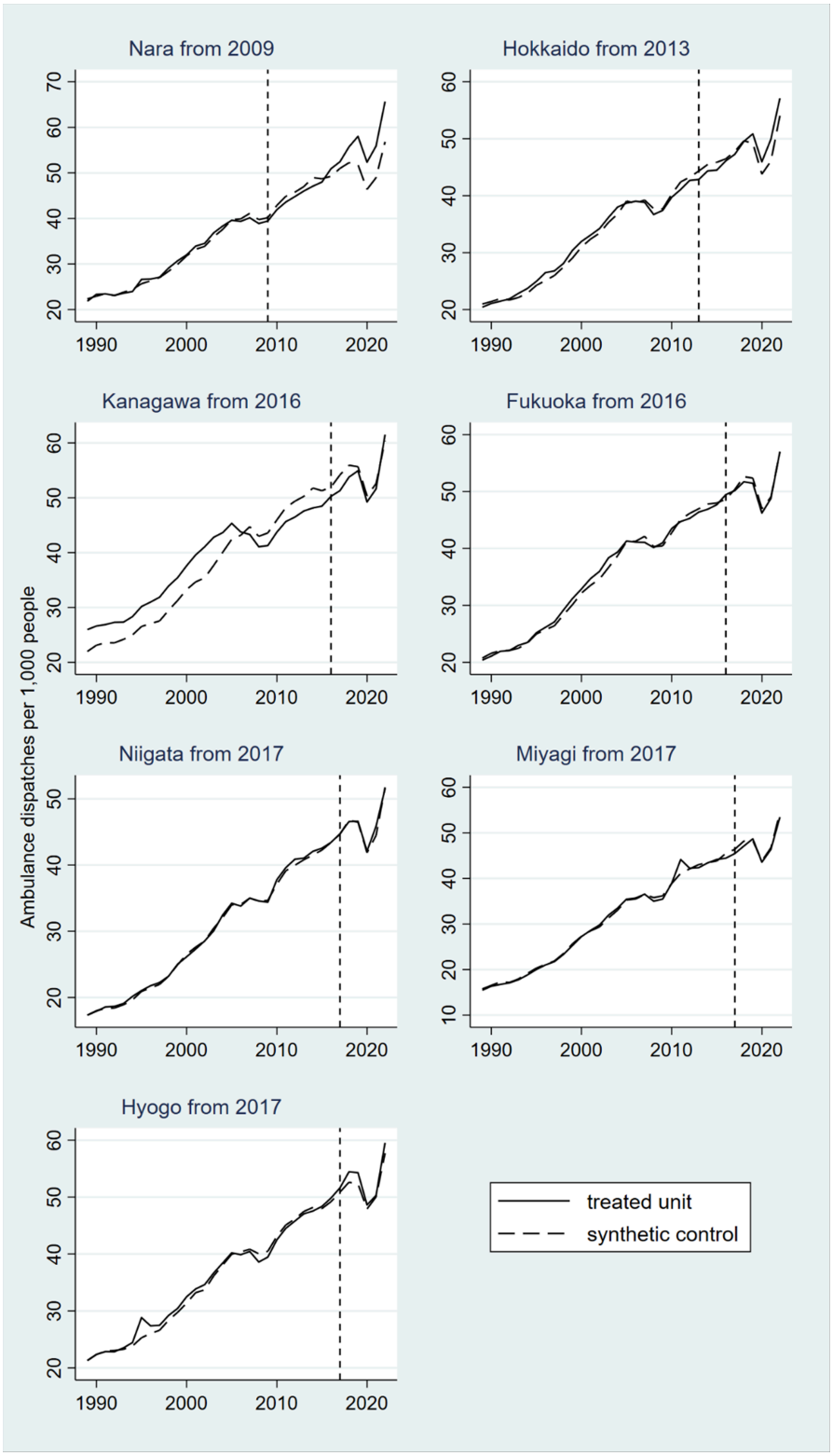



**Figure 2**

Estimated impacts of the #7119 service on ambulance dispatches in treated prefectures using synthetic control method (SCM).

SCM, synthetic control method.

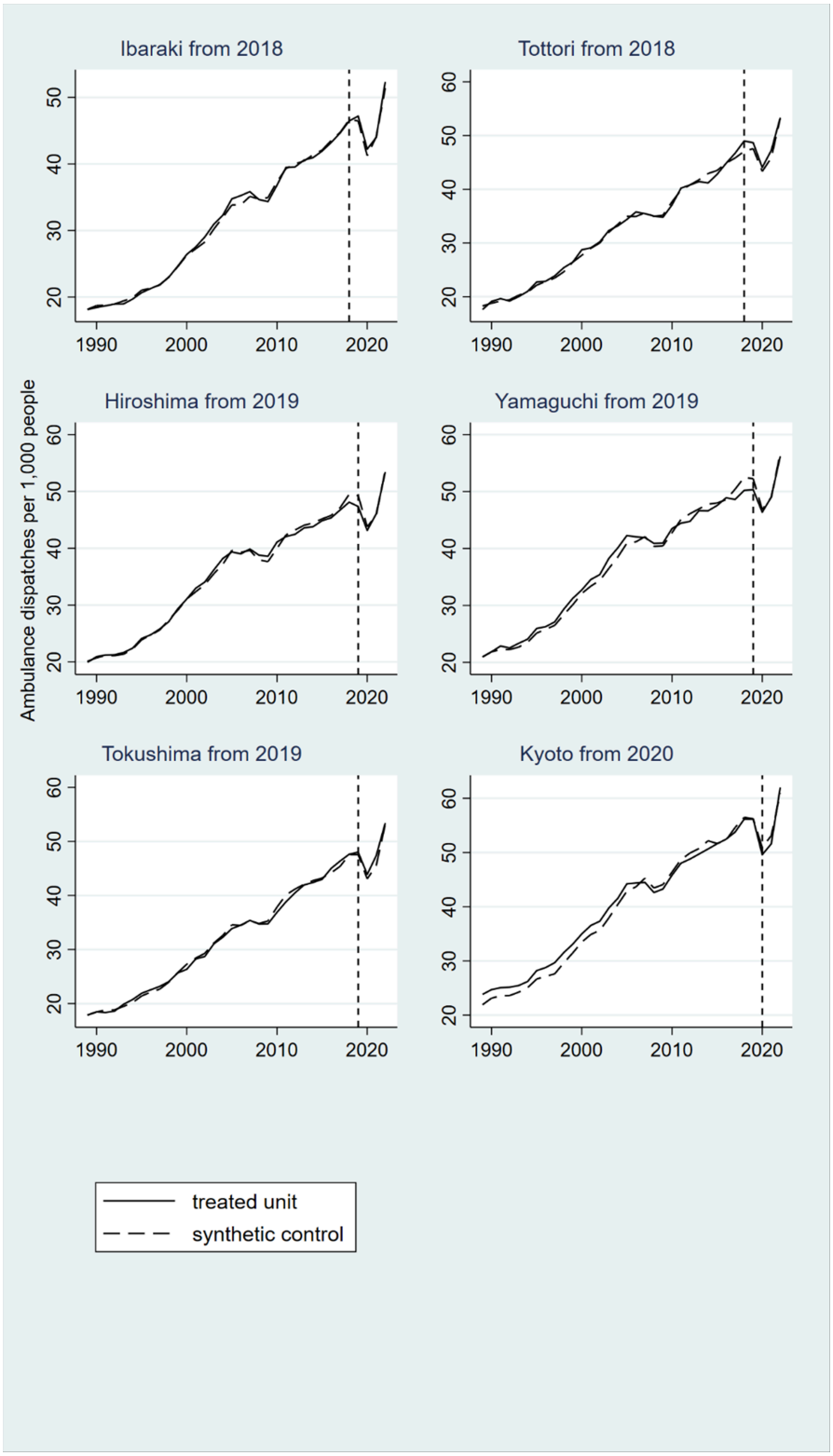



**Figure 3**

Estimated impacts of the #7119 service on ambulance dispatches in treated prefectures using synthetic control method (SCM) (continued).

SCM, synthetic control method.

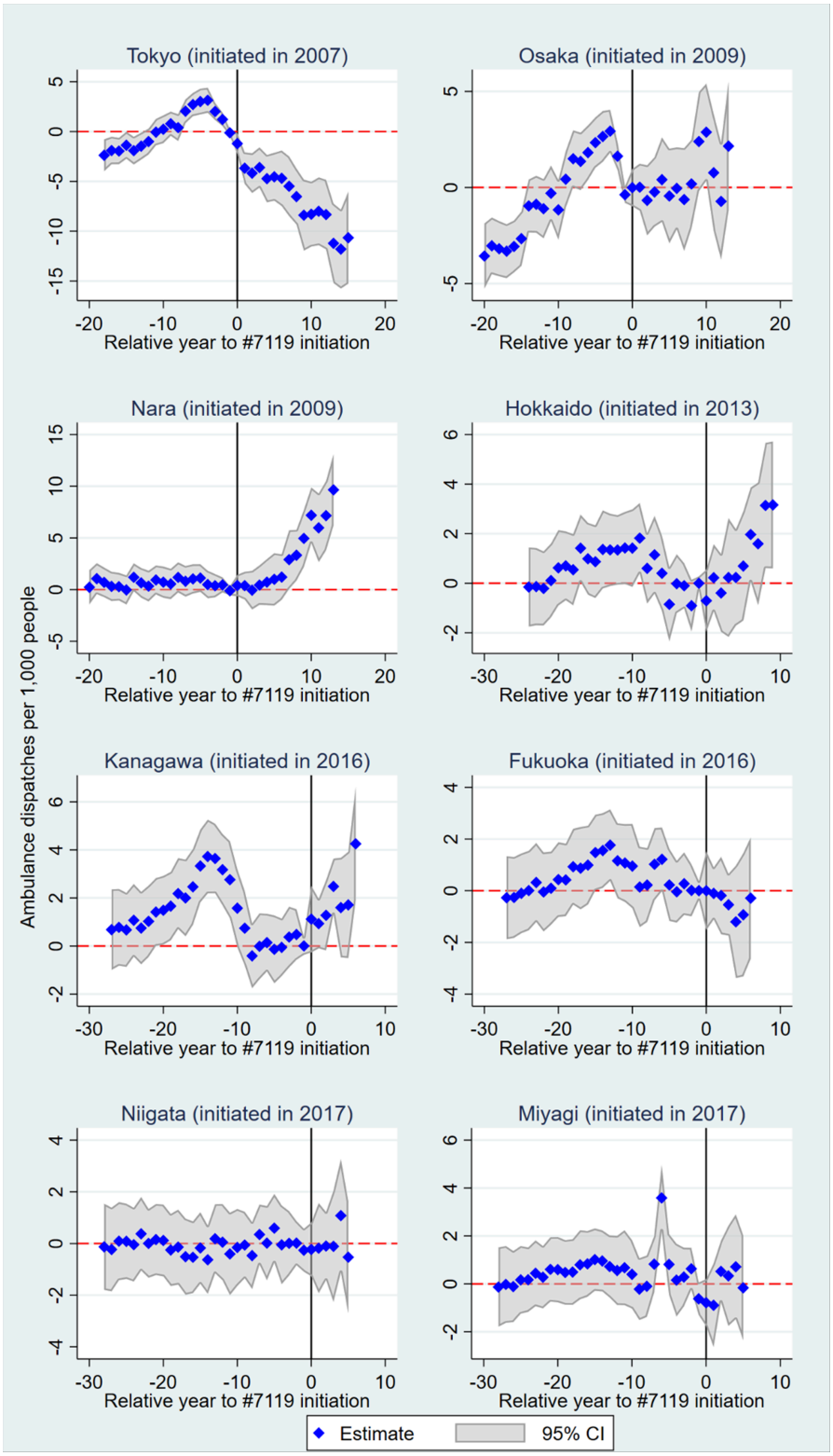



**Figure 4**

Event-study plots of the estimated impacts of the #7119 service on ambulance dispatches using synthetic difference-in-differences (SDID) method.

SDID, synthetic difference-in-differences; CI, confidence interval.

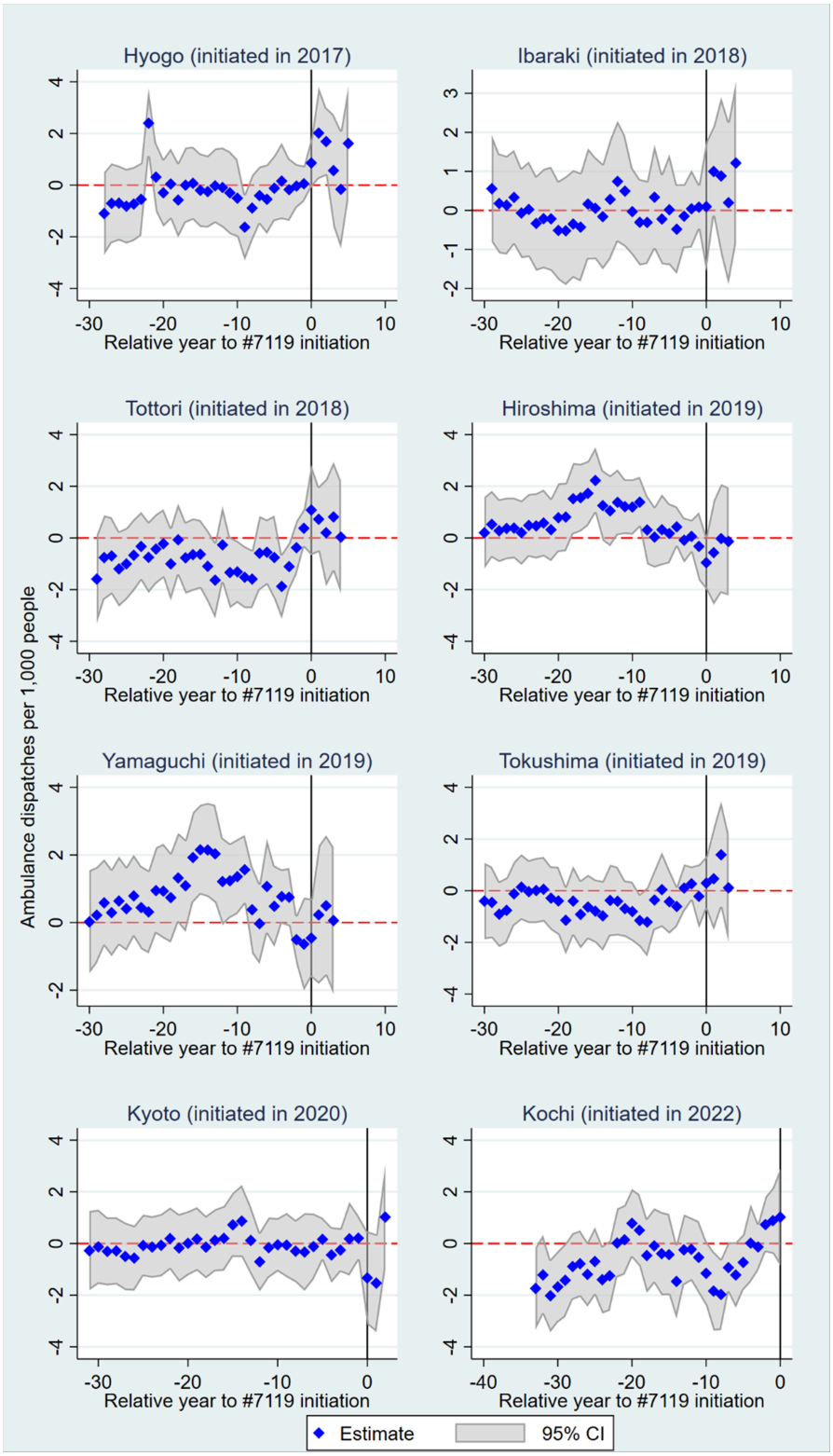



**Figure 5**

Event-study plots of the estimated impacts of the #7119 service on ambulance dispatches using synthetic difference-in-differences (SDID) method (continued).

SDID, synthetic difference-in-differences; CI, confidence interval.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryTable1.docx
- SupplementaryData.csv