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Do health checkup programs affect residents' health? Evidence from heterogeneous responses across local governments to the revision of national checkup policy in Japan

Masato Oikawa, Akira Kawamura, Takamasa Yamaguchi, Toshihide Awatani and Haruko Noguchi

Waseda INstitute of Political EConomy
Waseda University
Tokyo, Japan

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Masato Oikawa * Akira Kawamura † Takamasa Yamaguchi ‡
Toshihide Awatani § Haruko Noguchi ¶

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Abstract

This paper analyzes the effects of the expansion of the municipal per capita expense of health checkup programs due to the introduction of a health checkup policy in 2008 focusing on preventing lifestyle-related diseases (LRD) on residents' health outcomes and behaviors. Since the new policy required municipalities to provide a standardized checkup and guidance program, municipalities with lower per capita expenses before 2008 expanded their financial efforts on health checkup programs more than other municipalities. Using the regional variation, we regarded the municipalities with more considerable expansion as a treated group and the other municipalities as a control group, and implemented a difference-in-differences estimation. The estimation results show evidence of improving health outcomes among those treated after the policy revision, such as decreased outpatient visits due to LRD and decreased hospital admissions due to stroke, of which LRD is the major cause. Accompanied by the decrease in patients with LRD, the medical expenditure on outpatient visits due to LRD declined by 16.4 %. The treated group showed changes in health behaviors. A back-of-the-envelope calculation demonstrated that the decreased medical spending on LRD is worth increasing the municipal cost.

Keywords: health checkup; lifestyle-related diseases; health outcomes; health behaviors; cost-effectiveness
JEL Classifications: I10; I12; I18

*School of Education, Waseda University, Tokyo, Japan, and Waseda Institute of Social & Human Capital Studies (WISH), Tokyo, Japan, Email: masato.oikawa1991@gmail.com, m.oikawa@aoni.waseda.jp

†Faculty of Human Sciences, Waseda University, Saitama, Japan, and WISH, Tokyo, Japan, Email: akawamura@waseda.jp

‡WISH, Tokyo, Japan

§Department of Family Medicine, Kochi Medical School, Kochi, Japan, and WISH, Tokyo, Japan

¶Faculty of Political Science and Economics, Waseda University, Tokyo, Japan, and WISH, Tokyo, Japan, Email: h.noguchi@waseda.jp

1 Introduction

In the last few decades, both high- and middle-income countries have faced rapid population aging. Consequently, social security costs, including medical expenditure, erode the budgets of national and local governments, and the sustainability of these systems is being questioned. A significant cause of the financial burden is an increase in medical expenditure for non-communicable diseases associated with lifestyles, such as diabetes and high blood pressure. According to the World Health Organization (WHO), in 2014, approximately 422 million adults were estimated to have diabetes, and the prevalence was approximately 8.5 % of the world population (World Health Organization, 2016), which was nearly double compared to that in 1980. An estimate in the United States indicated that approximately 26.8 % of people aged 65 years and older had diabetes between 2013 and 2016 (US Department of Health and Human Services, 2020). Accompanied by the increase in the number of people having diabetes, the absolute global economic burden of diabetes in adults was estimated at 1.3 trillion USD in 2015, which corresponded to 1.8 % of the global GDP in 2015, and will increase to 2.1-2.5 trillion USD in 2030 (Bommer et al., 2018). In addition to the economic burden of lifestyle-related diseases, the current COVID-19 pandemic has revealed another health concern for patients with lifestyle-related diseases. These include high blood pressure and diabetes, a higher risk of disease aggravation, and death when COVID-19 infects them than those without the disease (for example, Ando et al., 2021; Holman et al., 2020; Tang et al., 2021). Decreasing the number of patients with lifestyle-related diseases is an important policy issue, not only to reduce the burden on the government's budget but also to protect people from the ongoing and next unknown pandemic.

As lifestyle-related diseases are not completely cured once people have them, the importance of preventive measures has recently received attention. For example, in the 2008, United States presidential election, candidates argued the importance of preventive health measures to control the increase in medical expenditure (Cohen et al., 2008), and the Affordable Care Act (ACA) of 2010, which placed a strong emphasis on public health and prevention, was enforced by the winner President Barack Obama (Chait and Glied, 2018; Chung et al., 2015; Obama, 2016).

Knowing our own health status through health checkup and screening programs, is important to prevent lifestyle-related diseases because the diseases are known as the "silent killer" so that patients with the diseases at an early stage or with high risk but not the onset, yet do not often have subjective symptoms. In many countries such as Austria (Hackl et al., 2015), China (Zhao et al., 2013), Japan (Fukuma et al., 2020; Iizuka et al., 2021; Inui et al., 2017; Kang et al., 2020; Oikawa, 2022), South Korea (Kim et al., 2019), and the United States (Alalouf et al., 2019; Jones et al., 2019; Oster, 2018), while economists have studied the effects of an exogenous variation in the ways of informing the current health status and the risks of behaviors faced by each individual, to date, there is no unified view of the effects.[1]

One possible cause for the mixed results is the nature of a regression discontinuity design (RDD) used in most previous studies. They applied an RDD focusing on a biomarker threshold for diagnosing health conditions, such as high blood pressure (Zhao et al., 2013), diabetes (Alalouf et al., 2019; Iizuka et al., 2021; Kim et al., 2019), hyperlipidemia (Kim et al., 2019), obesity (Kim et al., 2019), and waist circumference (Fukuma et al., 2020).[2] Although RDD is a powerful identification strategy in these contexts, the estimates often appear to be highly localized, with only a very short-term effect, and thus, myopic. The reasons for this are as follows. Using a biomarker threshold as a randomized assignment, these studies are limited to persons undergoing health checkups; therefore, the data must necessarily become self-selective. It is well known that people who voluntarily participate in checkups are more likely to be conscious of their health than those who do not (for example, Jones et al., 2019). The participants were informed not only about the diagnosis of diseases but also about the value of biomarkers. If participants know the biomarker threshold of a disease and are informed that their values of the biomarker are just below the threshold, they may change their behaviors to avoid the risk of having the disease. Therefore, the results of a series of previous studies based on RDD using the biomarker threshold should be the lower bound of the magnitude of the effect of health checkups or screening programs in absolute terms. If the results are conservative, we cannot identify the insignificant results as to whether the effects are either null or attenuated by people's strategic behavioral change. For further discussion of the effectiveness of health checkups or screening programs, we need to accumulate more evidence using not only the RDD but also the other empirical strategies, including the "never-taker" of health checkups.

In this backdrop, the objective of this study is to evaluate the total effects of health checkups or screening programs on health outcomes, medical expenditure, and behaviors rather than focusing on the specific role of the programs in informing each individual about their health status and risks. To this end, we utilize a unique identification strategy to introduce a new health checkup program entitled the Specific Health Checkups and Specific Health Guidance (SHC-SHG) in Japan in 2008 as an exogenous shock against municipal financial efforts. Japan has been experiencing the

[1]For example, some previous studies found evidence that knowing one's own health status through health checkup or screening programs would improve health outcomes (for example, Fukuma et al., 2020; Iizuka et al., 2021; Kim et al., 2019; Oikawa, 2022), whereas others found no such impact (for example, Alalouf et al., 2019; Hackl et al., 2015; Jones et al., 2019). For effect on health behaviors, for example, Kang et al. (2020), Oikawa (2022), Oster (2018), and Zhao et al. (2013) found statistically significant changes in health behaviors, while Alalouf et al. (2019), Jones et al. (2019), and Kim et al. (2019) did not.

[2]Since biomarkers are affected by various exogenous factors, such as the timing of the test, measurements just above and below a threshold are likely to be random. Thus, the effect of a diagnosis on subsequent health outcomes and behaviors is estimated around that threshold.

fastest population aging in the world and is facing an increase in medical expenditure on lifestyle-related diseases. Thus, to prevent diseases, the Japanese government introduced the SHC-SHG, focusing on people at high risk of diseases, for almost all residents aged 40 to 74. Although local governments have provided health checkup programs for residents since the 1980s, the financial efforts and menus of the programs largely differed across municipalities before 2008. The SHC-SHG required all municipalities to provide a standardized checkup and guidance program and also provided them with financial incentives to achieve better health outcomes for the eligible residents, which is discussed in detail in Section 2. Hence, depending on how many public resources they were spending before 2008, the incremental financial efforts to implement the new program would differ across municipalities. Using the regional variation in incremental efforts, we regarded the municipalities inevitable for the larger expansion of the per-capita expense of the health checkup programs as a treated group, and the other municipalities as a control group. We applied a difference-in-differences (DID) estimation to evaluate the effects of introducing the new program on various resident outcomes for people aged between 40 and 59 years.

Furthermore, this study provides evidence for the cost-effectiveness of health checkup and screening programs. Since not all preventive health measures, including health checkups or screening programs, are always cost-effective (Cohen et al., 2008), knowing the cost-effectiveness of the programs would be important for policymakers. However, only few studies have discussed this issue.[3]

In summary, our results show that an 11.2 % decrease in outpatient repeat visits due to lifestyle-related diseases as a whole and an 11.6 % decrease in hospital admissions due to stroke among treated municipalities after introducing SHC-SHG. Consequently, the medical expenditure spent on outpatient visits due to lifestyle-related diseases declined by 16.4 %. Furthermore, the proportion of residents with subjective symptoms decreased, and the residents changed their health-related behaviors. According to a back-of-the-envelope calculation of the increased cost and decreased medical expenditure due to the SHC-SHG, the amount of reduced medical spending is approximately six times larger than that of the increased cost.

The remainder of this paper is organized as follows. Section 2 describes the institutional background of the health checkup programs in Japan. Sections 3 and 4 explain the data and the estimation strategy, respectively. Sections 5 and 6 present and discuss estimation results. Finally,

[3] Iizuka et al. (2021) discussed the cost-effectiveness of the health checkup program in Japan and found that the improved health conditions due to the diabetes diagnosis are worth the increased medical spending on other preventive cares due to the diagnosis. Hackl et al. (2015) found some evidence for the cost-effective potential for the younger population, the people aged about 60 or younger, but did not for the older population. Kang et al. (2020) analyzed the effect of the health checkup program in Japan and found that the increased annual income due to a behavioral change aimed at improved health is worth the cost.

Section 7 concludes the paper.

2 Institutional Background

2.1 Japan's Health Checkup System

In Japan, health checkup programs are widely provided to middle-aged and older people as part of health promotion policies. First, the Industrial Safety and Health Act of 1972 requires all employers to provide a health checkup for their employees, regardless of their age, and salaried workers are obligated to take it. Virtually, most employees undergo a health checkup once a year in Japan.[4] Rather, in this study, we focused on the variations in health checkups provided by local governments.

For residents who are not salaried workers, such as the self-employed, and are aged over 40, local governments have provided health checkup programs since the 1980s. The Health and Medical Service Act for the Aged (HMSAA) legally requires municipalities to provide health checkup programs to residents aged over 40 years. Additionally, the residents were eligible for the health checkup provided as a duty of effort by municipalities based on the National Health Insurance Act (NHIA).[5] Whether mandatory or effort-based, the background of providing the health checkup by the local government is that municipalities administer the National Health Insurance system (NHI) for residents who are not covered by any other occupation-based health insurance system for employed people. There is a clear motivation for each municipality to conduct health checkups, such as maintaining and improving the health status of the insured and improving the financial soundness of the NHI administered by the local government. Accordingly, the Department of Health and Hygiene and the Department of NHI in each municipality oversee health checkup programs based on the HMSAA and NHIA, respectively.[6]

The content of health checkup programs varied depending on the implementing entity until the Specific Health Checkups and Specific Health Guidance (SHC-SHG), which is described in detail in the next section, was introduced in 2008. As discussed previously, the municipalities provided health checkup programs based on two laws, HMSAA and NHIA. The basic checkup program by the HMSAA includes approximately 20 general examinations, such as a medical examination for subjective and other symptoms, measurement of height and weight, and urine and blood tests. Examinations, such as a test for Hemoglobin A_{1c} and a 12-lead electrocardiogram,

[4]However, we notify that employees have no legal punishment although they do not undergo health checkups.

[5]The target population of health checkups based on the NHIA was following those on the HMSAA.

[6]The health checkup system in Japan prior to 2008 is summarized on the web page https://www.mhlw.go.jp/shingi/2005/07/s0725-7b01.html.

were implemented if a doctor in charge of health checkups was necessary. Health guidance was provided based on the results of the basic checkup program. This health guidance aimed to screen patients who were already in the early stages of the disease and treat them as early as possible. People with worse test values received health guidance, while those with much worse values were recommended to see a doctor.[7] For example, an individual with a systolic blood pressure value of > 160 mmHg was recommended to see a doctor, and those with a value between 140 and 159 mmHg received health guidance. Health guidance provided general information about the disease for which the individual was at high risk.

However, in addition to these, each municipality could provide extra programs based on the NHIA and the Health Promotion Act (HPA). Some municipalities provided extra checkup items in addition to the basic checkup program. Some municipalities also provided programs for people with a high risk of lifestyle-related diseases to encourage improvements in their lifestyle habits as the NHI Health Promotion Program (*Kokuho Health Up Jigyo* in Japanese) since 2002. Health guidance programs were similar to Specific Health Guidance, which will be explained later.[8] This could lead to differing contents of health checkup programs across municipalities.

Consequently, according to the Local Government Financial Survey, the per capita annual expense of public health services based on the NHIA varied, ranging from 0 to 4,211 JPY (Figure 1).[9] The mean per capita expense of NHIA-based public health services among the municipalities in the bottom 25% of its distribution was approximately 70% smaller than the mean of other municipalities. Additionally, the coefficient of variation (CV) of the per capita expense of the NHIA-based public health services was approximately 33% larger than the CV of the per capita expense of the commission fee of public health services by the health and hygiene departments

[7] https://www.wam.go.jp/wamappl/bb14GS50.nsf/0/98e6f3f836572e8b4925716f0006b833/$FILE/20060512siryou1-1.pdf(in Japanese)(accessed on December 14, 2022)

[8] For example, Inagi in Tokyo extracted individuals with a high risk of lifestyle-related diseases based on the results of the HMSAA basic health checkup program and recruited participants for a program aimed at improving eating habits and engaging in physical activity (https://www.fukushihoken.metro.tokyo.lg.jp/kensui/plan21/sinkouki.files/7.pdf, in Japanese, accessed on December 14, 2022).

[9] We calculated the average value of the per capita annual expense of public health services based on the NHIA within each municipality between 1995 and 2007, as given in Figure 1. Appendix A explains the details of the per capita expenses. We restricted the municipalities to cities and wards and excluded municipalities with high within-municipality variation (81 municipalities with the top 10 % of within-municipality variation) between 1995 and 2007.

of municipalities, including the health checkup programs based on the HMSAA.[10,11] The results suggest that the NHIA-based public health service could make the contents of municipal health checkup programs different.[12,13,14]

Despite these publicly provided checkup programs that have taken place annually for decades, in the early 2000s, people's health did not sufficiently improve. Specifically, according to the mid-term evaluation of the nationwide health promotion entitled "Health Japan 21" implemented in 2000, the incidence of lifestyle-related health conditions such as diabetes and obesity had increased. As a large proportion of public health expenditures contribute to the treatment of these diseases, the problems with health checkups were investigated and summarized in a Council of Governments' report.[15] First, to that point, the screening interventions were primarily targeted at patients who were already in the early stages of a disease, although screening is most effective for people with a high risk of a disease but who have not yet been screened (Schellenberg et al., 2013).[16] Second, the intervention is problematic and insufficient. For example, while Knowler et al. (2002) found that

[10]Most municipalities commissioned medical institutions to conduct health checkup programs based on the HMSAA. Therefore, the commission fee for public health services by the Health and Hygiene Department included the expense of health checkup programs based on the HMSAA. Unfortunately, because we cannot access the commission fee of public health services by the health and hygiene department directly, we estimated it using the annual supply and service expenses, including the commission fees, for the *health and hygiene services* and the ratio of commission fees to the supply and service expenses for hygiene services. Note that *health and hygiene services* are a sub-category of hygiene services. Appendix A explains the detail of the estimation.

[11]The CV of the per capita expense of the NHIA-based public health service is 0.554, and that of the per capita expense of the commission fee of public health services for the health and hygiene department of municipalities is 0.408.

[12]The budget reported by some municipalities provided insights for interpreting the difference in the per capita expenses of NHIA-based public health services. According to the reports, Suginami-ward in Tokyo Prefecture, whose per capita expense of the NHIA-based public health services was in the bottom 10% of its distribution, budgeted only the expense of managing the recreation facilities for the insured in 2007, while Kurayoshi-city in Tottori Prefecture, whose per capita expense was in the top 10%, did the expense for the comprehensive medical examination (*ningen dock* in Japanese) for the insured. Both Suginami-ward and Kurayoshi-city also budgeted health checkups for the health and hygiene department. This provided supportive evidence that municipalities with a relatively low per capita expense did not provide additional health checkup programs for their residents, while those with a relatively high per capita expense were provided.

[13]The health and hygiene department has also provided checkup and screening programs, such as cancer screening and dental checkups since the 1980s, and these were not affected by the SHC-SHG introduction.

[14]One could argue that the prices of each checkup program content were different across municipalities. For example, doctors in a municipality could have the political power to negotiate the prices with the municipality to increase those. We cannot deny the possibility that the difference in the per capita expense in Figure 1 included the price differences. However, if we can suppose that those municipalities' factors were constant over time in the sample period, the above possibility does not matter in the interpretation of the estimation results because we controlled the municipality-fixed effects.

[15]Further information (in Japanese) can be found in https://www.wam.go.jp/wamappl/bb14GS50.nsf/vAdmPBigcategory40/98E6F3F836572E8B4925716F0006B833?OpenDocument and https://www.mhlw.go.jp/shingi/2005/09/s0915-8.html.

[16]The Schellenberg et al. (2013) is a systematic review that finds no evidence that intervention is effective for those who already have type 2 diabetes, but is effective for those at high risk of getting it.

for those with a high risk of diabetes, interventions to help change lifestyle habits are more effective in preventing the onset of diabetes than medication, the health checkups merely provided those identified as high risk with general information about the disease and a recommendation to see a doctor. Third, the content of health checkups vary across municipalities under various local laws, as discussed above. Fourth, health guidance for high-risk populations after health checkups was not provided enough. Finally, some groups' participation rates are too low, such that self-employed workers, who are eligible to participate in checkups provided by local governments, have lower participation rates than salaried workers. Addressing these identified inadequacies of the existing health checkups thus requires a reform of the system to provide a substantial and uniform nationwide intervention targeting those at high risk of disease across all institutions.

2.2 Specific Health Checkups and Specific Health Guidance

In April 2008, a new health checkup program (SHC-SHG) was introduced, which aimed to prevent lifestyle-related diseases by providing participants with objective assessments of their health risks and specific guidance from health professionals. The SHC-SHG is based on the Act on Assurance of Medical Care for Elderly People, which is a revised version of the HMSAA. Although the previous checkup programs aimed at the prevention of lifestyle-related diseases, they focused on patients who were already in the early stages of the disease, the population being less effective by the interventions. However, SHC-SHG now focuses on metabolic syndrome, a condition represented by a confluence of biomarkers, including excess body fat, high blood pressure, and high blood sugar, which together identify people at high risk of lifestyle-related diseases (for example, Gami et al., 2007; Lakka et al., 2002; Mendrick et al., 2018). Therefore, the new policy screens the population for whom interventions for the prevention of lifestyle-related diseases are effective and implements health guidance interventions by professionals, which may increase the effectiveness of the health checkup program. The policy reform was introduced uniformly for individuals covered by public health insurance, including the NHI operated by municipalities and their dependents aged between 40 and 74.

The current program is divided into two parts: a health checkup to screen for participants at high risk for metabolic syndrome, followed by face-to-face guidance by a doctor, public nurse, or dietitian aimed at prevention by changing lifestyle habits. The content of the checkup is based on medical and scientific evidence for identifying metabolic syndrome and includes body measurements, blood tests, and questionnaires on topics such as smoking and medication histories. Because excess body fat is a marker of metabolic syndrome, a measure of abdominal girth was added to the new system to estimate the amount of visceral fat. Based on the health checkup results, an objective assessment of the risk of metabolic syndrome was determined. The participants then received health guidance specifically tailored to their physical condition. Those at high risk are given health guidance about their lifestyle habits, aimed at informing participants of the benefits and risks of their lifestyle habits and providing support to change behavior. In the SHC-SHG, health guidance is more widely provided for high-risk populations of lifestyle-related diseases than in previous health checkup programs. The new policy provides checkup participants with objective knowledge of the risks associated with their health condition and specific information about the benefits and risks of their health behaviors.

Health insurance insurers are required to provide a new health checkup system. In the case of municipal health checkups, the department of the NHI now has the responsibility to provide checkups, while before the new system was introduced, the department of the health and hygiene of municipalities mainly had the responsibility. The Ministry of Health, Labour and Welfare of Japan (MHLW) provides insurers with guidelines for health checkups and guidance to standardize the contents among insurers, which could fill the gap in checkup program contents.

The SHC-SHG provides insurers with financial incentives to achieve better health outcomes for those eligible to undergo checkups. The central government imposes some numerical targets on insurers related to their insured population's health, such as the higher participation rates in health checkup and health guidance and the lower rate of people with metabolic syndrome. The SHC-SHG's incentive for insurers is that the amount of financial support to the medical care system for the latter-stage elderly obligated for all insurers increases or decreases depending on the attainment of the numerical targets.[17] In other words, an insurer with low attainment of numerical targets must pay more financial support than that with high attainments.[18] This incentive scheme aims to improve the low participation rate in health checkups among some groups, resulting in an improvement in participants' health outcomes.[19] If an insurer does not provide enough effort to its insured population's health, the insurer has a strong incentive to raise the effort due to the introduction of the SHC-SHG. Since we had access to the data on the municipal expenses for public health services, including health checkups, we analyzed municipal responses to the introduction of the SHC-SHG and their effects on residents' health outcomes and behaviors.

[17] A summary of the medical care system for the latter-stage elderly is available at https://www.mhlw.go.jp/english/wp/wp-hw3/dl/2-003.pdf (accessed June 7, 2022).

[18] This incentive scheme was implemented in 2013.

[19] A summary of SHC-SHG is available at https://www.mhlw.go.jp/english/wp/wp-hw3/dl/2-007.pdf (accessed on June 7, 2022).

3 Data

This section briefly discusses the three datasets used in the analysis, the sample restrictions, and the descriptive statistics.

3.1 Patient Survey

The Patient Survey is a triennial, nationally representative survey conducted by the MHLW. We used data from 1999 to 2017 (seven survey years). The employees of hospitals and clinics in charge of the survey responded to the survey, not to the patients themselves. The Patient Survey consists of six sub-surveys. Of these, we used three sub-surveys: a survey on outpatient visits in hospitals, a survey on hospital admissions in hospitals, and a survey on outpatient visits and hospital admissions in clinics.[20] Medical institutions were selected using stratified random sampling. The stratification of the survey on outpatient visits in hospitals and the survey for clinics was based on the prefecture, and that of the survey on hospital admissions was based on the secondary medical area.[21] The patients who used the sampled institutions on one day were designated for each institution during a three-day period in mid-October. Note that, for the sampled hospitals, the survey was conducted for selected patients by birthday to reduce the hospital's load for the survey.[22] All patients were surveyed in the clinics.

The Patient Survey collects the patients' gender and birthday, type of outpatient visit (first or repeat visits), the reason for outpatient visit (e.g., diagnosis or treatment for injuries and illnesses, health checkups, and vaccination), name of the primary injury or illness based on the International Classification of Diseases (ICD-10), and way of payment, which can identify the type of health insurance for the patients. Using the Patient Survey, we aggregated the number of outpatient visits by municipality and year, and constructed municipality-level panel data. We also constructed municipality-level panel data on hospital admissions. We used the number of outpatient visits and hospital admissions as the outcome variables in the analysis. To construct municipality-level panel

[20]In Japan, a medical facility with 20 or more beds are defined as a "hospital" and the one with less than 19 beds as a "clinic. As of 2022, 6.1% (6,303) of the total number of clinics (102,612) had beds and the rest (96,309) did not, according to the 2020 Summary of Survey of Medical Institutions and Hospital Reports (https://www.mhlw.go.jp/toukei/saikin/hw/iryosd/20/dl/09gaikyo02.pdf)(in Japanese)(accessed on December 7, 2022).

[21]A secondary medical area is defined as an area that includes multiple municipalities that can provide adequate inpatient care to people living in that area. The number of secondary medical areas in April 2016 was 344.

[22]For the hospital survey, the patients were sampled according to the following rules: for hospitals with less than 500 beds, patients with an odd ending day of birth were sampled; for hospitals with 500-599 beds, patients whose ending day of birth was one, three, five, or seven; and for hospitals with 600 beds or more, patients whose ending day of birth was three, five, or seven.

data, we have to consider issues such as frequent municipal mergers in the 2000s[23] and the unknown residential addresses of patients. This is explained in detail in Appendix B.

3.2 Statistics of Medical Care Activities in Public Health Insurance

The Statistics of Medical Care Activities in Public Health Insurance (SMCA) survey is a nationally representative annual survey conducted by the MHLW. The SMCA collects the medical claim data for the patients who used hospitals and clinics in June of the survey year using a two-stage stratified random sampling; first, medical institutions are sampled from all medical institutions in Japan, and medical claims are sampled from the sampled medical institutions. Therefore, we had access to data such as the patient's status with injuries and illnesses in that month. In the SMCA, we can use the monthly expenditure on healthcare services covered by health insurance, which is not available from the Patient Survey. Using the SMCA, we aggregated the number of patients who visited medical institutions and the total expenditure on healthcare services by municipality and year, and constructed municipality-level panel data in the same manner as in the Patient Survey. We used the SMCA from the eleven years between 1999 and 2010 because the data were available up to 2010.

3.3 Comprehensive Survey of Living Conditions

The Comprehensive Survey of Living Conditions (CSLC) is a nationally representative repeated cross-sectional survey conducted by MHLW every three years. The respondents were sampled by stratified random sampling all over Japan for each survey year. The survey collected data on demographic characteristics, such as age, gender, marital status, type of residence, and prefectures where respondents live, and health-related characteristics, such as the status of subjective symptoms, status of health checkups, type of health insurance, and lifestyle habits. Health-related variables were used as outcomes. We merged this individual-level repeated cross-sectional data with municipality-level public health service expense per capita. The CSLC data from the six survey years from 2001 to 2016 were used for the analysis.

Note that we can directly use information on the municipality where a respondent lives only for respondents living in government ordinance-designated cities (*Seirei Shitei Toshi* in Japanese), which was 12 as of 2001. Fortunately, we can identify other large municipalities with more than 150 thousand residents than the *Seirei Shitei Toshi* by a variable–the type of municipality. We identified 19 large municipalities throughout the six survey years. Additionally, since we could

[23]The results showed that municipalities decreased by approximately 45% between April 2000 and March 2009. Change in the number of municipalities can be seen using https://www.soumu.go.jp/main_content/000651406.pdf (in Japanese)(accessed on June 1, 2022).

identify whether a respondent lived in the 23 special wards of Tokyo but could not identify the exact wards' names, we regarded the 23 special wards of Tokyo as one municipality in the analysis. Finally, we identified 32 municipalities throughout the six survey years. The 32 municipalities are sparsely located in Japan[24] and as of 2007, covered approximately 27% of the population in Japan.

3.4 Sample Restriction

We restricted the analysis sample to cities and wards with relatively large population sizes. Thus, 813 of the 1,741 municipalities were left in the final analysis. Since towns and villages have a relatively small number of medical institutions,[25] residents of towns and villages may visit medical institutions outside their resident municipalities. To reduce the possibility of cross-border outpatient visits, we implemented the above sample restrictions. We also excluded municipalities with high within-municipality variation in the per capita expense of public health services based on the NHIA in 2007 or earlier.[26] After implementing the above sample restrictions, municipality-level panel data were constructed for 732 municipalities for the Patient Survey and SMCA and 31 municipalities from the CSLC.

In the analysis, we focused on insured persons aged 40-59 by NHI, who are the primary targets of municipal public health services. Since health checkups by the local governments have been provided to residents aged 40 and older, we set the age of 40 as the lower limit of the sample restriction. In general, the age of 60 is a mandatory retirement age, particularly for employees, who have been legally guaranteed since 2013 to continue working at the same company if they want to. Now, let us suppose that those who retire in response to the mandatory retirement age of 60 are less healthy than those who continue to work. After retirement, the type of health insurance changes from employee health insurance to NHI. In this case, the characteristics of the individuals who joined the NHI discontinuously changed from the age of 60 years. To eliminate this possibility, we restricted the sample to those aged between 40-59.

3.5 Descriptive Statistics

Table 1 shows the summary statistics of the municipality-level panel data. We focused on lifestyle-related diseases as the main outcome because the SHC-SHG aims to prevent these diseases. For the

[24]Please see Figure C.1.

[25]According to the 2017 Survey of Medical Institutions, the average number of medical institutions in 2017 was approximately 116, 461, 10, and 3 for cities, wards, towns, and villages, respectively.

[26]We calculated the standard deviation of the per capita expense of the public health service based on the NHIA within each municipality in 2007 or earlier and excluded the top 10% of municipalities from the distribution of the standard deviation.

Patient Survey, we aggregated the number of outpatient visits due to high blood pressure (I11-I15), diabetes (E10-E14), and hyperlipidemia (E78.5) as measures of outpatient visits due to lifestyle-related diseases (Panel A). Among those insured by the NHI aged between 40-59, the average number of cases for outpatient visits due to these lifestyle-related diseases on a day in mid-October was 6.72.[27] Almost all outpatient visits were repeated visits (0.27 and 6.45 for the first and repeated visits, respectively). The number of cases for first outpatient visits is a good indicator to assess the effectiveness of SHC-SHG in screening high-risk populations for lifestyle-related diseases because those with a high risk are encouraged to visit medical institutions to undergo health guidance, which could increase the number of cases. However, the number of repeat visits could be a more plausible measure to evaluate the validity of health guidance for those with mild symptoms, as health guidance could improve their health condition, resulting in a decrease in the frequency of outpatient visits. Since high blood pressure and diabetes are key causes of major adverse cardiovascular events, such as stroke and myocardial infarction, we also focused on stroke and myocardial infarction. The numbers of cases of hospital admissions due to stroke (I60-I63) and that myocardial infarction (MI)(I21-I24) are 1.68 and 0.11, respectively. However, we used only hospital admissions due to stroke for the estimation because there were too few MI cases. We also generated the number of cases for outpatient visits due to injuries (S00-S99), which are considered to be less related to SHC-SHG. The average number of outpatient visits due to injuries was 1.58 on a day in mid-October.

In the SMCA, we focused only on high blood pressure and diabetes as lifestyle-related diseases because we could not identify hyperlipidemia in the SMCA (Panel B). Among those insured by the NHI aged 40-59, the average number of cases for outpatients at least once in June was 2.7, and the average expenditure was 32,245 JPY. Panel C of Table 1 shows the summary statistics of other municipality characteristics such as population, financial index, and measures of medical resources.

Table 2 shows the summary statistics of the health-related variables from the CSLC. We have data on subjective symptoms and health behaviors or lifestyle habits, such as health checkups, smoking cessation, exercise, drinking, and eating habits. However, the survey years in which the data were available differed across variables. The data on subjective symptoms, health checkups, and smoking cessation are available for all six survey years, while other variables are available for only three years: 2001, 2013, and 2016.

As discussed in Section 2, one of the major objectives of introducing the SHC-SHG is to unify the contents of health checkup programs, which varied largely across municipalities in the pre-SHC-SHG era. To this end, therefore, municipalities with fewer contents than the SHC-SHG's standardized program and a low expense of the health checkup program in pre-SHC-SHG periods

[27]Note that the actual number of cases could be larger than the aforementioned number because not all patients were sampled for the hospital survey.

must raise their expenses, while those with almost the same or more adequate program than the standardized one; thus, high spending of the program in pre-SHC-SHG periods would not need to increase their expenses. In other words, the change in the municipal expense of the health checkup programs before and after the SHC-SHG ought to be heterogeneous, depending on the spending of health checkup programs in the pre-SHC-SHG era.

If there are heterogeneous changes in per capita expenses due to the change in the health checkup program menu, we could use the variation to identify the causal effect of the policy introduction on residents' health and behaviors. To examine whether this hypothesis is plausible, we compared the change in the per capita expense of public health services based on the NHIA across municipalities, where per capita expense in the pre-SCH-SHG era was in the bottom 25% of its distribution with other municipalities with the one above the bottom 25%.

Table 3 shows the average per capita expense of public health services across the two groups–the bottom 25% versus others – and the differences before and after the SHC-SHG were introduced. Columns (1) and (3) show the per capita expenses of public health services based on the NHIA before and after SHC-SHG, respectively. Column (1) shows the per capita expense calculated from the expense of public health services spent by the Department of NHI in the pre-SHC-SHG era. However, the values in Column (1) are underestimated and unfair when compared to those in the post-SHC-SHG era because, before the SHC-SHG, both the departments of health and hygiene and NHI in municipalities were in charge of the health checkup programs. Therefore, we have to sum up the expenses of public health services by both departments to capture the per capita expense of health checkup programs (Column (2)).[28] According to Appendix A, after the policy was introduced, only the department of NHI was responsible for the health checkup, and most of the expenses of the public health services based on the NHIA were spent on the SHC-SHG so that we could regard the per capital expense of the public health services by the department of NHI as one of the health checkup program (Column (3)). Column (4) shows the difference between Columns (2) and (3) and Column (5) shows the percentage change between the two columns.

According to Table 3, the estimated per capita expense of health checkup programs among the bottom 25% of municipalities was about 31.5% smaller than that of the other municipalities before the SHC-SHG (2,422.1 JPY versus 3,538.9 JPY), and the magnitude of the difference became approximately 7.6% after the SHC-SHG (4,488.7 JPY versus 4,855.1 JPY), which corresponds to less than one-fourth of that before the policy was introduced (Columns (2) and (3)). The result implies that the SHC-SHG makes the gap in health checkup program contents among municipalities smaller. On average, the estimated per capita expense of the health checkup programs increased by

[28]The details of the estimation of the per capita expense of the health checkup programs by the health and hygiene department are in Appendix A.

approximately 46.1% after the SHC-SHG was introduced.

The magnitude of the increase depended on the level of per capita expenses in the pre-SHC-SHG period. Among the bottom 25% of municipalities, after the SHC-SHG was introduced, the estimated per capita expense of the health checkup programs increased by 2066.6 JPY, which corresponds to an 85.3% increase compared to that before the SHC-SHG. The magnitude of the increase in the bottom 25% is approximately 129% larger than that of the other municipalities (85.3% versus 37.2%). This implies that municipalities with a lower per capita expense of the health checkup program in pre-SHC-SHG periods must increase their expenses of the program more than those with higher expenses in the same periods.[29]

4 Identification Strategy

The basic idea of the identification strategy is to use the variation in the change in the per capita expense of health checkup programs before and after the SHC-SHG was introduced. As discussed in Section 3.5, on average, the expense of health checkup programs expanded in the post-SHC-SHG periods. This expansion may change residents' behaviors to improve their health conditions. Additionally, the magnitude of the expansion depends on its level before the SHC-SHG, which may lead to the heterogeneity of the residents' health improvement; among the bottom 25% of municipalities before the policy introduction with the larger expansion, their residents' health may improve more than those among the other municipalities. We regarded the bottom 25% of municipalities as a treated group and the others as a control group, and compared the before-after changes between the two groups, that is, a difference-in-differences (DID) estimation.[30]

We confirmed the differences in municipal characteristics in 2005, and municipal characteristics in the pre-SHC-SHG period were not significantly different, except for the total population. Table 4 summarizes the municipal characteristics in the pre-SHC-SHG period in 2005 by treatment

[29]One may argue that before the SHC-SHG, the total expenses related to the health checkup programs were the same across the municipalities. Let us suppose that the total expenses related to the health checkup programs were the same across the municipalities, but that some municipalities budgeted more for the health and hygiene department than for the NHI department and others budgeted more for the NHI department. This could result in heterogeneity in the per capita expenses of NHI-based public health services. If this is the case, the per capita expense of the health checkup programs based on the NHIA ((by the NHI department)) and that based on the HMSAA (by the health and hygiene department) should be negatively correlated. We confirmed this possibility using the per capita expense of public health services based on the NHIA and the per capita commission fee for public health services conducted by the health and hygiene department. However, we did not have access to both per capita expenses of the health checkup programs directly. According to Figure C.2, there is no statistically significant correlation between the two variables after adjusting for prefecture fixed effects.

[30]We implemented a robustness check of the threshold and found that the estimation results were robust against the threshold when we used outpatient visits as outcome variables (Table C.3).

status. Columns (1) and (2) show the means of municipal characteristics for the control and treated municipalities, respectively. Column (3) shows the differences between Columns (1) and (2), and Column (4) shows the differences after controlling for prefecture-fixed effects. We also controlled for the logged municipal population, except in the first row (municipal population).

The treated group had a much larger population than the control group, suggesting a need to control the population in the analysis. The demographic composition and accessibility to healthcare services were not significantly different between the two groups after we controlled for population and prefecture fixed effects, while the treated group had 4.7 % fewer elderly people aged 75 years than the control group. The treated group is statistically richer than the control group at the 10% significance level, as measured by the financial index, with a magnitude of 6.0%. We also add other municipal characteristics, such as the financial index, to the estimation models.

An important assumption for causal interpretations of the DID strategy is the common trend assumption, namely that the counterfactual change in outcomes among the "bottom 25%" municipalities and others must have been the same if policy reform had not occurred. The typical means of testing for this assumption is to check the trends in target outcomes before the reform. In this study, we employed event studies to confirm whether the trends in target outcomes before the reform were statistically different between the "bottom 25%" municipalities and the others. In Section 5, we discuss the model specifications and the results of event studies.

We implemented two types of placebo regression. One is to use a variable that is less related to the SHC-SHG as the dependent variable. As discussed, since SHC-SHG focuses on lifestyle-related diseases, the health outcome variables related to the diseases should be less affected by the policy introduction. The other is to use people insured by employees' health insurance (EHI) for the analysis.[31] Since the municipal health checkup programs are for the residents insured by the NHI, not those insured by the EHI, the people insured by the EHI should be less affected by the expansion of the municipal expenses for the health checkup programs.

Note that, even when the common trend assumption holds, we need to carefully interpret the DID estimates because the control group also expanded public health services in response to the policy introduction, as seen in Table 3. In other words, this DID strategy compares changes in outcome variables between groups with high and low treatment intensities. This can lead to the estimated effects being lower than the true treatment effects on the treated group in absolute value if the signs of the effects are the same between the treated and control groups. We suspect that the expansion of health checkup programs improves residents' health outcomes but does not aggravate

[31] The EHIs cover healthcare services not only for insured people but also for their dependents. In these placebo regressions, we used only the insured themselves because, in some cases, the insurers of the EHI entrust the provision of health checkup programs for dependents to municipalities where dependents live.

them, although we cannot eliminate the possibility that there are no effects due to insufficient policy content. Therefore, it is plausible to interpret the DID estimates as the lower bounds of the policy introduction effects.

4.1 Estimation Model for The Municipality-Level Panel Data

The estimation equation for the analysis using municipality-level panel data was as follows:

$$y_{jpt} = \alpha_0 + \alpha_1 T_j + \alpha_2 After_t + \alpha_3 T_j \times After_t + x'_{1jt}\delta_1 + \mu_{1pt} + \eta_{1j} + \phi_{1t} + u_{1jt}, \tag{1}$$

where j and t are the indices of municipality, prefecture, and year, respectively. The dependent variable y_{jpt} represents health outcomes, such as the number of outpatient visits due to lifestyle-related diseases, from the Patient Survey. The variable T_j takes one if the municipality's public health services expense per capita in the pre-treatment period is in the "bottom 25 %". In other words, the variable indicates the municipality that considerably increased public health services expense per capita in the post-SHC-SHG era. The dummy variable $After_t$ takes the value one after 2008, the year when SHC-SHG was introduced. The vector x_{1jt} is a set of control variables that includes the logged municipal total population, the logged municipal population by five-year age group (40-44, 45-59, 50-54, 55-59, 60-64, 65-69, and 70-74), the logged financial index, the number of beds in municipalities, the number of medical institutions in municipalities, the ratio of hospitals to total medical institutions (hospitals + clinics) in municipalities, the number of medical institutions per capita, the number of beds per capita, and linear trends of municipalities by the level of the per capita expense of the public health services based on the NHI before 2008 (above v.s. below median). Parameters μ_{1pt}, η_{1j}, and ϕ_{1t} are year-prefecture fixed effects, municipality fixed effects, and year fixed effects, respectively. Parameter u_{1jt} is an error term. In Equation (1), the parameter α_3 corresponds to the DID estimate and is the parameter of interest in this study. This parameter captures the difference in the change in the outcome variable between municipalities with a considerable expansion in public health services and others.

4.2 Estimation Model for The CSLC

The estimation equation for the analysis using CSLC is as follows:

$$y_{ijrt} = \beta_0 + \beta_1 T_j + \beta_2 After_t + \beta_3 T_j \times After_t + x'_{2ijt}\delta_2 + \mu_{2rt} + \eta_{2j} + \phi_{2t} + u_{2ijt}, \tag{2}$$

where i, j, r, and t are the indices of individuals, municipalities, regions, and years, respectively. The dependent variable y_{ijrt} represents health outcomes and behaviors such as the subjective symptoms dummies by body part, the health checkup dummy, the quitting smoking dummy, the drinking dummy, the regular exercise dummy, and the eating habit dummies. The variables T_j and $After_t$ have the same definitions as those in Equation (1). Vector x_{2ijt} is a set of control variables that includes individual characteristics and municipality-level characteristics. We used age dummies, gender dummy, dummy indicating the number of household members, and marital status dummies (married or having a partner (base), never married, widowed, divorced). We also used the triple cross term of the big city (government ordinance-designated cities and Tokyo's 23 special wards) dummy, house type dummies (one's own house (base), private rental housing, company housing, public rental housing, and others), and the number of rooms with the first- and second-order terms to control for the economic conditions of the household to which the respondents belong. We used the logged municipal total population, the logged municipal population by age group (40-49, 50-59, and 60-74), the logged financial index, the number of beds in municipalities, the number of medical institutions in municipalities, the ratio of hospitals to total medical institutions (hospitals + clinics) in municipalities, the number of medical institutions per capita, the number of beds per capita, and linear trends of municipalities by the level of the per capita expense of public health services based on the NHI before 2008 (above vs. below median) as municipality level characteristics. Additionally, the model includes the logged prefecture unemployment rate and the region-year fixed effects (μ_{2rt})[32] instead of year–prefecture fixed effects. This is because, in many cases, municipalities and prefectures have a one-to-one relationship in our sample because of the method used to identify the municipalities for the CSLC, which makes it difficult to identify the prefecture-year fixed effects and the DID term. Parameters η_{2j} and ϕ_{2t} are the municipality fixed effects and year fixed effects, respectively, and parameter u_{2ijt} is an error term. In Equation (2), the parameter β_3 corresponds to the DID estimate and is the parameter of interest in this study.

5 Results

5.1 Common Trend Assumption

First, we demonstrate the validity of the common trend assumption using an event-study model. Figure 2, 3, and 4 summarize the results of the event study model for outpatient visits, hospital admissions, medical expenditures, subjective symptoms, and health behaviors. For health behaviors

[32]The regions are defined as Hokkaido, Tohoku, Kanto-I, Kanto-II, Hokuriku, Tokai, Kinki-I, Kinki-II, Chugoku, Shikoku, Kita-kyusyu, and Minami-kyusyu.

in CSLC, as discussed in Section 3.5, data on exercise, drinking, and eating habits are available only for 2001, 2013, and 2016. Therefore, we conducted the event study only for subjective symptoms, health checkups, and smoking cessation, which were available for all the six survey years. Figure 2 shows the results of Equation (1) using the Patient Survey (Panels (a), (b), and (c)) and SMCA (Panel (d)), and Figure 3 and 4 show the results of Equation (2) using CSLC.

In all the figures, the diamond symbols indicate the point estimates of the cross terms of the treatment and year dummies, and the red bars are the 95% confidence intervals for the estimates, calculated using standard errors robust against municipality-level clustering. Note that the reference years varied across outcomes. We defined 2005 as the reference year for the Patient Survey and 2007 for the SMCA and CSLC, which were the survey years when these surveys were conducted just prior to SHC-SHG was introduced.

According to Figure 2, in all three outcomes, all point estimates before 2008 are statistically insignificant, indicating that before the SHC-SHG was introduced, the differences in the outcome variables between the treated and control groups were not statistically different from those in the reference year. Additionally, for subjective symptoms and smoking cessation, the differences in the outcomes were not statistically different from those in the reference year before the SHC-SHG (Figure 3 and Panel (b) of Figure 4). These results suggest that the common trend assumptions are credible for these outcomes. Note that the probability of having two or more symptoms seems to have an upward trend among the treated groups compared to the control group between 2001 and 2007, but the trend is not statistically significant.

However, for the health checkup, all point estimates are positive and statistically significant, indicating that the difference in checkup participation rates between the treated and control groups declined only in 2007 (Panel (a) of Figure 4). If we change the reference year from 2007 to 2001, the point estimates are statistically insignificant, indicating that the difference seems to be the same as that between 2001 and 2004 (Panel (b) of Figure C.4). Furthermore, in this setting, the difference also declined in 2007, but it was not statistically significant, with a p-value of 0.125. Digging even deeper, we find that the decline in 2007 was due to the increase in the participation rate for the control group according to Panel (a) of Figure C.4, summarizing the changes in the participation rates by treatment status. The health checkup participation rates for the treated ("bottom 25%") were slightly higher than that of the control ("others") by 1.6 and 4.4 percentage points in 2001 and 2004, respectively. Participation rates showed downward trends from 2001 to 2004 for both groups. In 2007, the participation rate of the control group showed an upward trend and approached that of the treated group; therefore, the rate of treatment was only 0.6% higher than that for the control group. Although we do not have clear explanations of the temporary approach to the participation rates between the two groups in 2007, we excluded the respondents in 2007 from the estimation to avoid a temporary shock in 2007 when we estimated the DID model for the health checkup as the dependent variable.

5.2 Effects on The Health Outcomes

This subsection discusses the effect of the expansion of the per capita expenses of health checkup programs on health outcomes. According to the results of the event study, for outpatient repeat visits due to lifestyle-related diseases, the estimates of the cross terms of the treatment and year dummies are negative and statistically significant at the 5% level for several years after the introduction of the SHC-SHG, indicating that the number of cases for repeated outpatient visits for the treated are statistically fewer than those for the control, compared with the difference between the two groups at the reference year (Panel (b) of Figure 2). However, there is no such effect for the first outpatient visits due to lifestyle-related diseases (Panel (a) of Figure 2).

The medical expenditure spent on outpatient visits due to lifestyle-related diseases of the treated group was significantly smaller than that of the control group at the 5% level in 2010, compared with the difference in the reference year (Panel (c) of Figure 2). This could be accompanied by a decline in outpatient visits due to disease. Additionally, the number of cases of hospital admissions due to stroke for the treated group is gradually lower than that for the control group, compared to the difference in the reference year, and it is statistically significant at the 5% level in 2017 (Panel (b) of Figure 2).

Note that the cross-term of the treatment and 2008 dummy is statistically insignificant for all four outcome variables, while it is the post-SHC-SHG introduction period. Since the Patient Survey and the SMCA were conducted just six and two months after the policy introduction, respectively, some people might not have undergone health checkup programs yet. Additionally, even if people change their behavior by undergoing health checkup programs, behavioral changes may not necessarily immediately change their health outcomes.

When we estimated the DID model, we observed results similar to those from the event study model. Table 5 summarizes the estimation results of DID based on Equation (1). In the estimation, we excluded the sample in 2008 because in that year the expansion of the per capita expense for the treated might not fully affect the residents because of the short period between the timing of the policy introduction and the surveys. The table shows the estimated coefficient of the DID term ("Treat×After"), the number of observations, the average dependent variable for the treated group in the pre-SHC-SHG period ("Mean (treated, before)"), and data for each dependent variable.

According to Table 5, the DID estimate for outpatient repeat visits due to lifestyle-related diseases is estimated to be -1.311 and is statistically significant at the 1 % level (Column (2)), while that for outpatient first visits is statistically insignificant (Column (1)). The magnitude of the estimate can be interpreted such that, compared to the mean for those treated in the pre-SHC-SHG period, the number of outpatient repeat visits due to lifestyle-related diseases decreased by 11.2 % ($-1.311/11.696 \times 100$) for the post-SHC-SHG period. The DID estimate for inpatient admissions due to stroke is also negative and statistically significant, at a significance level of 10 % (Column (4)). The magnitude can be interpreted as an 11.6 % ($-0.405/3.497 \times 100$) decrease in hospital admissions due to stroke for the treated compared to the mean of the hospital admissions in pre-SHC-SHG periods. These results suggest that the larger expansion of the municipal per capita expense of the health checkup programs due to the introduction of the SHC-SHG improved residents' health conditions. Accompanied by the decrease in outpatient visits due to lifestyle-related diseases, the medical expenditure spent on visits due to diseases decreased by about 16.4% (Column (3)).

One could argue that outpatient visits and hospital admissions represent healthcare utilization, which is a measure of health behaviors rather than health outcomes. However, outpatient visits due to lifestyle-related diseases and hospital admissions due to stroke in municipalities could capture the health conditions of residents. For example, since regular treatment and medication are necessary to prevent serious health deterioration in patients with lifestyle-related diseases, the decrease in the number of outpatient repeat visits, that is, the patients who regularly visit medical institutions in an area, could be interpreted as a decrease in the number of patients with lifestyle-related diseases in the area. Additionally, as noted in the phrase "time is brain," that a person who has an acute stroke has to take medical treatment immediately to prevent sequelae and death due to stroke (Saver, 2006). Therefore, the decrease in hospital admissions due to stroke in an area could be interpreted as an improvement in the health of residents in the area.

Furthermore, the results of the event study show that the proportion of the people with subjective symptoms for the treated tends to decline for several years after the SHC-SHG was introduced (Figure 3). However, the timing of the impact varied according to the number of symptoms. The proportion of people with at least one subjective symptom for the treated group was statistically significantly smaller than that of the control group in 2016, compared with its difference in the reference year (Panel (a) of Figure 3), whereas it was significantly smaller in both 2013 and 2016 for those with two or more subjective symptoms (Panel (b) of Figure 3). We should note that we did not obtain statistically significant estimates for 2010 for either subjective symptom dummy. Similarly, no significant DID estimates are found (Columns (5) and (6) in Table 5).

As lifestyle-related diseases are known as the "silent killer," patients with diseases at early stages or with high risk but not the onset of the diseases does not often have subjective symptoms. Therefore, the expansion of the per capita expense of the health checkup program in the treated municipalities may not have an immediate impact on those with subjective symptoms. This would initially reduce the number of patients with high-risk or mild conditions and then reduce the number of people with serious conditions. This hypothesis is consistent with the results showing that hospital admissions due to stroke, of which severe lifestyle-related diseases are major causes, decreased for several years after the SHC-SHG was introduced.

5.3 Effects on The Health Behaviors

In this subsection, we discuss the results of health behaviors using individual-level data constructed by the CSLC. One possible channel for improving the health outcomes of the treated group due to the introduction of the SHC-SHG is a change in behaviors. Regarding the health checkup participation rate, the event study shows that the difference between the treated and control groups is statistically different only in 2016, compared to the difference in 2001 as the reference year (Panel (b) of Figure C.4). The DID estimate is positive and statistically significant at the 10 % level with a p-value of 0.080, and the magnitude can be interpreted as a 5.6% ($0.0263/0.4573 \times 100$) increase compared to the mean of the treated before 2008 (Table 6). The results of the event study suggest that the health checkup participation rate of the treated group did not significantly increase just after the policy introduction, while it significantly increased only eight years after the policy introduction. As mentioned in Section 5.1, we have already excluded the 2007 respondents because the event study results (Panel (b) of Figure C.4) show the effects of some temporary shocks, but we still cannot deny the possibility of the presence of another one. Hence, we concluded that we did not obtain clear evidence that the expansion of the per capita municipal expense of the health checkup programs for the treated municipalities in response to SHC-SHG affected their participation.

According to Panel (b) in Figure 4, the results of the event study imply that, after 2008, the proportion of people quitting smoking in the treated group is larger than that of the control group, compared with the reference year, yet the estimate is statistically significant at the 10 % level only in 2010 with a p-value of 0.060. However, the DID estimate for the smoking cessation dummy is negative and statistically significant at the 10 % level, and the magnitude can be interpreted as an 87.4 % ($0.0139/0.0159 \times 100$) increase in the proportion of people quitting smoking compared to its mean among those treated before 2008. Additionally, behavioural changes were observed in drinking and eating habits. The estimates for drinking, three proper meals, and non-overeating were statistically significant at the 5 % level for the former two and 10 % for the last variables. The magnitudes can be interpreted as a 4.5 % ($-0.0229/0.5071 \times 100$) decrease, 9.6 % ($0.0430/0.4495 \times 100$) increase, and 8.3 % ($0.0316/0.3796 \times 100$) increase for drinking, three proper meals, and non-overeating dummies, respectively. Surprisingly, the proportion of people doing some exercises decreased in the treated group due to the introduction of policy. Since the SHC-SHG provides participants with health guidance specifically tailored to them, the pattern of behavioral changes could be different across participants depending on their previous behaviors. It is possible that among the treated municipalities of the CSLC sample, the respondents changed behaviors to improve their health conditions by putting more weight on their smoking, drinking, and eating habits than exercising. This may be because there is still skepticism among clinicians and investigators regarding the actual potency of exercise for disease and/or disability prevention and treatment, particularly in frail or near-frail adults (Singh, 2002).

6 Discussion

6.1 Interpretation of The DID Estimates

We compared the change in health-related variables across the municipalities that largely increased the per capita expense of the health checkup programs with that of other municipalities to identify the effect of the expansion of municipal-based programs due to the SHC-SHG on residents' health outcomes and behaviors. The results show a decrease in outpatient repeat visits due to lifestyle-related diseases, along with a decrease in the medical expenditure for those visits and a decrease in hospital admissions due to stroke for the treated after the SHC-SHG was introduced. The results also showed some behavioral changes. These results suggest the improvement in residents' health conditions due to the larger increase in the per capita expense of the municipal health checkup programs due to the introduction of SHC-SHG.

One possible mechanism behind the health improvement for the treated after the introduction of the SHC-SHG is an increase in the quality of municipal health checkup programs due to policy introduction. The SHC-SHG screens people at high risk of lifestyle-related diseases, that is, the population for whom the interventions are effective, and implements health guidance interventions by professionals such as doctors, while the previous programs focused on those with diseases already for whom the interventions are less effective. Therefore, people at high risk of the diseases could change their behaviour towards health improvement before they get it due to the interventions. Hence, we can say that the SHC-SHG could be more effective in preventing lifestyle-related diseases than the previous programs. The health improvement among the treated after the introduction of the SHC-SHG could be explained by the increase in the quality of municipal programs.

The heterogeneous effect by type of outpatient visit (first versus repeat) could provide an insight into the discussion of the above quality hypothesis. As discussed in Section 3.5, the number of cases for first outpatient visits is a good indicator for assessing the effectiveness of SHC-SHG in screening high-risk populations of lifestyle-related diseases. Thus, if SHC-SHG screens high-risk populations and encourages them to visit doctors to implement health guidance and/or medical treatments more than the previous programs, the number of first outpatient visits should increase, at least in the short run. However, the number of repeat visits could be a more plausible measure for evaluating the validity of health guidance for those with mild symptoms, as health guidance could improve their health condition, resulting in a decrease in Frequency of outpatient visits. Therefore, the result that shows significant changes only in outpatient repeat visits suggests that the health guidance part of the SHC-SHG contributed to residents' health improvement rather than the screening part of the SHC-SHG.

Another possibility is that the introduction of the SHC-SHG increased the number of participants in the checkup programs, resulting in an improvement in the health of participants, even if the introduction of the SHC-SHG does not change the quality of the checkup programs. As discussed, we did not observe significant evidence showing that the introduction of SHC-SHG changed the participation rates in the event study. However, the results of DID showed that the expansion of the per capita expense increased the participation rate by 5.8%, with a 10% significance, although its magnitude was only about 35% of the magnitude of the medical expenditure for outpatient visits (5.8%/16.4%). We cannot completely deny this possibility; however, this possibility alone did not explain the health improvement in the post-SHC-SHG periods for the treated patients.[33]

6.2 Validity of Identification Strategy

Additional analyses were conducted to confirm the validity of our identification strategy. First, as a placebo test, the estimation results using the outcome variable and sample less related to the SHC-SHG do not show the same tendency as the results observed in the main analysis. Outpatient visits due to injuries were defined as the dependent variable. Since the SHC-SHG focuses on lifestyle-related diseases, outpatient visits due to injuries should not have the same tendency as lifestyle-related diseases, and the estimation result supports this hypothesis (Panel (a) of Figure C.5). Second, we re-estimated the results with the people insured by the EHI, who were not eligible for municipal health checkup programs. The estimation results do not show the same tendency as

[33]Previous studies provide some evidence that individuals with health consciousness are more likely to participate in preventive health programs, such as workplace wellness programs in the U.S. and breast cancer screening in the U.S. (for example, Einav et al., 2020; Jones et al., 2019; Myerson et al., 2018). Therefore, individuals interested in the prevention of lifestyle-related diseases might start to participate in the programs in response to the introduction of SHC-SHG. Additional descriptive statistics, using the Longitudinal Survey of Middle-aged and Elderly Persons (LSMEP), show that among the individuals who did not participate in the health checkup programs before the policy introduction, the individual characteristics before the introduction were not significantly different between those who did not participate in the programs and those who started to participate in the programs, suggesting that the SHC-SHG introduction did not induce a systematic change in health checkup participation. (Table C.1.)

the main results (panels (b) and (c) of Figure C.5, C.6 and C.7). Among the people insured by the EHI, the improvement in health among the treated compared to the control was observed before the SHC-SHG was introduced.

There could be a potential threat to our identification strategy: systematic migration owing to the introduction of the SHC-SHG. Suppose that a person with health consciousness wants to move to the treated municipalities, but hesitates to move because of the lower level of the health checkup program in the treated municipalities. After the introduction of theSHC-SHG, the person may decide to move to the municipalities. In this case, the proportion of people with health consciousness increases in the treated municipalities, which could also explain the health improvement for the treated municipalities, even if the effects of the introduction of the SHC-SHG itself are null. In other words, DID estimates reflect the change in population composition rather than the effect of the expansion of health checkup programs. To examine the possibility of systematic migration, we estimated the DID with the migration and target population of the SHC-SHG as dependent variables. The estimation results show that there are no statistically significant effects on the number of migrants from the other municipalities and the target population of the SHC-SHG, implying that systematic migration is unlikely to exist, as discussed above (Table C.5).[34]

6.3 How Much the Policy Introduction Could Reduce the Medical Expenditures

In this subsection, we discuss the cost-effectiveness of the expansion of the per capita expense of health checkup programs using a back-of-the-envelope calculation (Table 7). We used an official statistic, the Estimates of National Medical Care Expenditure (ENME), and calculated reduced medical expenditure by the expansion of the per capita expense in the treated municipalities

[34] We estimated the DID model using municipality-level panel data on the number of migrants from other municipalities and the target population of the SHC-SHG. We used the estimated population insured by the munic- ipalities' NHI and aged–40-74 as the target population of the SHC-SHG. Appendix A explains the details of the estimation. Note that the number of migrants from the other municipalities is the overall number, not the target population of the SHC-SHG, due to data limitations. The number of migrations from other municipalities is available on the e-Stat webpage (https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200523&tstat=000000070001&cycle=7&tclass1=000001011680&tclass2val=0.)

To estimate the number of migrations, we controlled for the logged municipal population (total, 40-44, 45-59, 50-54, 55-59, 60-64, 65-69, 70-74), the logged financial index, linear trends of municipalities by the level of the per capita expense of public health services based on the NHI (above and below median), municipality fixed effects, year fixed effects, and prefecture and year fixed effects. In the estimation for the target population, we used the same control variables as those for the number of migrations, except for the municipal population by five-year age group. This is because the population insured by the municipalities' NHI is estimated using the municipal population by five-year age group and the proportion of the population insured by the municipalities' NHI by prefecture and year. Table C.5 summarizes the estimation results.

due to the introduction of the SHC-SHG. The ENME provides estimates of annual total medical expenditures in Japan for major diseases by outpatient visits and hospital admissions by age group (0-14, 15-44, 45-64, 65+). In 2007, the estimate of annual medical expenditures among people aged at 45-64 spent on outpatient visits due to lifestyle-related diseases (i.e., hypertensive diseases (ICD-10:I10-I15) and diabetes mellitus (ICD-10:E10-E14)) was 778.4 billion JPY,[35] and that for hospital admission due to cerebrovascular diseases (ICD-10:I60-I69) was 265.5 billion JPY.[36] The annual medical expenditures for outpatient visit due to lifestyle-related diseases and hospital admissions due to cerebrovascular diseases accounted for approximately 16% of the total medical expenditures in 2007.[37] Suppose that the prevalence and severity of diseases are constant across municipalities and types of health insurance for people aged 45-64. We estimated the total medical expenditures for the people insured by the municipalities' NHI and aged at 45-64 in the treated municipalities by multiplying the total medical expenditures and the ratio of the people insured by the municipalities' NHI in the treated municipalities to the total population: 96.7 billion JPY for lifestyle-related diseases, and 33.0 billion JPY for cerebrovascular diseases.[38] Then, by multiplying the estimated total medical expenditures for the people insured by the municipalities' NHI and aged between 45-64 in the treated municipalities by the estimated effects of the expansion of the per capita expense of the programs on the outpatient visits and hospital admissions, the reduced medical expenditure by the expansion of the per capita expense in the treated municipalities could be calculated to -15.83 billion JPY for outpatient visits due to lifestyle-related diseases and -3.82 billion JPY for hospital admission due to stroke.[39] Thus, the sum of the reduced medical expenditures is 19.66 billion JPY.

As in Table 3, among the treated ("$Bottom25\%$"), on average, the increase in the estimated per capita expense of the municipal health checkup programs was 750.5 JPY more than the increase for the control. Therefore, suppose that the effects estimated by the DID reflect a 750.5 JPY increase in the per capita expense of the municipal health checkup programs. Then, by multiplying it with the people aged between 45-64 and insured by the municipalities' NHI in the treated municipalities,[40]

[35]The estimates for outpatient visit due to hypertensive diseases and diabetes mellitus are 481.6 and 296.8 billion JPY, respectively.

[36]The data can be downloaded from the e-Stat web page (https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00450032&tstat=000001020931&cycle=8&tclass1=000001032180&stat_infid=000004485743&tclass2val=0(in Japanese)(accessed December 12, 2022)).

[37]The total medical expenditure is the sum of medical expenses for medical treatment and does not include dental and pharmacy expenses, and it was 25.64 trillion JPY in 2007.

[38]The ratio of the number of insured by the municipalities' NHI to the total population aged between 45 and 64 for the treated municipalities was about 0.124 in 2007.

[39]We used the DID estimate for medical expenditure spent on outpatient visits due to lifestyle-related diseases (-16.4 %) and for hospital admissions due to stroke(-11.6 %) for the calculation.

[40]The number of population aged–45-64 who are insured by the municipalities' NHI in the treated municipalities is estimated to be approximately 4,303,786.

the increase in the total expense of the health checkup program for the treated could be calculated as 3.23 billion JPY. According to the back-of-the-envelope calculations, the magnitude of the reduced medical expenditures is about six times larger than that of the increased cost, suggesting that the expansion of the per capita cost of the health check-up programs has the value of improving the health status of the residents insured by the municipalities' NHI for the treated municipalities.

7 Conclusion

This paper analyzes the effects of the expansion of the municipal per capita expense of health checkup programs due to the introduction of the SHC-SHG on residents' health outcomes and behaviors. The results of the event study and DID showed a decrease in outpatient visits due to lifestyle-related diseases as a whole and inpatients caused by stroke for the treated municipalities. Accordingly, the medical expenditure spent on outpatient visits declined. In the treated group, the proportion of people with subjective symptoms also decreased, and some behavioral changes among the residents were observed. Our results suggest that the municipal response to the introduction of SHC-SHG is cost-effective, which is consistent with previous studies. Being healthy in middle age or older is important for reducing the country's budget on medical spending and saving people from ongoing and next unknown pandemics; preventive health services such as health checkup and screening programs could have important roles. Therefore, there is a need to accumulate broad evidence on the cost-effectiveness of programs for policymakers to create sustainable social security systems.

Declaration of Interest

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Appendix

A Municipal Per Capita Expense of Public Health Services

We used two suverys, the *Local Government Finance Survey* ("*Chiho Zaisei Jokyo Chosa*" in Japanese, LGFS) and the population, vital events, and households derived from the Basic Resident Registration, to measure the per capita expense of the public health service of municipalities. The LGFS is a survey of the public finances of local governments, including 47 prefectures and 1,718 municipalities, conducted by the Ministry of Internal Affairs and Communications (MIC). The survey asked local governments about their revenue and expenditure by type and purpose. All the local governments in Japan were required to respond to the survey. Some data from the survey are available on the portal site of the official statistics of Japan, e-Stat.[41]

The data includes the annual expenditures of the services related to the National Health Insurance (NHI) operated by municipalities, such as the expense of public health services based on the National Health Insurance Act (NHIA). Public health services based on the NHIA include health checkups, health education, and health consultation for the insured enrolled in NHI. After the Specific Health Checkups and Specific Health Guidance (SHC-SHG) was introduced in 2008, most of the expenses of public health services based on the NHIA were spent on the SHC-SHG. For example, according to twenty-one municipalities' annual financial reports, which are available on the website, the budget amount of the SHC-SHG accounted for more than 80 % of the total budget of public health services in the fiscal year 2018 in 14 municipalities. In addition, half of these municipalities allocated more than 90 % of the public health services budget to the SHC-SHG budget (Table A.1).[42,43,44]

In the LGFS, there is a category of expenses for *hygiene services* (*eisei hi* in Japanese). In this category, the expense of the health checkup programs based on the Health and Medical Service Act for the Aged (HMSAA) is classified as that of public health services in *health and hygiene services*, but no data are available to identify the detailed expense items of hygiene expenses nationwide.[45] Most municipalities commissioned medical institutions to conduct the health checkup programs

[41] You can download the data from the web page (https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200251&tstat=000001077755&cycle=7&tclass1=000001077756&tclass2=000001077757&tclass3val=0).

[42] Table A.1 shows the budget amount of public health services based on the NHIA, the budget amount of the SHC-SHG, and the percentage of the amount of SHC-SHG to that of the public health services based on the NHIA. The table also shows the summary statistics.

[43] The data are available from https://www.e-stat.go.jp/api/sample2/tokeidb/getMetaInfo?statsDataId=0003173060 (in Japanse)(accessed May 31, 2022).

[44] Note that the definition of public health service expenses is the same before and after the policy introduction.

[45] Note that *health and hygiene services* is a subcategory of *hygiene services*.

based on the HMSAA, and the commission fee for the *health and hygiene services* included the expense of the HMSAA-based health checkup programs. Unfortunately, commission fees for public health services are unknown. Thus, we can estimate it using two variables: the annual supply and service expenses, including the commission fees, for the *health and hygiene services* and the ratio of commission fees to the supplies and services expenses for the entire *hygiene services* as follows:

$$\widehat{CF_{HHS}} = SSE_{HHS} \times \frac{CF_{HS}}{SSE_{HS}}, \tag{3}$$

where $\widehat{CF_{HHS}}$ is the estimated commission fee for the *health and hygiene services*, SSE_{HS} and SSE_{HHS} are the annual supply and service expenses for the entire *hygiene services* and *health and hygiene services*, respectively, and CF_{HS} is the commission fee for the *hygiene services*.

To calculate per capita expenses, we used the number of residents in each municipality from the counts of population, vital events, and households derived from the Basic Resident Registration. The data contain the population of the five-year age group for each municipality from 1995.[46] We estimated the population insured by the municipalities' NHI, which is the target of their health checkup programs. We calculated the ratio of the population insured by the municipalities' NHI to the total population by prefecture, year, and five-year age groups using the Comprehensive Survey of Living Conditions (CSLC). Because we had access to the CSLC from 1995 to 2016 only every three years, we linearly interpolated and extrapolated the rest of the years from 1995 to 2017.[47] We multiplied the municipal population and prefectures' ratio of the population insured by the municipal NHI to estimate the population insured by the municipalities' NHI by the five-year age group.

We used the estimated population insured by the municipalities' NHI, which is eligible to undergo health checkup programs, to calculate the per capita expenses. The population aged 40 and over was used for public health services based on the NHIA and the estimated commission fee for *health and hygiene services* for 2007 or earlier. The population aged between 40 and 74 was used for NHIA-based public health services for 2008 or later.

The frequent municipal mergers in the 2000s made it challenging to construct municipality-level panel data in the long run.[48] For example, because of frequent municipal mergers, one data point

[46]The data are available from https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200241&tstat=000001039591&cycle=7&tclass1=000001039601&tclass2val=0 (in Japanse)(accessed May 31, 2022).

[47]We use the stata command "ipolate".

[48]Municipalities decreased by approximately 45% between April 2000 and March 2009. Change in the number of municipalities on https://www.soumu.go.jp/main_content/000651406.pdf (in Japanese)(accessed on June 1, 2022).

was aggregated by pre-merger municipalities in some cases. By contrast, the other was aggregated by post-merger municipalities, even in the same year. In this case, we could not merge the two datasets directly. We construct municipality-level panel data on public health service expenses per capita based on the procedure developed by Kondo (2019) to cope with frequent municipal mergers. We aggregated the pre-merger municipalities into post-merger municipalities throughout the study period. We had 1,741 municipalities after implementing the procedure developed by Kondo (2019).

Table A.2 shows the summary statistics of municipal expenses for public health services. We used the 732 municipalities that remained after we restricted the sample according to Section 3.4. We estimated the statistics for each variable using the average within each municipality in the given period. The expense of public health services based on the NHIA was 37.8 million JPY in 2007 or earlier and increased to 113.3 million JPY after 2008. The commission fee for the *health and hygiene services* was 392.9 million JPY in 2007 or earlier and is much larger than the expense of public health services based on the NHIA. This is because the public health services provided by the health and hygiene department include not only the health checkup program based on the HMSAA but also public health programs for mothers and children, vaccination, food hygiene, and antipollution measures.

A.1 Estimating the Per Capita Expense of Health Checkup Programs by the Health and Medical Service Act for the Aged

Figure A.1 summarizes the average commission fee for *health and hygiene services* by fiscal year. According to the figure, on average, the commission fee for *health and hygiene services* was almost constant between 2001 and 2007, and declined by about 15% compared to the average between 2001 and 2007, just after the SHC-SHG was introduced. As discussed in Section 2, after the SHC-SHG was introduced, the department in charge of municipal health checkup programs changed from the health and hygiene department to the department of the municipalities' NHI. Therefore, a sudden decline in commission fees may reflect a change in the department in charge. We estimated the per capita expense of the health checkup programs based on the HMSAA using the decline as follows: First, we defined the expense of health checkup programs based on the HMSAA by subtracting the average commission fee in 2008 from the mean of the average commission fee between 2001 and 2007, using all municipalities. Then, we calculated the per capita expense of the health checkup programs based on the HMSAA by dividing the estimated expense by the mean of the average population insured by the municipalities' NHI and aged over 40 between 2001 and 2007, and its value is about 1916 JPY.

B Construction of municipality-level panel data

Owing to frequent municipal mergers, one data point was aggregated by pre-merger municipalities in some cases. By contrast, the other was aggregated by post-merger municipalities, even in the same year. In this case, we could not merge the two datasets directly. We construct municipality-level panel data based on the procedure developed by Kondo (2019) to cope with frequent municipal mergers. We aggregated the pre-merger municipalities into post-merger municipalities throughout the study period. For example, suppose that City A (id=001) and City B (id=002) are merged into City C (id=003) within a year. Kondo (2019)'s procedure reassigns City C's identifier (id=003) for City A and City B of the pre-merger periods (Figure B.1). Therefore, we can handle City A and City B as City C not only in the post-merger period, but also in the pre-merger period. By implementing this procedure, we obtained 1,741 municipalities.

Further, in the Patient Survey on outpatient visits, we used the municipalities where the medical institutions are located for data aggregation instead of the patients' residential addresses, which are unknown. Suppose patients visit medical institutions located in municipalities where they do not reside. In this case, the number of outpatients in a municipality is not identical to that of the municipality's residents. To avoid serious cross-municipal-border outpatient visits, we restricted the sample to larger municipalities, cities, and wards, where at least five medical institutions existed in the analysis period. In conclusion, almost all observations (municipality × year) had non-missing values for the number of patients.

C Additional Figures and Tables

Figure C.1 summarizes the 32 municipalities that can be identified for the CSLC.[49]

Figure C.2 summarizes the relationship between the per capita expense of public health services based on the National Health Insurance Act (NHIA) and the per capita commission fee for public health services conducted by municipalities' health and hygiene departments before 2007 after we controlled for prefecture fixed effects.

Table C.1 shows the individual characteristics of the individuals not participating in any health checkup program before the Specific Health Checkups and Specific Health Guidance were introduced from 2005 to 2007. We divided the sample by individuals' change in participation behavior after the policy introduction: keeping not participating (0 → 0, Column (1)) and increasing the frequency of participation to 2 or 3 in the following three years (2008-2010) (0 → 2+, Column (2)).

[49]Further details are provided in Section 3.3.

We used individuals aged between 50 and 54 years in 2005 who did not undergo any health checkup program between 2005 and 2007 from the Longitudinal Survey of Middle-aged and Elderly Persons (LSMEP).[50]. We restricted the sample to individuals who were likely to be insured by National Health Insurance, such as individuals who do not work, self-employed workers, family employees, and part-time workers. Column (3) shows the differences between Columns (1) and (2).

C.1 Results of Event Study Models

Figure C.3 summarizes the estimation results of the event study model for outpatient visits owing to lifestyle-related diseases. Panel (a) shows the results using the total number of outpatient visits (first + repeat visits) calculated from the Patient Survey as the dependent variable, and Panel (b) shows the results using the number of first visits calculated from the Patient Survey. Panel (c) shows the results using the total number of outpatient visits calculated from SMCA.

Figure C.4 summarizes the change in the health checkup participation rate by treatment status and the results of the event study model for the checkup dummy when we change the reference year from 2007 to 2001.

C.2 Results of Placebo Regressions

Figures C.5, C.6 and C.7 and Table C.2 summarize the results of the placebo regressions for health outcomes, subjective symptoms, and health behaviors.

C.3 Robustness Check Against Cutoff Values for Treatment Status

Table C.3 summarizes the estimation results of the robustness check against cutoff values to construct the treatment status dummies. We used five percentiles (15, 20, 25, 30, and 35 percentiles) as cutoff values for the robustness check. The magnitude of the percentage increase in per-capita expense of health checkup programs for the treated municipalities is about 2.14-2.59 times more than that for the control municipalities depending on the percentile values used to construct the treatment status. We reestimated Columns (2), (3), and (4) of Table 5 using the various definitions of the treatment status. We have only 31 municipalities for the data from the Comprehensive Survey of Living Conditions (CSLC), making it difficult to implement the robustness check for the outcome variables from the CSLC. Therefore, we used outcome variables from the Patient Survey and Statistics of Medical Care Activities in Public Health Insurance. The table includes the pre-SHC-SHG mean

[50] Since the LSMEP does not provide information on the municipalities where respondents live, we did not use this data in the main analysis.

of outcome variables in the treated municipalities (Columns (1), (4), and (7)), the DID estimates (Columns (2), (5), and (8)), and the percentage change in outcome variables due to the SHC-SHG introduction compared to the pre-SHC-SHG mean (Columns (3), (6), and (9)).

According to Table C.3, the DID estimates for the number of repeat visits and medical expenditures for outpatient visits due to lifestyle-related diseases are robust against the definition of treatment status (Columns (2), (3), (5), and (6)). The estimation results are somewhat fragile compared to the definition of treatment status in the case of hospital admissions due to stroke. The DID estimates for hospital admissions due to stroke were similar among the cutoff values of the 15 and 20 percentiles and that of the 25 percentile, while the former two were not statistically significant. For the case using 30 and 35 percentiles, compared with the case for the 25 percentile, the sign of the estimates is the same, but the magnitude of the estimates is smaller.

As seen in Panel (c) of Figure 2, hospital admissions due to stroke decreased several years after the SHC-SHG was introduced. To account for this delayed-acting effect on stroke, we re-estimated Column (8) of Table C.3 using a new after-dummy with two categories:2011-2014 and 2017 (Table C.4). Columns (2) and (4) show the estimates of the cross-terms of the treatment status and the dummy indicating 2011 and 2014, and the dummy indicating 2017. The percentage change in outcome variables due to the SHC-SHG introduction compared to the pre-SHC-SHG mean are in Columns (3) and (5) for each after-dummy category. When we focus on the effects in 2017 ("'$Treat \times 2017$'), the magnitudes of the percentage change are similar for all definitions of the treatment status (Column (5)), while they are not statistically significant except for the case using the 25 percentile. As in Column (8) of Table C.3, for the case using 30 and 35 percentiles, the magnitudes of the percentage change in 2011-2014 are smaller than those using the 15 - 25 percentiles.

Since individuals with a high risk of stroke are likely to have conditions of serious lifestyle-related diseases and need to receive medical treatment, it should be difficult to improve or maintain their health condition through checkups and health guidance. The reduced number of hospital admissions due to stroke could reflect the decreased population with a high risk of and an early stage of lifestyle-related diseases through the SHC-SHG rather than the SHC-SHG improved the health conditions of the individuals with a high risk of stroke. The magnitude of the effects estimated in 2017 is not substantially different, which could reflect the above, while noting that the statistical significance of the effects is not robust. Therefore, a health care promotion policy that encourages take health checkup programs early enough could effectively reduce the population with serious lifestyle-related diseases.

C.4 Analysis of Systematic Migrations

Table C.5 summarizes the estimation results of the DID model using municipality-level panel data on the number of migrations from the other municipalities and the target population of the SHC-SHG. Note that the number of migrants from the other municipalities is the overall number, not the target population of the SHC-SHG, due to data limitations.[51] To estimate the number of migrations, we controlled for the logged municipal population (total, 40-44, 45-59, 50-54, 55-59, 60-64, 65-69, 70-74), the logged financial index, linear trends of municipalities by the level of the per capita expense of public health services based on the NHI (above and below median), municipality fixed effects, year fixed effects, and prefecture and year fixed effects. In the estimation for the target population, we used the same control variables as those for the number of migrations, except for the municipal population by five-year age group. This is because the population insured by the municipalities' NHI is estimated using the municipal population by five-year age group and the proportion of the population insured by the municipalities' NHI by prefecture and year.

[51]The number of migrations from the other municipalities is available on e-Stata (https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00200523&tstat=000000070001&cycle=7&tclass1=000001011680&tclass2val=0).

References

Alalouf, Mattan, Sarah Miller, and Laura Wherry, "What Difference Does a Diagnosis Make? Evidence from Marginal Patients," Technical Report, National Bureau of Economic Research, Cambridge, MA oct 2019.

Ando, Wataru, Takeshi Horii, Takayuki Uematsu, Hideaki Hanaki, Koichiro Atsuda, and Katsuya Otori, "Impact of overlapping risks of type 2 diabetes and obesity on coronavirus disease severity in the United States," *Scientific Reports*, 2021, *11* (1), 1–8.

Bommer, Christian, Vera Sagalova, Esther Heesemann, Jennifer Manne-Goehler, Rifat Atun, Till Bärnighausen, Justine Davies, and Sebastian Vollmer, "Global Economic Burden of Diabetes in Adults: Projections From 2015 to 2030," *Diabetes Care*, 2018, *41* (5), 963–970.

Chait, Nadia and Sherry Glied, "Promoting Prevention under the Affordable Care Act," *Annual Review of Public Health*, 2018, *39*, 507–524.

Chung, Sukyung, Lenard I. Lesser, Diane S. Lauderdale, Nicole E. Johns, Latha P. Palaniappan, and Harold S. Luft, "Medicare annual preventive care visits: Use increased among fee-for-service patients, but many do not participate," *Health Affairs*, 2015, *34* (1), 11–20.

Cohen, Joshua T., Peter J. Neumann, and Milton C. Weinstein, "Does Preventive Care Save Money? Health Economics and the Presidential Candidates," *New England Journal of Medicine*, feb 2008, *358* (7), 661–663.

Einav, Liran, Amy Finkelstein, Tamar Oostrom, Abigail Ostriker, and Heidi Williams, "Screening and Selection: The Case of Mammograms," *American Economic Review*, 2020, *110* (12), 3836–3870.

Fukuma, Shingo, Toshiaki Iizuka, Tatsuyoshi Ikenoue, and Yusuke Tsugawa, "Association of the National Health Guidance Intervention for Obesity and Cardiovascular Risks with Health Outcomes among Japanese Men," *JAMA Internal Medicine*, 2020, *180* (12), 1630–1637.

Gami, Apoor S., Brandi J. Witt, Daniel E. Howard, Patricia J. Erwin, Lisa A. Gami, Virend K. Somers, and Victor M. Montori, "Metabolic Syndrome and Risk of Incident Cardiovascular Events and Death. A Systematic Review and Meta-Analysis of Longitudinal Studies," *Journal of the American College of Cardiology*, 2007, *49* (4), 403–414.

Hackl, Franz, Martin Halla, Michael Hummer, and Gerald J. Pruckner, "The Effectiveness of Health Screening," *Health Economics*, aug 2015, *24* (8), 913–935.

Holman, Naomi, Peter Knighton, Partha Kar, Jackie O'Keefe, Matt Curley, Andy Weaver, Emma Barron, Chirag Bakhai, Kamlesh Khunti, Nicholas J. Wareham, Naveed Sattar, Bob Young, and Jonathan Valabhji, "Risk factors for COVID-19-related mortality in people with type 1 and type 2 diabetes in England: a population-based cohort study," *The Lancet Diabetes & Endocrinology*, oct 2020, *8* (10), 823–833.

Iizuka, Toshiaki, Katsuhiko Nishiyama, Brian Chen, and Karen Eggleston, "False alarm? Estimating the marginal value of health signals," *Journal of Public Economics*, 2021, *195*, 104368.

Inui, Tomohiko, Yukiko Ito, Atsushi Kawakami, Xin Xin MA, Masaru Nagashima, and Meng Zhao, "Empirical Study on the Utilization and Effects of Health Checkups in Japan," *RIETI Discussion Paper Series*, 2017, *17-E-082.*

Jones, Damon, David Molitor, and Julian Reif, "What do Workplace Wellness Programs do? Evidence from the Illinois Workplace Wellness Study," *The Quarterly Journal of Economics*, nov 2019, *134* (4), 1747–1791.

Kang, Cheolmin, Akira Kawamura, and Haruko Noguchi, "Benefits of knowing own health status: effects of health check-ups on health behaviours and labour participation," *Applied Economics Letters*, 2020, *28* (11), 1–6.

Kim, Hyuncheol Bryant, Suejin A. Lee, and Wilfredo Lim, "Knowing is not half the battle: Impacts of information from the National Health Screening Program in Korea," *Journal of Health Economics*, 2019, *65*, 1–14.

Knowler, William C., Elizabeth Barrett-Connor, Sarah E. Fowler, Richard F. Hamman, John M. Lachin, Elizabeth A. Walker, and David M. Nathan, "Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin," *New England Journal of Medicine*, 2002, *346* (6), 393–403.

Kondo, Keisuke, "Municipality-level panel data and municipal mergers in Japan," *RIETI Technical Paper No. 19-T-001*, 2019.

Lakka, Hanna Maaria, David E. Laaksonen, Timo A. Lakka, Leo K. Niskanen, Esko Kumpusalo, Jaakko Tuomilehto, and Jukka T. Salonen, "The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men," *Journal of the American Medical Association*, 2002, *288* (21), 2709–2716.

Mendrick, Donna L., Anna Mae Diehl, Lisa S. Topor, Rodney R. Dietert, Yvonne Will, Michele A. La Merrill, Sebastien Bouret, Vijayalaskshmi Varma, Kenneth L. Hastings, Thaddeus T. Schug, Susan G.Emeigh Hart, and Florence G. Burleson, "Metabolic syndrome and associated diseases: From the bench to the clinic," *Toxicological Sciences*, 2018, *162* (1), 36–42.

Myerson, Rebecca Mary, Darius Lakdawalla, Lisandro D. Colantonio, Monika Safford, and David Meltzer, "Effects of Expanding Health Screening on Treatment - What Should We Expect? What Can We Learn?," *NBER Working Paper Series*, 2018, (24347), 1–31.

Obama, Barack, "United States health care reform: Progress to date and next steps," *JAMA - Journal of the American Medical Association*, 2016, *316* (5), 525–532.

Oikawa, Masato, "The Role of Education In Health Policy Reform Outcomes: Evidence From Japan," *SSRN No.4296819*, 2022.

Oster, Emily, "Diabetes and diet: Purchasing behavior change in response to health information," *American Economic Journal: Applied Economics*, 2018, *10* (4), 308–348.

Saver, Jeffrey L., "Time is brain - Quantified," *Stroke*, 2006, *37* (1), 263–266.

Schellenberg, Elizabeth Sumamo, Donna M. Dryden, Ben Vandermeer, Christine Ha, and Christina Korownyk, "Lifestyle Interventions for Patients With and at Risk for Type 2 Diabetes," *Annals of Internal Medicine*, 2013, *159* (8), 543.

Singh, Maria Antoinette Fiatarone, "Exercise comes of age: Rationale and recommendations for a geriatric exercise prescription," *Journals of Gerontology - Series A Biological Sciences and Medical Sciences*, 2002, *57* (5), 262–282.

Tang, Qiang, Yanwei Liu, Yingfeng Fu, Ziyang Di, Kailiang Xu, Bo Tang, Hui Wu, and Maojun Di, "A comprehensive evaluation of early potential risk factors for disease aggravation in patients with COVID-19," *Scientific Reports*, 2021, *11* (1), 1–13.

US Department of Health and Human Services, "National diabetes statistics report 2020: estimates of diabetes and its burden in the United States," Technical Report 2020.

World Health Organization, *Global Report on Diabetes* 2016.

Zhao, Meng, Yoshifumi Konishi, and Paul Glewwe, "Does information on health status lead to a healthier lifestyle? Evidence from China on the effect of hypertension diagnosis on food consumption," *Journal of Health Economics*, 2013, *32* (2), 367–385.

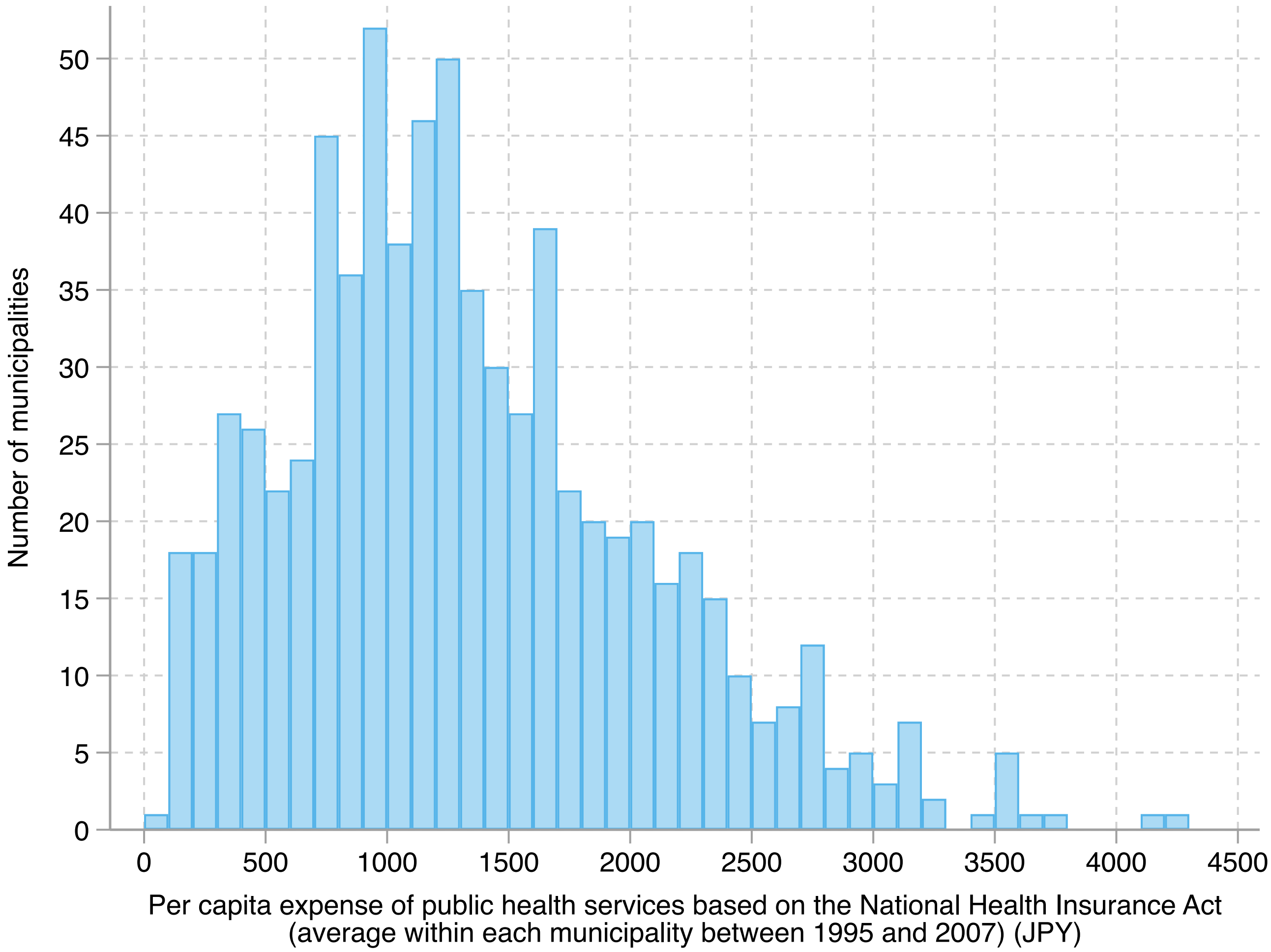
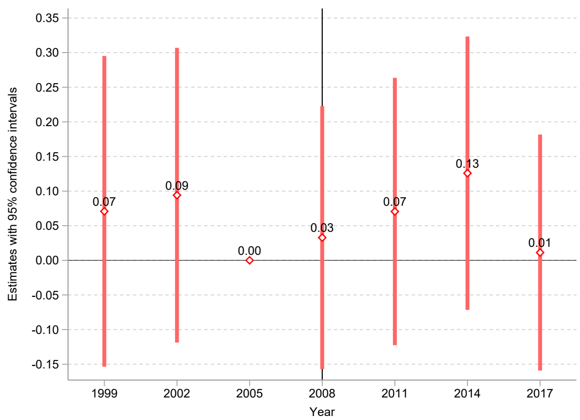
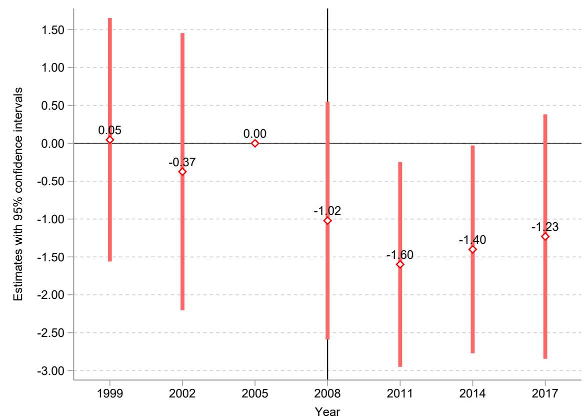


Figure 1: Per Capita Expense of Public Health Services Based on The National Health Insurance Act Before 2007 (JPY)

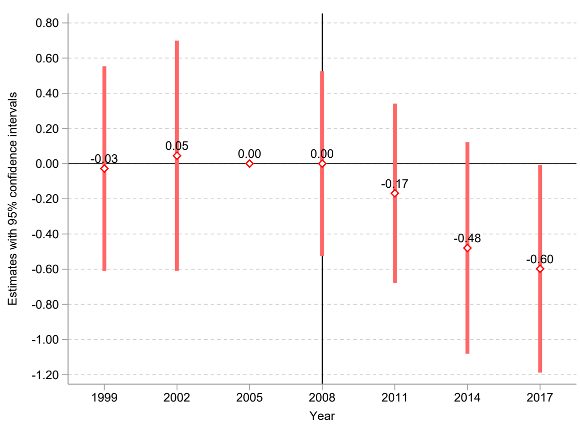
Notes: We used the 732 municipalities which remained after we implemented the sample restriction. We calculated the average value of the per capita expense within each municipality between 1995 and 2007. The mean, standard deviation, and coefficient of variation are 1344.1, 744.7, and 0.554, respectively.



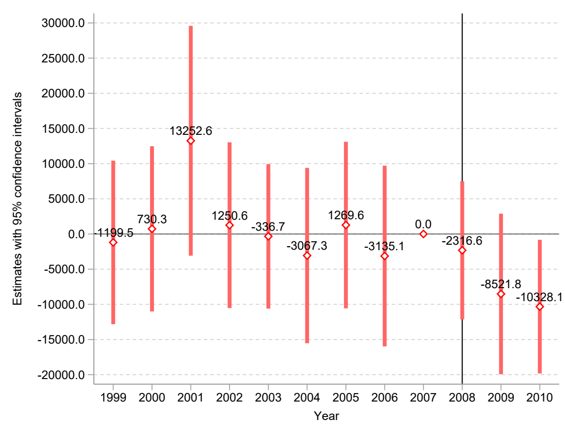
(a) Outpatient visit: lifestyle-related diseases (first)



(b) Outpatient visit: lifestyle-related diseases (repeat)



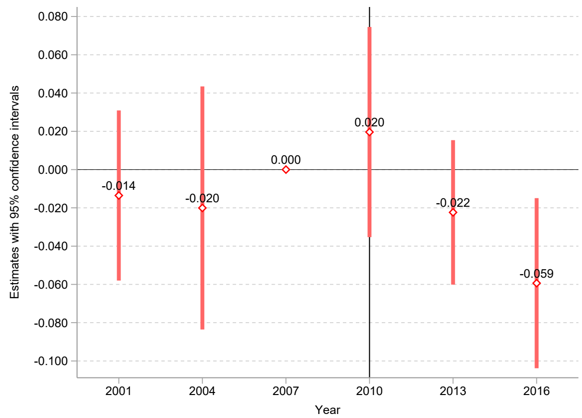
(c) Hospital admission: stroke



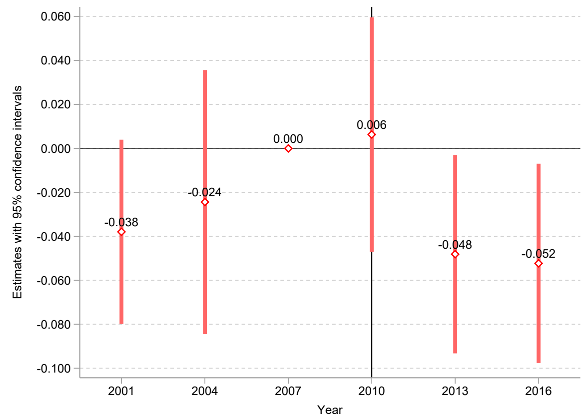
(d) Medical expenditure: outpatient visits due to lifestyle-related diseases

Figure 2: Event Study: Outpatient Visits, Hospital Admissions, and Medical Expenditure

Notes: We estimated Equation (1) by using the cross terms of the treatment dummy and the year dummy variables instead of the DID term. We set 2005 and 2007 as the reference time period for the Patient Survey and the SMCA, respectively. The diamond symbols indicate the estimates of the cross terms of the treatment dummy and the year dummy variables. The bars are the 95% confidence intervals for the estimates. The confidence intervals are calculated using standard errors robust against municipality-level clustering. Panels (a), (b) and (c) use the Patient Survey, and Panel (d) uses the SMCA.



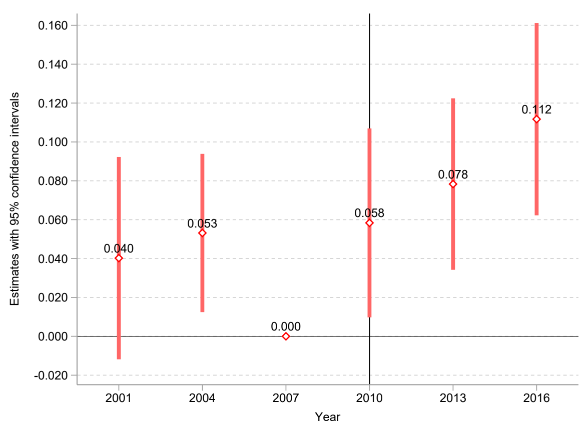
(a) Having At Least One Symptom



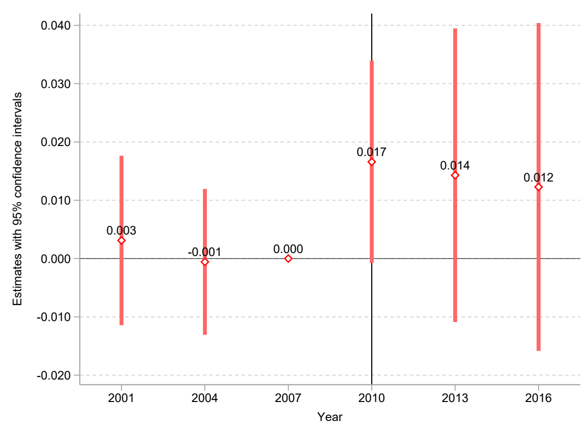
(b) Having Two or More Symptoms

Figure 3: Event Study: Subjective Symptoms

Notes: We estimated Equation (2) by using the cross terms of the treatment dummy and the year dummy variables instead of the DID term. We set 2005 as the reference time period. The diamond symbols indicate the estimates of the cross terms of the treatment dummy and the year dummy variables. The bars are the 95% confidence intervals for the estimates. The confidence intervals are calculated using standard errors robust against municipality-level clustering.



(a) Having Health Checkups



(b) Currently Quit Smoking

Figure 4: Event Study: Health Behaviors

Notes: We estimated Equation (2) by using the cross terms of the treatment dummy and the year dummy variables instead of the DID term. We set 2005 as the reference time period. The diamond symbols indicate the estimates of the cross terms of the treatment dummy and the year dummy variables. The bars are the 95% confidence intervals for the estimates. The confidence intervals are calculated using standard errors robust against municipality-level clustering.

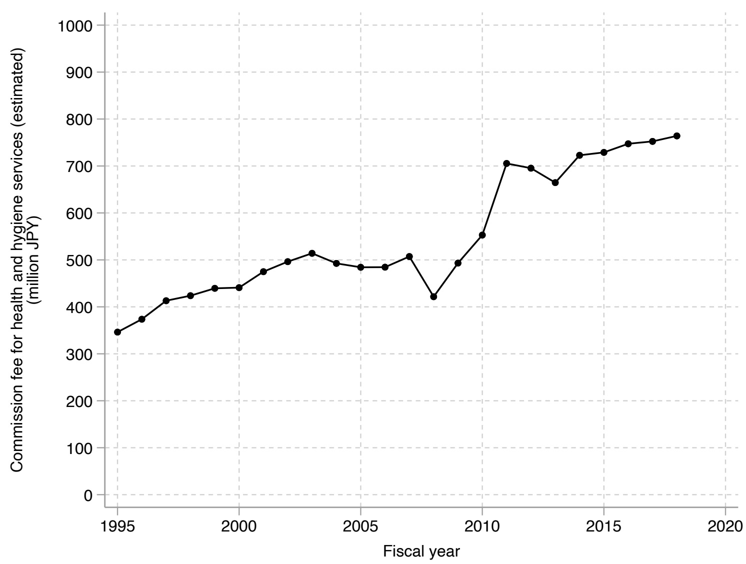


Figure A.1: Changes in Commission Fee for Health and Hygiene Services

Notes: We used the 732 municipalities that remain after the sample restriction to calculate the average commission fee fee for the *health and hygiene services* by fiscal year.

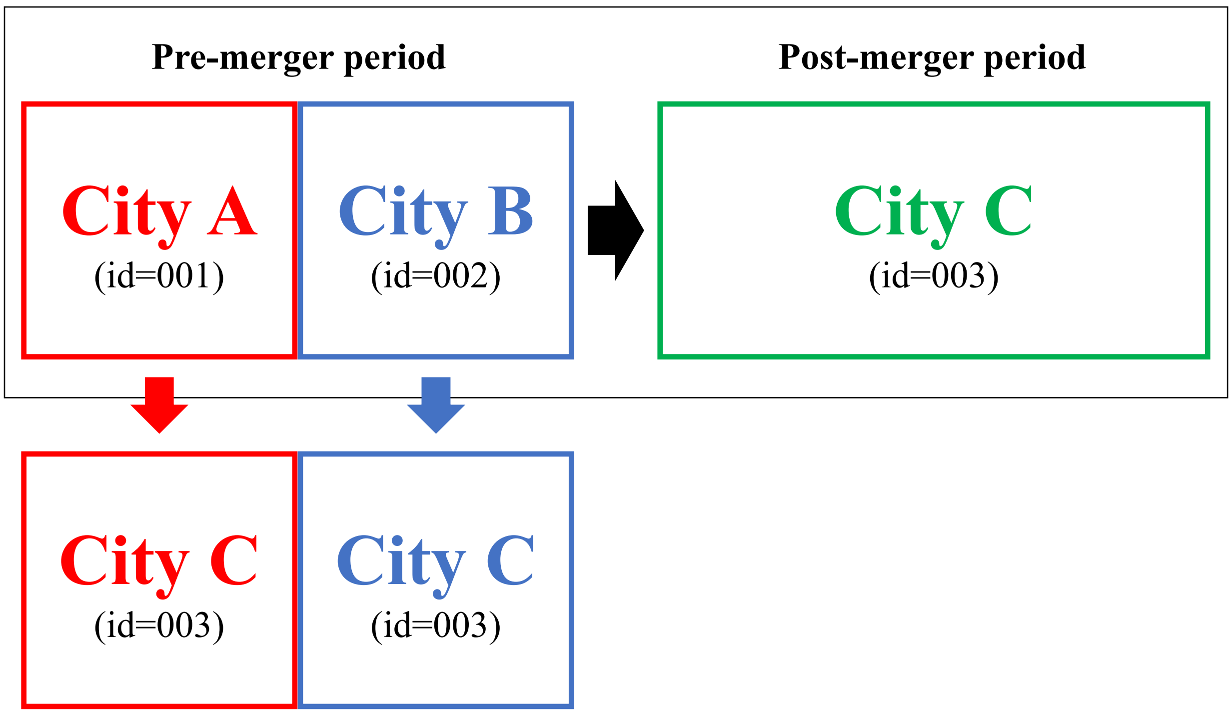


Figure B.1: Image of Kondo (2019)

Figure C.1: 32 Municipalities Which We Can Identify in The CSLC

Notes: As of 2007, the 32 municipalities covered about 27% of the population in Japan.

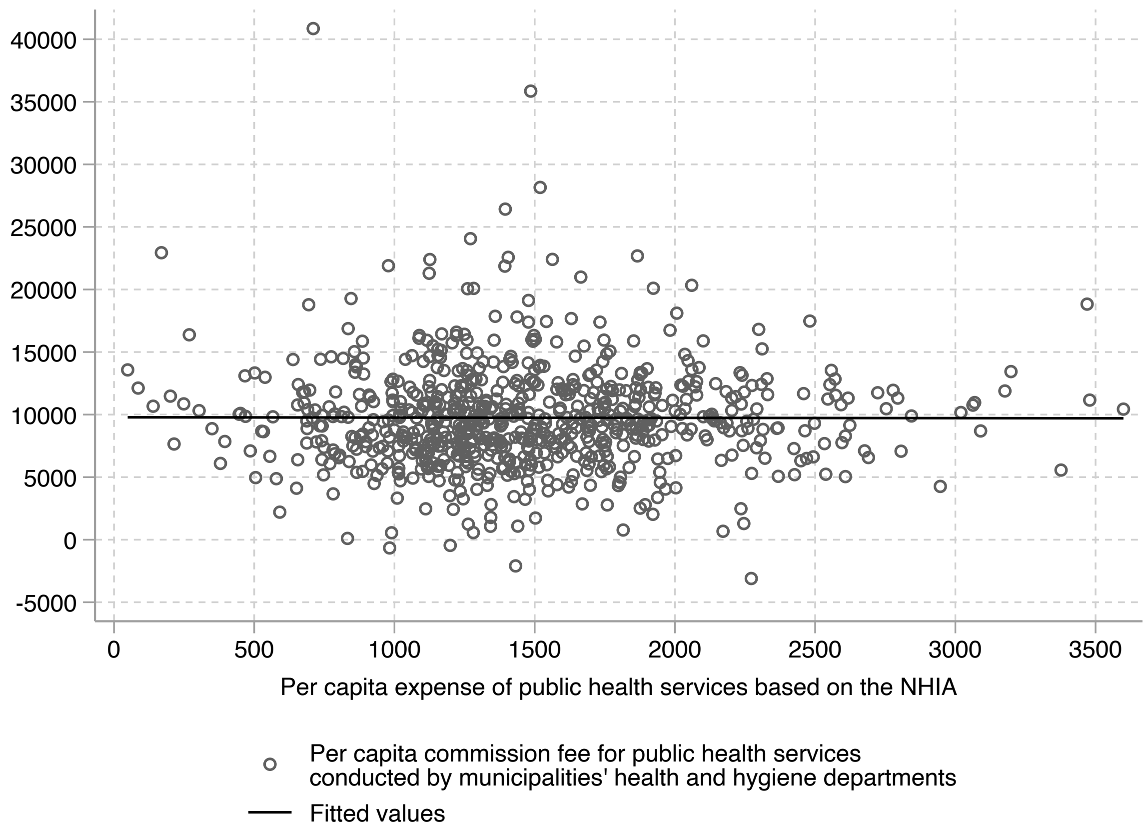
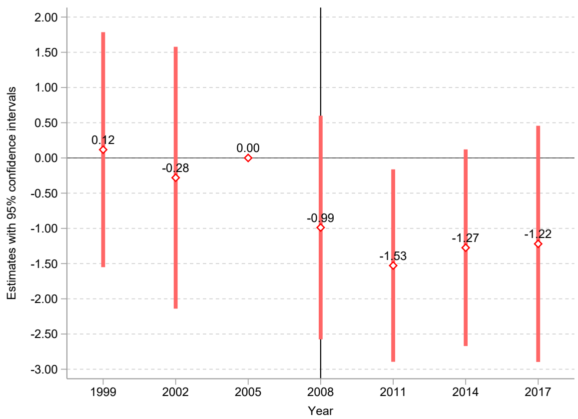
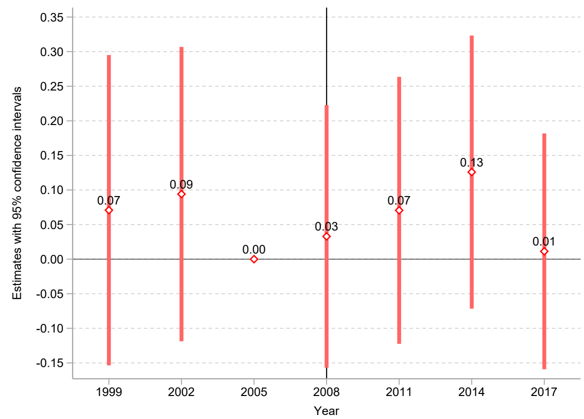


Figure C.2: Relationship between the Per Capita Expense of Public Health Services Based on the National Health Insurance Act (NHIA) and the Per Capita Commission Fee for Public Health Services Conducted by Municipalities' Health and Hygiene Departments before 2007 (Adjusted by Prefecture Fixed Effects)

Notes: The figure uses the 732 municipalities which remain after the sample restriction. We used the average values within each municipality between 1995 and 2007 for both the per capita expense of public health services based on the National Health Insurance Act (NHIA) and the per capita commission fee for public health services conducted by municipalities' health and hygiene departments. The plots are adjusted by prefecture fixed effects: we regressed each variable on prefecture fixed effects and used its residual by adding the constant term for scatter plots. The estimated slope coefficient is -0.023 with a p-value of 0.953.



(a) Total visits

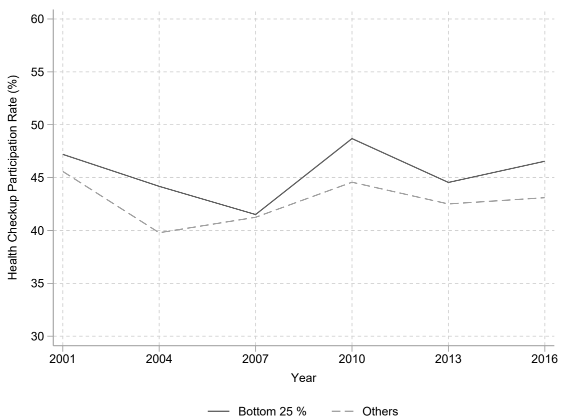


(b) First visits

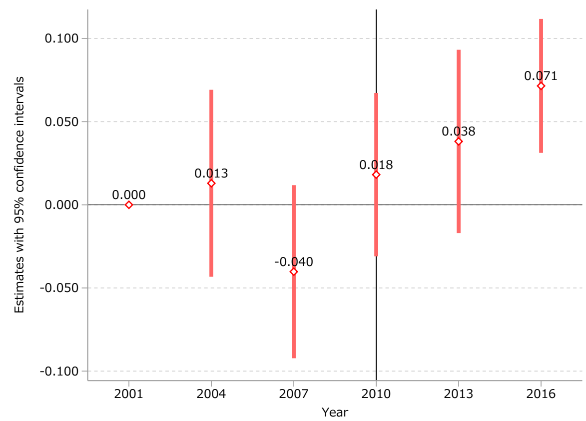
(c) Total visits (the SMCA)

Figure C.3: Event Study: Outpatient Visit Due to Lifestyle-Related Diseases

Notes: We estimated Equation (1) by using the cross terms of the treatment dummy and the year dummy variables instead of the DID term. We set 2005 as the reference time period for the Patient Survey. The diamond symbols indicate the estimates of the cross terms of the treatment dummy and the year dummy variables. The bars are the 95% confidence intervals for the estimates. The confidence intervals are calculated using standard errors robust against municipality-level clustering. Panels (a) and (b) use the Patient Survey, and Panel (c) uses the SMCA.



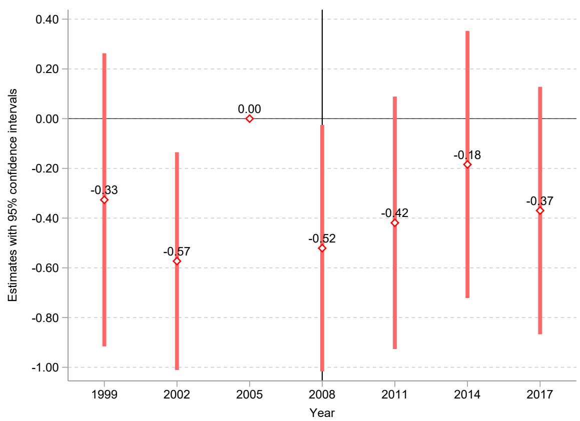
(a) Change in Raw Participation Rate



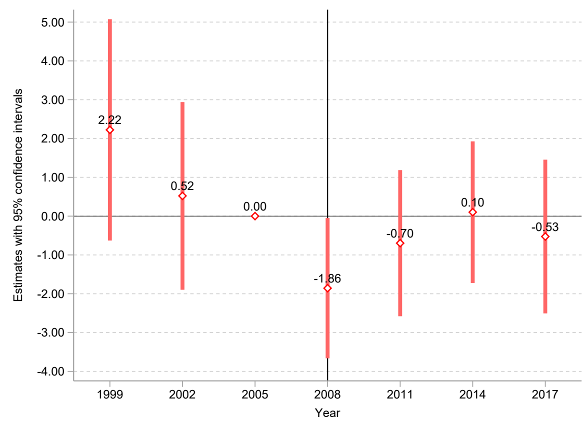
(b) Event Study (Reference year = 2001)

Figure C.4: Additional Figure for Health Checkup Participation

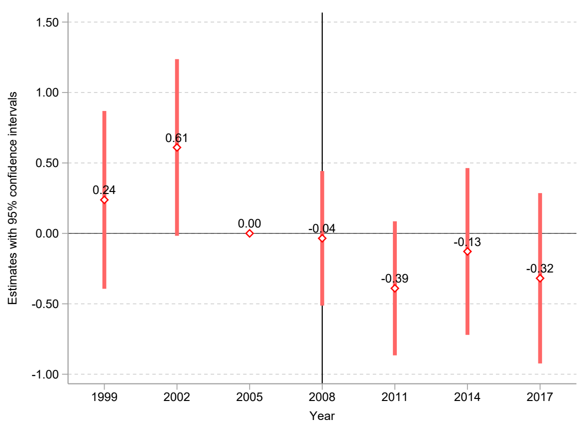
Notes: We used the people insured by the National Health Insurance (NHI) and aged between 40 and 59 for the estimations. Panel (a) shows the change in the health checkup participation rate by treatment status. Panel (b) shows the estimation results of Equation (2) by using the cross terms of the treatment dummy and the year dummy variables instead of the DID term. We set 2001 as the reference time period for Panel (b). The diamond symbols indicate the estimates of the cross terms of the treatment dummy and the year dummy variables, and the bars are the 95% confidence intervals for the estimates. The confidence intervals are calculated using standard errors robust against municipality-level clustering.



(a) Outpatient visit: Injuries (NHI)



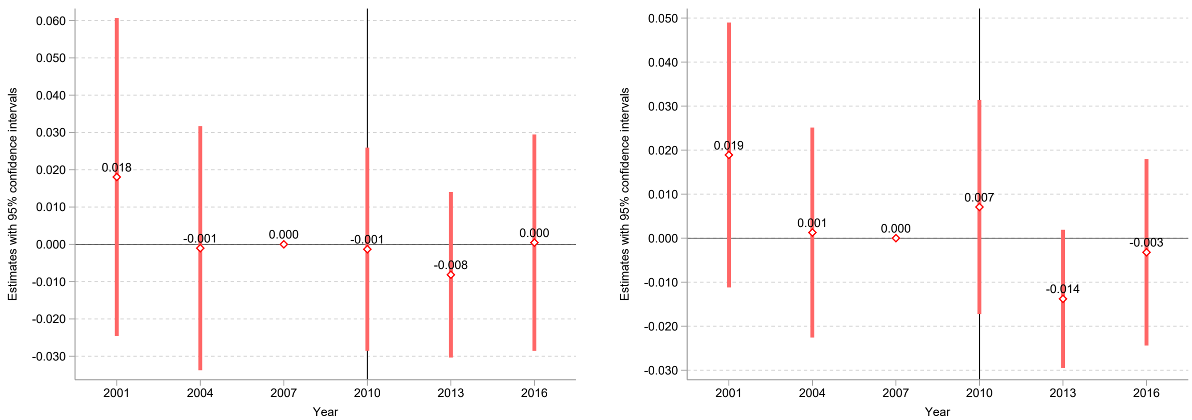
(b) Outpatient visit: lifestyle-related diseases (repeat) (EHI)



(c) Hospital admission: stroke (EHI)

Figure C.5: Placebo Regression: Health Outcomes

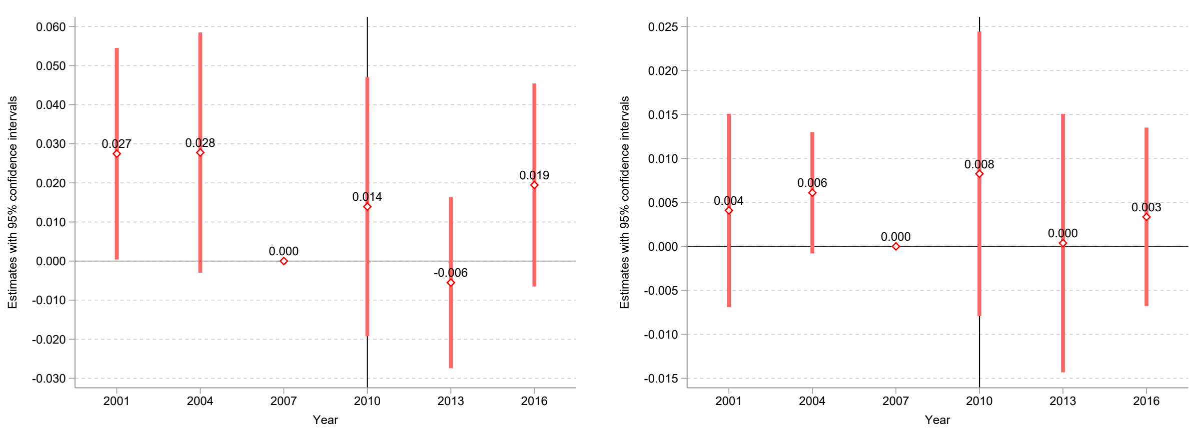
Notes: We estimated Equation (1) by using the cross terms of the treatment dummy and the year dummy variables instead of the DID term. We set 2005 as the reference time period. The diamond symbols indicate the estimates of the cross terms of the treatment dummy and the year dummy variables. The bars are the 95% confidence intervals for the estimates. The confidence intervals are calculated using standard errors robust against municipality-level clustering. Panel (a) uses the people insured by the National Health Insurance (NHI) and aged between 40 and 59, and Panels (b) and (c) use the people insured by the Employees' Health Insurance (EHI) and aged between 40 and 59.



(a) Having At Least One Symptom (EHI) (b) Having Two or More Symptoms (EHI)

Figure C.6: Placebo Regression: Subjective Symptoms (Using Individuals Insured by The EHI)

Notes: We estimated Equation (2) by using the cross terms of the treatment dummy and the year dummy variables instead of the DID term. We set 2007 as the reference time period. The diamond symbols indicate the estimates of the cross terms of the treatment dummy and the year dummy variables. The bars are the 95% confidence intervals for the estimates. The confidence intervals are calculated using standard errors robust against municipality-level clustering. We used the people insured by the Employees' Health Insurance (EHI) and aged between 40 and 59 for the estimations.



(a) Having Health Checkups (EHI) (b) Currently Quit Smoking (EHI)

Figure C.7: Placebo Regression: Health Behaviors (Using Individuals Insured by The EHI)

Notes: We estimated Equation (2) by using the cross terms of the treatment dummy and the year dummy variables instead of the DID term. We set 2007 as the reference time period. The diamond symbols indicate the estimates of the cross terms of the treatment dummy and the year dummy variables. The bars are the 95% confidence intervals for the estimates. The confidence intervals are calculated using standard errors robust against municipality-level clustering. We used the people insured by the Employees' Health Insurance (EHI) and aged between 40 and 59 for the estimations.

Table 1: Summary Statistics: The Municipality Level Panel Data

	mean	sd
Panel A: The Patient Survey		
Number of outpatient visits		
Lifestyle-related diseases	6.72	10.08
First visit	0.27	0.67
Repeat visit	6.45	9.71
Injuries	1.58	2.73
Number of hospital admission		
Major adverse cardiovascular events	1.79	3.00
Stroke	1.68	2.84
Myocardial infarction	0.11	0.40
Panel B: The SMCA		
Number of outpatient visits		
Lifestyle-related diseases	2.74	4.52
Major adverse cardiovascular events	0.45	1.12
Total expenditure spent for the outpatient visits (JPY)		
Lifestyle-related diseases	32245.38	62269.67
Major adverse cardiovascular events	6502.74	20508.22
Panel C: Other municipality characteristics		
Municipal population		
Total	153862.50	257455.45
40-44	10573.25	18825.30
45-49	10742.88	18590.50
50-54	10491.23	17659.61
55-59	10402.76	17199.41
60-64	10312.61	16912.90
65-69	9370.96	15372.13
70-74	7706.31	12504.90
Municipal financial index	0.67	0.25
Number of beds	132.37	256.20
Number of medical institutions	2220.75	3718.24
Proportion of hospitals to medical institutions	0.10	0.06
Number of medical institutions per capita	0.00	0.00
Number of beds per capita	0.02	0.01

The unit of observation is municipality-year. The number of observations is 4,883 for outpatient visits of the Patient Survey, 4996 for hospital admissions of the Patient Survey, and 8382 for the SMCA. The summary statistics for other municipality characteristics are calculated using the sample for the outpatient visits of the Patient Survey. The numbers of patients are calculated for the people insured by the NHI and aged between 40 and 59.

Table 2: Summary Statistics: The Comprehensive Survey of Living Conditions (CSLC)

	mean	sd	Survey years in which data are available: 2001	2004	2007	2010	2013	2016
Presence of subjective symptoms								
At least one	0.34	0.47	✓	✓	✓	✓	✓	✓
Two or more	0.26	0.44	✓	✓	✓	✓	✓	✓
Having health checkups	0.44	0.50	✓	✓	✓	✓	✓	✓
Smoking cessation	0.03	0.16	✓	✓	✓	✓	✓	✓
Currently drinking	0.58	0.49	✓				✓	✓
Eating habits								
Eating three proper meals	0.43	0.49	✓				✓	✓
Eating light-flavored foods	0.27	0.44	✓				✓	✓
Not overeating	0.37	0.48	✓				✓	✓
Eating well-balanced diets	0.35	0.48	✓				✓	✓
Doing exercises regularly	0.30	0.46	✓				✓	✓

The unit of observation is the individual. We calculated the statistics using the people joining the NHI aged between 40 and 59. The survey years in which data are available differ across variables, and the number of observations differs across the variables.

Table 3: Change in Per Capita Expense of Public Health Services Based on The National Health Insurance Act

	Before (1) raw	Before (2) +1916 JPY	(3) After	Difference (4) Δ	Difference (5) %Δ
All municipalities	1344.1	3259.7	4763.5	1503.7	46.1
Bottom 25%	506.5	2422.1	4488.7	2066.6	85.3
Others	1623.3	3538.9	4855.1	1316.1	37.2

Units of values are JPY. Columns (1) and (3) show the mean of the per capita expense of public health services based on the NHIA before and after the SHC-SHG was introduced, respectively. We calculated the mean values using the average values of the per capita expense within each municipality in each time period. Before the SHC-SHG was introduced, since not only the department of the NHI but also the health and hygiene department provided the health checkup programs, we estimated the per capita expense of the health checkup programs by the health and hygiene department and added it to the per capita expense of the NHI-based public health services to capture the per capita expense of the health checkup programs (Column (2)). The per capita expense of the health checkup programs by the health and hygiene department is 1916 JPY. Column (4) shows the difference between Columns (2) and (3), and Column (5) is the percentage difference between the two columns. The first row is the means among all the municipalities. We divided the 732 municipalities into two categories using the distribution of the per capita expense of public health services based on the NHIA within each municipality in 2007 or earlier: the bottom 25% and the others (the second and third rows).

Table 4: The Differences in Municipal Characteristics Between Treatment and Control Groups in 2005

	Mean		Difference		
	Control (1)	Treated (2)	Raw (3)	Adjusted[1] (4)	(4)/(1)*100 (5)
Demographics					
Municipal population	105353.2	283077.6	177724.3***	177724.3***	168.7***
			(31575.1)	(31575.1)	(30.0)
Proportion of the people aged 0-39	0.4392	0.4745	0.0353***	0.0005	0.1
			(0.0035)	(0.0036)	(0.8)
Proportion of the people aged 40-74	0.4568	0.4488	-0.0081***	0.0044**	1.0**
			(0.0019)	(0.0021)	(0.5)
Proportion of the people aged 75+	0.1039	0.0767	-0.0272***	-0.0049**	-4.7***
			(0.0020)	(0.0019)	(1.8)
Female ratio	0.5143	0.5065	-0.0078***	0.0013	0.3
			(0.0011)	(0.0008)	(0.2)
Accessibility to healthcare service					
Number of medical institutions	87.4	255.1	167.7***	19.9	22.8
			(31.5)	(16.6)	(19.0)
Number of beds	1679.8	3634.2	1954.3***	321.6	19.1
			(428.7)	(267.2)	(15.9)
Proportion of hospitals to medical institutions	0.1076	0.0805	-0.0271***	0.0005	0.5
			(0.0041)	(0.0044)	(4.1)
Number of medical institutions per capita	0.0008	0.0009	0.0001*	0.0000	5.9
			(0.0001)	(0.0000)	(4.6)
Number of beds per capita	0.0159	0.0134	-0.0025***	0.0007	4.7
			(0.0007)	(0.0007)	(4.7)
Financial condition					
Municipal financial index	0.6161	0.8261	0.2099***	0.0370*	6.0*
			(0.0222)	(0.0214)	(3.5)

We used the 732 municipalities in 2005. In Columns (3), (4), and (5), robust standard errors are in parenthesis. Inference: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[1] Column (4) shows the differences between Columns (1) and (2) after we controlled for prefecture fixed effects. We also controlled for the logged municipal population except for the first row (municipal population).

Table 5: Effects on Health Outcomes

	Outpatient visits due to lifestyle-related diseases			Hospital admissions	Subjective symptoms	
	(1)	(2)	(3)	(4)	(5)	(6)
	First visit	Repeat visit	Medical Expenditure	Stroke	≥ 1	≥ 2
Treat × After	0.020	-1.311***	-9326.727***	-0.405*	-0.0045	-0.0090
	(0.056)	(0.492)	(2899.994)	(0.209)	(0.0169)	(0.0156)
Number of observations	4181	4181	7682	4275	42836	42836
Mean (treated,before)	0.437	11.696	56988.296	3.497	0.3519	0.2746
Data	PS	PS	SMCA	PS	CSLC	CSLC

We used the people insured by the National Health Insurance (NHI) and aged between 40 and 59 for the estimations. Columns (1), (2), (3), and (4) are estimated using a fixed effects model with the municipality-level panel data and include the control variables such as the logged municipal total population, the logged municipal population by five-year age group (40-44, 45-59, 50-54, 55-59, 60-64, 65-69, and 70-74), the logged financial index, the number of beds in municipalities, the number of medical institutions in municipalities, the ratio of hospitals to total medical institutions (hospitals + clinics) in municipalities, the number of medical institutions per capita, the number of beds per capita, linear trends of municipalities by the level of the per capita expense of the public health services based on the NHI before 2008 (above v.s. below median), year-prefecture fixed effects, municipality fixed effects, and the year fixed effects. Columns (5) and (6) are estimated using the individual level data, and include the control variables such as the age dummies, the gender dummy, the dummy indicating the number of household members, and the marital status dummies (married or have partner (base), never married, widowed, divorced), the triple cross term of the big city (government ordinance-designated cities and Tokyo 23 special wards) dummy, house type dummies (one's' own house (base), private rental housing, company housing, public rental housing, and others), and the number of rooms with those first and second order terms, the logged municipal total population, the logged municipal population by an age group (40-49, 50-59, and 60-74), the logged financial index, the number of beds in municipalities, the number of medical institutions in municipalities, the ratio of hospitals to total medical institutions (hospitals + clinics) in municipalities, the number of medical institutions per capita, the number of beds per capita, linear trends of municipalities by the level of the per capita expense of the public health services based on the NHI before 2008 (above v.s. below median), the region-year fixed effects, the logged prefecture unemployment rate, the municipality fixed effects, and the year fixed effects. Standard errors robust against municipality-level clustering are shown between parentheses. Inference: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Effects on The Health Behaviors

				Eating habits				
	(1) Checkup	(2) Smoking cessation	(3) Drinking	(4) Three proper meals	(5) Light-flavored foods	(6) Not overeating	(7) Well-balanced diet	(8) Exercise
Treat × After	0.0263*	0.0139*	-0.0229**	0.0430**	0.0084	0.0316*	-0.0069	-0.0494***
	(0.0145)	(0.0072)	(0.0101)	(0.0192)	(0.0212)	(0.0156)	(0.0296)	(0.0157)
Number of observations	35508	41166	21335	21931	21931	21931	21931	21931
Mean (treated,before)	0.4573	0.0159	0.5071	0.4495	0.2952	0.3796	0.3685	0.3075

We used the people insured by the National Health Insurance (NHI) and aged between 40 and 59 for the estimations. All specifications are estimated using the individual level data, and include the age dummies, the gender dummy, the dummy indicating the number of household member, and the marital status dummies (married or have partner (base), never married, widowed, divorced), the triple cross term of the big city (government ordinance-designated cities and Tokyo 23 special wards) dummy, house type dummies (one's' own house (base), private rental housing, company housing, public rental housing, and others), and the number of rooms with those first and second order terms, the logged municipal total population, the logged municipal population by an age group (40-49, 50-59, and 60-74), the logged financial index, the number of beds in municipalities, the number of medical institutions in municipalities, the ratio of hospitals to total medical institutions (hospitals + clinics) in municipalities, the number of medical institutions per capita, the number of beds per capita, linear trends of municipalities by the level of the per capita expense of the public health services based on the NHI before 2008 (above v.s. below median), the region-year fixed effects, the logged prefecture unemployment rate, the municipality fixed effects, and the year fixed effects.. Standard errors robust against municipality-level clustering are shown between parentheses. Inference: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Back-of-the-Envelope Calculations of the Cost-Effectiveness of the Expansion of the Per Capita Expense of the Health Checkup Programs

	Lifestyle-related diseases outpatients	Cerebrovascular diseases hospital admission
Panel A		
Medical expenditure reduced by the expansion		
Annual medical expenditures (billion JPY)		
(1) For entire population	778.4	265.5
Source: ENME		
(2) For treated individuals (billion JPY)	96.7	33.0
(1) × ratio of treated individuals (0.124) [1]		
(3) Estimated effects of the expansion	-16.4% [2]	-11.6% [3]
Calculated using data from Table 5		
(4) Reduced medical expenditure for each service	-15.83	-3.82
(2) × (3) (billion JPY)		
(5) Total (billion JPY)		-19.7
Panel B		
Municipal expense of the health checkup program by the expansion		
(6) Increased total expense of the health checkup program for the treated (billion JPY)		3.23
Increased per capita expense (750.5 JPY) [4] × number of treated individuals(4,303,786)		
Panel C		
Ratio of reduced medical expenditure to increased expense		
(5)/(6)		-6.1

[1] 0.12426784.

[2] -9326.727/56988.296.

[3] -0.405/3.497.

[4] The increase in the estimated per capita expense of the municipal health checkup programs among the treated municipalities compared to that among the control municipalities.

Table A.1: The Budget Amounts of Public Health Services Based on the National Health Insurance Act in The Fiscal Year of 2018

	Total	SHC-SHG	% of SHC-SHG
Sapporo	1163.6	795.9	68.4
Sendai	1025.6	946.6	92.3
Saitama	1194.0	1115.0	93.4
Chiba	902.9	822.0	91.0
Setagaya	958.2	948.2	99.0
Suginami	694.5	648.1	93.3
Nerima	744.6	726.6	97.6
Adachi	715.6	712.6	99.6
Katsushika	560.4	560.4	100.0
Edogawa	665.9	494.1	74.2
Hachioji	812.1	775.2	95.5
Tachikawa	179.0	140.1	78.3
Machida	634.9	611.0	96.2
Yokohama	2052.8	1902.7	92.7
Kawasaki	762.2	658.7	86.4
Sagamihara	822.0	544.8	66.3
Nagoya	1427.7	1166.1	81.7
Osaka	1713.3	1145.4	66.9
Sakai	838.2	534.2	63.7
Kobe	1174.4	1094.5	93.2
Fukuoka	889.6	705.0	79.2
Summary statistics			
mean	949.1	811.8	86.1
median	838.2	726.6	92.3
min	179.0	140.1	63.7
max	2052.8	1902.7	100.0

We collected the data on the budget amounts from municipalities' web pages. The unit of the first and second columns is one billion JPY.

Table A.2: Summary Statistics of Municipal Expenses

	mean	sd
Expense of public health services based on the NHIA (million JPY)		
-2007	37.8	52.9
2008-	113.3	145.2
Commission fee for public health services by the HHD (million JPY) (-2007)	392.9	644.1
Population insured by the municipalities' NHI		
aged over 40 (-2007)	35335.6	54917.2
aged between 40 and 74 (2008-)	26212.1	43046.1
Per capita expense of public health services based on the NHIA (JPY)		
-2007	1344.1	744.7
2008-	4763.5	1495.5
Per capita commission fee for public health services by the health and hygiene department (JPY) (-2007)	12334.0	5036.4

We used the 732 municipalities.

Table C.1: Individual Characteristics among the Individuals Not Participating in Any Health Checkup Program before 2008 by Individuals' Change in the Participation Behavior after the Policy Introduction

	(1) $0 \rightarrow 0$	(2) $0 \rightarrow 2+$	(3) Difference
Age (2005)	52.27	52.10	-0.17*
			(0.10)
Male	0.34	0.29	-0.05
			(0.03)
University graduates	0.11	0.10	-0.02
			(0.02)
Live with spouse (2005)	0.81	0.84	0.03
			(0.03)
Diagnosed with lifestyle-related diseases (at least once in 2005-2007)	0.14	0.18	0.04
			(0.03)
Poor health (at least once in 2005-2007)	0.26	0.24	-0.03
			(0.03)
Spending for health promotion (1k JPY) (average between 2005 and 2007	1.80	15.71	13.92
			(10.79)
Drinking more than 3 days per week (at least once in 2005-2007)	0.35	0.34	-0.00
			(0.04)
Currently smoking (at least once in 2005-2007)	0.32	0.29	-0.03
			(0.03)

Notes: This table shows the individual characteristics among the individuals not participating in any health checkup program before the Specific Health Checkups and Specific Health Guidance was introduced, from 2005 to 2007. We divided the sample by individuals' change in participation behavior after the policy introduction: keeping not participating ($0 \rightarrow 0$, Column (1)) and increasing frequency of the participation to 2 or 3 in the following three years (2008-2010) ($0 \rightarrow 2+$, Column (2)). We used individuals aged between 50 and 54 in 2005 and who were not undergoing any health checkup program between 2005 and 2007 from the Longitudinal Survey of Middle-aged and Elderly Persons (LSMEP). We restricted the sample to the individuals who are likely to be insured by the National Health Insurance, such as individuals who do not work, self-employed workers, family employees, and part-time workers. Column (3) indicates the differences between Columns (1) and (2). Inference: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.2: Placebo Regression: Health Behaviors (Using Individuals Insured by The EHI)

		Eating habits				
	(1) Drinking	(2) Three proper meals	(3) Light-flavored foods	(4) Not overeating	(5) Well-balanced diet	(6) Exercise
Treat×After	0.0034	0.0015	-0.0290**	0.0162	-0.0036	0.0421***
	(0.0172)	(0.0159)	(0.0128)	(0.0101)	(0.0101)	(0.0146)
Number of observations	54433	55345	55345	55345	55345	55345
Mean (treated,before)	0.6630	0.4554	0.2689	0.3336	0.3591	0.3055

We used the people insured by the Employees' Health Insurance (EHI) and aged between 40 and 59 for the estimations. All specifications are estimated using the individual level data, and include the age dummies, the gender dummy, the dummy indicating the number of household member, and the marital status dummies (married or have partner (base), never married, widowed, divorced), the triple cross term of the big city (government ordinance-designated cities and Tokyo 23 special wards) dummy, house type dummies (one's' own house (base), private rental housing, company housing, public rental housing, and others), and the number of rooms with those first and second order terms, the logged municipal total population, the logged municipal population by an age group (40-49, 50-59, and 60-74), the logged financial index, the number of beds in municipalities, the number of medical institutions in municipalities, the ratio of hospitals to total medical institutions (hospitals + clinics) in municipalities, the number of medical institutions per capita, the number of beds per capita, linear trends of municipalities by the level of the per capita expense of the public health services based on the NHI before 2008 (above v.s. below median), the region-year fixed effects, the logged prefecture unemployment rate, the municipality fixed effects, and the year fixed effects.. Standard errors robust against municipality-level clustering are shown between parentheses. Inference: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.3: Robustness Check Against Cutoff Values for Treatment Status

	Outpatient visits due to lifestyle-related diseases								
	Repeat visits			Medical expenditure			Hospital admission due to Stroke		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Cutoff values	pre-SHC-SHG mean (treated)	DID estimates	%Δ compared to pre-SHC-SHG mean	pre-SHC-SHG mean (treated)	DID estimates	%Δ compared to pre-SHC-SHG mean	pre-SHC-SHG mean (treated)	DID estimates	%Δ compared to pre-SHC-SHG mean
15 percentile	13.065	-1.434**	-11.0%	66889.504	-7135.804*	-10.7%	3.766	-0.464	-12.3%
[2.59]		(0.651)			(3851.497)			(0.294)	
20 percentile	12.353	-1.437**	-11.6%	61526.254	-7720.870**	-12.5%	3.583	-0.305	-8.5%
[2.40]		(0.565)			(3429.426)			(0.273)	
25 percentile	11.696	-1.311***	-11.2%	56988.296	-9326.727***	-16.4%	3.497	-0.405*	-11.6%
[2.29]		(0.492)			(2899.994)			(0.209)	
30 percentile	10.743	-1.052**	-9.8%	52848.979	-9763.709***	-18.5%	3.234	-0.169	-5.2%
[2.18]		(0.458)			(2786.943)			(0.195)	
35 percentile	10.460	-1.162**	-11.1%	50368.848	-7455.665***	-14.8%	3.101	-0.143	-4.6%
[2.14]		(0.451)			(2854.519)			(0.189)	

We used the people insured by the National Health Insurance (NHI) and aged between 40 and 59 for the estimations. All specifications are estimated using a fixed effects model with the municipality-level panel data and include the control variables such as the logged municipal total population, the logged municipal population by five-year age group (40-44, 45-59, 50-54, 55-59, 60-64, 65-69, and 70-74), the logged financial index, the number of beds in municipalities, the number of medical institutions in municipalities, the ratio of hospitals to total medical institutions (hospitals + clinics) in municipalities, the number of medical institutions per capita, the number of beds per capita, linear trends of municipalities by the level of the per capita expense of the public health services based on the NHI before 2008 (above v.s. below median), year-prefecture fixed effects, municipality fixed effects, and the year fixed effects. We used five percentiles (15, 20, 25, 30, and 35 percentiles) as cutoff values to construct the treatment status variable. The square bracket below each cutoff value indicates the ratio of the percentage increase in the health checkup programs expense per capita in the treated municipalities to the increase in the control municipalities. So, the value of 2.59 indicates that the percentage increase in the treated municipalities is about 2.59 times larger than that in the control municipalities. The percentage change is calculated in the same manner as Column (5) of Table 3. Inference: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.4: Robustness Check Against Cutoff Values for Treatment Status 2 (Hospital Admission Due to Stroke)

		$Treat \times 2011-2014$		$Treat \times 2017$	
	(1)	(2)	(3)	(4)	(5)
Cutoff values	pre-SHC-SHG mean (treated)	Estimates	%Δ compared to pre-SHC-SHG mean	Estimates	%Δ compared to pre-SHC-SHG mean
15 percentile [2.59]	3.766	-0.431 (0.299)	-11.4%	-0.535 (0.380)	-14.2%
20 percentile [2.40]	3.583	-0.240 (0.271)	-6.7%	-0.455 (0.365)	-12.7%
25 percentile [2.29]	3.497	-0.331 (0.224)	-9.5%	-0.585** (0.251)	-16.7%
30 percentile [2.18]	3.234	-0.105 (0.205)	-3.2%	-0.340 (0.238)	-10.5%
35 percentile [2.14]	3.101	-0.110 (0.192)	-3.5%	-0.250 (0.238)	-8.1%

We used the people insured by the National Health Insurance (NHI) and aged between 40 and 59 for the estimations. All specifications are estimated using a fixed effects model with the municipality-level panel data and include the control variables such as the logged municipal total population, the logged municipal population by five-year age group (40-44, 45-59, 50-54, 55-59, 60-64, 65-69, and 70-74), the logged financial index, the number of beds in municipalities, the number of medical institutions in municipalities, the ratio of hospitals to total medical institutions (hospitals + clinics) in municipalities, the number of medical institutions per capita, the number of beds per capita, linear trends of municipalities by the level of the per capita expense of the public health services based on the NHI before 2008 (above v.s. below median), year-prefecture fixed effects, municipality fixed effects, and the year fixed effects. We used five percentiles (15, 20, 25, 30, and 35 percentiles) as cutoff values to construct the treatment status variable. The square bracket below each cutoff value indicates the ratio of the percentage increase in the health checkup programs expense per capita in the treated municipalities to the increase in the control municipalities. So, the value of 2.59 indicates that the percentage increase in the treated municipalities is about 2.59 times larger than that in the control municipalities. The percentage change is calculated in the same manner as Column (5) of Table 3. Inference: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.5: The Effects on the Migration from the Other Municipalities and the Target Population of the SHC-SHG.

	(1) Migration (log)	(2) Target population (log)
Treat × After	0.010	0.006
	(0.010)	(0.005)
Number of observations	13176	16831
Years in which data are available	2000-2017	1995-2017

The unit of observations is municipality-year. In the estimation for the number of migrations, we controlled for the logged municipal population (total, 40-44, 45-59, 50-54, 55-59, 60-64, 65-69, 70-74), the logged financial index, linear trends of municipalities by the level of the per capita expense of the public health services based on the NHI (above and below median), municipality fixed effects, year fixed effects, and prefecture and year fixed effects. In the estimation for the target population, we used the same control variables as that for the number of migrations except for the municipal population by the five-year age group. This is because the population insured by the municipalities' NHI is estimated using the municipal population by the five-year age group and the proportion of the population insured by the municipalities' NHI by prefecture and year. Inference: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.