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ABSTRACT

Objective: To investigate the association between participation in government subsidies for domestic travel (subsidize up to 50% of all travel expenses) introduced nationally in Japan on July 22, 2020, and the incidence of symptoms indicative of COVID-19 infections.

Design: Cross-sectional analysis of nationally-representative survey data.

Setting: Internet survey conducted between August 25 and September 30, 2020, in Japan. Sampling weights were used to calculate national estimates.

Participants: 25,482 survey respondents (50.3% [12,809] women; mean [SD] age, 48.4 [17.4] years).

Main Outcome Measures: Incidence rate of five symptoms indicative of the COVID-19 infection (high fever, sore throat, cough, headache, and smell and taste disorder) within the past month of the survey, after adjustment for characteristics of individuals and prefecture fixed effects (effectively comparing individuals living in the same prefecture).

Results: At the time of the survey, 3,289 (12.9%) participated in the subsidy program. After adjusting for potential confounders, we found that participants in the subsidy program exhibited higher incidence of high fever (adjusted rate, 4.8% for participants vs. 3.7% for non-participants; adjusted odds ratio [aOR], 1.90; 95%CI, 1.42-2.54; p<0.001), sore throat (19.8% vs. 11.3%; aOR, 2.09; 95%CI, 1.37-3.20; p=0.002), cough (19.1% vs. 11.2%; aOR 1.96; 95%CI, 1.27-3.02; p=0.007), headache (29.1% vs. 25.5%; aOR, 1.24; 95%CI, 1.07-1.43; p=0.007), and smell and taste disorder (2.6% vs. 1.8%; aOR 1.98; 95%CI; 1.15-3.40; p=0.01) compared with non-participants. These findings remained qualitatively unaffected by additional adjustment for the use of 17 preventative measures (e.g., social distancing, wearing masks, and handwashing).

Conclusions: The participation of the government subsidy program for domestic travel was associated with a higher probability of exhibiting symptoms indicative of the COVID-19 infection.

Keywords: Pandemic; coronavirus; COVID-19; public policy; economic stimulus

ARTICLE SUMMARY

Strengths and limitations of this study

- This is the first study that investigates the association between the participation in government subsidy program for domestic travel and the incidence of symptoms indicative of COVID-19, by using data from a large nationwide internet survey conducted in Japan.
- We used a unique setting in which a large nationwide government subsidy for travel was initiated before the spread of COVID-19 was contained.
- Given the cross-sectional design of our study, we could not identify the temporal relationship between the subsidy program and the incidence of COVID-19-like symptoms.
- Our findings may be affected by the possibility that individuals who presented with COVID-19-like symptoms might recall and report using the subsidy program for domestic travel (recall bias).

INTRODUCTION

As of the end of December 2020, 81 million people have been infected by the coronavirus disease 2019 (COVID-19), and 1.8 million have died from this infection [1]. To tackle this unprecedented pandemic, many countries have implemented public health measures — also known as non-pharmaceutical interventions (NPIs) — to control the spread of the virus, including lockdowns, movement restrictions, quarantines, and border controls [2]. Given that the number of infections and deaths due to COVID-19 has resurged this winter, these NPIs are likely to be implemented intermittently [3], until effective vaccines are developed and become widely available. While these NPIs have been shown to be effective in reducing the spread of COVID-19 infections [2,4], they have a substantial negative impact on economies [5]. As a countermeasure against the economic downturns due to the NPIs, many countries have introduced, or are actively considering, financial incentives such as government subsidies to engage in economic activities, such as using restaurants or traveling domestically [6-10].

Evidence is limited as to whether the government interventions to financially incentivize economic activities, such as using restaurants or traveling, impact the COVID-19 infection rate. For example, the United Kingdom implemented the "*Eat out to Help out*" campaign, in which the government subsidized up to 50% of the expenses of food and non-alcoholic drinks for immediate consumption at restaurants using a budget of around £500 million throughout August, 2020 [9]. A recent study using ecological data on COVID-19 infections by region suggested that regions that implemented this campaign experienced 8-17 percentage points higher number of COVID-19 clusters [11]. However, an ecological association does not imply that the same association would be observed at the individual level (the "ecological fallacy"), and therefore, it remains unknown as to whether this policy actually led to an increased number of individuals infected by COVID-19. Indeed, to our knowledge, no study to date has evaluated the impact of such an economic policy on the risk of contracting the COVID-19 infection using individual-level data. Moreover, it remains unknown as to how similar policies implemented in other countries that incentivize economic activities (e.g., eating out, travel) affected the COVID-19 pandemic.

Japan implemented a large-scale, nationwide government subsidy program for domestic travel (called the "*Go-To Travel*" Campaign) [8] on July 22, 2020 (announced on July 10, 2020) to revive the travel industry, which has been hit hard by a substantial decrease in the number of foreign tourists visiting Japan. This program incentivizes people to travel domestically by subsidizing up to 50% of transportation and accommodation expenses for travelers. As of the end of October 2020, more than 200 billion Japanese yen (JPY) (approximately 2 billion US dollars (USD), using an exchange rate of 100 JPY per USD) have been used to subsidize a total of 40 million people who traveled domestically [12]. However, as the number of COVID-19 infected cases has resurged, the Japanese government has faced fierce criticisms from those speculating that increased mobility and human interactions due to the "*Go-To Travel*" program may be causing the increase in the number of COVID-19 infections [13]. Yet, empirical evidence is lacking as to whether the introduction of this program is associated with an increased risk of contracting the COVID-19 infection. Japan's experience from this social experiment provides a unique opportunity to understand the impact of government subsidies for travel on the spread of COVID-19 infections.

In this context, using data from a large internet survey conducted in Japan between August 25 and September 30, 2020, we examined whether individuals who used subsidies experienced a higher incidence of symptoms indicative of the COVID-19 infection (COVID-19-like symptoms).

METHODS

Study design, setting, and data sources

We analyzed data from the *Japan "COVID-19 and Society" Internet Survey (JACSIS)* study, a cross-sectional, web-based, self-reported questionnaire survey administered by a large internet research agency (Rakuten Insight, Inc., which had approximately 2.2 million qualified individuals in 2019) [14]. This internet research agency has been used in previous studies [15,16]. This study collected a wide range of socio-demographic, lifestyle, and health measures from individuals aged 15-79 years. The questionnaires were distributed to 224,389 individuals selected by gender, age, and prefecture category using simple random sampling and covering all 47 prefectures (first-tier administrative districts in Japan). Individuals who consented to participate in the survey accessed the designated website and responded to questionnaires; they also had the option not to respond or to discontinue at any point in the survey. Questionnaires were distributed from August 25, 2020, until September 30, 2020, when the target number of respondents for each gender, age, and prefecture category were met. These target numbers had been determined in advance according to the population distribution in 2019 as 28,000 respondents and a response rate of 12.5% (28,000/224,389). We excluded 2,518 individuals showing unnatural or inconsistent responses using the algorithm we developed. The final sample size was 25,482 respondents (91.0% of the total survey respondents).

Exposure variables

The primary exposure variable was participation in the subsidy program for domestic travel, which was announced on July 10, 2020, and implemented on July 22, 2020.

Outcome variables

Our outcome variable was the incidence of five self-reported COVID-19-like symptoms (high fever, sore throat, cough, headache, and smell and taste disorder) within the past month of the survey [17]. Self-reported COVID-19-like symptoms have been reported as a useful measure to monitor the spread of COVID-19 infections [18,19].

Adjustment variables

We adjusted for the respondents' demographics [20], socio-economic status (SES) [21], health-related characteristics [20], use of preventive measures (see below for details), and prefecture fixed effects. The demographics included age (categorized as 15-19, 20-29, …, 70-79) and gender. The SES included academic attainment (graduated from college or institutions of higher education vs. high school or lower institutions), income level (categorized using the tertiles of household equivalent income ["low" = less than 2.5 million JPY, "medium" = 2.5 to 4.3 million JPY, and "high" = more than 4.3 million JPY], and an indicator for those who refused to respond to this question), household size (number of household members: 1, 2, 3, 4 and 5+), employment status (employer, self-employed, employee, and unemployed), and marital status (married, never married, widowed, and separated). The household equivalized income was calculated as the gross (pre-tax) income in 2019, divided by the square root of the number of household members.

Health-related characteristics included smoking status (never, ever, and current smokers), walking disability (whether the person is experiencing difficulties in walking), and eight comorbidities (overweight [body mass index ≥ 25 kg/m^2] and seven self-reported past medical histories of hypertension, diabetes, asthma, coronary disease, stroke, chronic obstructive pulmonary disease, and cancer). Body mass index was calculated by dividing self-reported body weight by self-reported body height squared (m^2).

As for preventive measures, the personal preventive actions included indicators of whether the respondent implemented each of the nine personal protective measures (1 = always/sometimes, 0 = rarely/never) recommended by the World Health Organization (WHO) [22]: social distancing, wearing masks, avoiding closed spaces, avoiding crowded spaces, avoiding close contact settings, handwashing, avoiding touching face, respiratory hygiene, and surface disinfection. High-risk behavior patterns included indicators of whether the respondent visited restaurants, bars/nightclubs, karaoke bars, fitness clubs, and brothels during the state of emergency in April-May (1 = frequently, occasionally, at least once, 0 = never) [23]. Proxy variables of other preventive measures included indicators of the use of the contact-tracing application [24], support for stay-at-home requests (1 = very/somewhat, 0 = slightly/never), and influenza vaccination in the last season (as a proxy for the likelihood of receiving the COVID-19 vaccination when it becomes available).

Prefecture fixed effects are indicator variables for each prefecture, which account for both measured and unmeasured characteristics of the prefecture (Japan consists of 47 prefectures, which are the country's first jurisdiction and administrative division levels). The inclusion of prefecture fixed effects allows us to effectively compare participants vs. non-participants of the program living in the same prefecture.

Statistical analysis

First, we compared the demographics, SES, health-related characteristics, and preventive measures employed by participants in the subsidy program for domestic travel vs. non-participants. To account for the possibility that those who participated and responded to the internet-based survey may differ from the general population (e.g., a younger population may be more likely to participate and respond to an internet-based survey), we applied an inverse probability weighting (IPW) approach throughout the analyses [25]. The weights (the inverse of propensity scores representing the estimated probability of participating in the survey) were calculated by fitting a logistic regression model using demographics, SES, and health-related characteristics to adjust for the difference in respondents between the current internet survey and a widely-used nationwide representative survey (i.e., the 2016 Comprehensive Survey of Living Conditions [26,27]) (see **Method A1** for details).

Second, we examined the association between participation in the subsidy program for domestic travel and the incidence rates of COVID-19-like symptoms. For each outcome, we constructed two regression models to control for potential confounders. Model 1 adjusted for the respondents' sociodemographic characteristics, health-related characteristics, and prefecture fixed effects. Model 2 adjusted for all the variables included in Model 1 plus the use of preventive measures, to investigate whether these factors could explain the observed differences in the incidence of symptoms related to COVID-19. We used weighted multivariable logistic regression models, with standard errors clustered at the prefecture-level, to account for the potential correlation of respondents within the same prefecture. To calculate risk-adjusted incidence rates of COVID-19-like symptoms, we used marginal standardization (also known as predictive margins or margins of response) [28]. For each respondent, we calculated predicted probabilities of the incidence of COVID-19-like symptoms with participation in the subsidy program fixed at each category and then averaged over the distribution of covariates in our sample.

To adjust for multiple comparisons of having five outcome variables using the Holm method [29], which sequentially compares the i-th smallest P value (for $i = 1, \ldots, 5$) among the five original P values with progressively less restrictive alpha levels ($= 0.05/(5 - i + 1)$). To make the interpretation easier, we calculated the adjusted P value by multiplying the unadjusted P values by $(5 - i + 1)$ times, and considered the adjusted P value < 0.05 to be statistically significant [30].

Secondary analysis

We conducted sensitivity analyses. First, we additionally adjusted for a categorical variable representing the perceived fear against the COVID-19 infection (measured on a five-point scale of "not afraid at all (0% if I were to rate the level of fear between 0% and 100%)," "not afraid (25%), "neutral (50%)," "somewhat afraid (75%)," and "very afraid (100%)" to the question "Are you afraid of the COVID-19 infection?") to test whether the difference in the risk preference between participants and non-participants could explain the observed differences in the incidence of the COVID-19-like symptoms. Second, travelers to and from Tokyo were ineligible for the subsidy program until September 15, due to a large number of COVID-19 cases in Tokyo [8]. To assess whether our findings were sensitive to the inclusion of Tokyo residents (we included these individuals in our main analyses as they could still participate in the subsidy program if their companion lived in prefectures other than Tokyo), we reanalyzed the data after excluding those respondents living in Tokyo prefecture. Third, we repeated the analyses without using IPW to examine how the use of this approach affected our findings. Fourth, it is possible that we were comparing individuals who were more versus less likely to travel regardless of the existence of the government subsidy program for travel. To test this hypothesis, we reanalyzed the data restricting to individuals who reported that did not eliminate the possibility of traveling in the past month (excluded individuals who reported that they had avoided any travels in the past month to the question "Have you avoided travels in the past one month?" Fifth, to test whether the impact of the subsidy program varied by respondents' characteristics, we conducted stratified analyses by age (15-64 years and 65-79 years), the presence of comorbidities (no comorbidities vs. having at least one comorbidity), and gender.

All analyses were conducted using Stata version 15 (College Station, TX; StataCorp LLC.).

Patient and public involvement

No respondents were involved in setting the research question or the outcome measures, nor were they involved in the design, implementation, interpretation of the study. All respondents gave informed consent to enroll in the study.

RESULTS

Characteristics of respondents

Of the 25,482 respondents, 3,289 (12.9%) had participated in the subsidy program for domestic travel at the time of the survey. Participants in the subsidy program were younger; had higher education and income levels; and were more likely to be overweight (**Table 1**). We found no systemic patterns regarding the implementation of preventive actions recommended by WHO (**Table 2**). Notably, participants in the subsidy program were more likely than non-participants to engage in risky behavior patterns (visiting restaurants, bars/nightclubs, karaoke bars, or fitness clubs at least once) during the state of emergency. As for other preventive measures, participants in the subsidy program were more likely to use the contact-tracing application and to have received the flu vaccine in the prior year.

Participation in the subsidy program for domestic travel and COVID-19-like symptoms

After adjusting for demographics, SES, health-related characteristics and indicators of prefectures (Model 1 in **Table 3**), we found that the adjusted incidence rates of COVID-19-like symptoms were higher for subsidy program participants compared with non-participants for high fever (adjusted rate, 4.8% for participants vs. 3.7% for non-participants; adjusted odds ratio [aOR], 1.90; 95%CI, 1.42-2.56; p<0.001), sore throat (19.8% vs. 11.3%; aOR, 2.09; 95%CI, 1.37-3.20; p=0.002), cough (19.1% vs. 11.2%; aOR 1.96; 95%CI, 1.27-3.02; p=0.007), headache (29.1% vs. 25.5%; aOR, 1.24; 95%CI, 1.07-1.43; p=0.007), and smell and taste disorder (2.6% vs. 1.8%; aOR 1.98; 95%CI; 1.15-3.40; p=0.01). These findings remained largely unchanged after additional adjustments for the use of preventive measures in Model 2: the adjusted incidence rates of COVID-19-like symptoms were higher for subsidy program participants compared with non-participants for high fever (4.4% vs. 3.7%; aOR, 1.58; 95%CI, 1.11-2.24; p=0.03), sore throat (18.7% vs. 11.5%; aOR, 1.91; 95%CI, 1.35-2.72; p=0.001), cough (17.4%

vs. 11.5%; aOR 1.70; 95%CI, 1.22-2.38; p=0.007), headache (28.1% vs. 25.7%; aOR, 1.16; 95%CI, 1.02-1.33; p=0.03), and smell and taste disorder (2.4% vs. 1.8%; aOR 1.63; 95%CI; 1.10-2.40; p=0.03).

Secondary analysis

Our findings were largely unaffected by additional adjustment for fear against the COVID-19 infection (**Table A1**), excluding respondents living in Tokyo (**Table A2**), and using unweighted regression models (**Table A3**). The results of the analysis excluding individuals who avoided travels in the past month showed higher incidence rates of sore throat and cough among subsidy program participants compared with non-participants (**Table A4**). However, we found no evidence that the incidence of the other three symptoms differed between these two groups. The result of the stratified analyses by age showed that the higher incidence rates of COVID-19-like symptoms were more salient among young respondents (**Table A5**). For example, among respondents aged 15-64 years, the adjusted incidence rate of smell and taste disorder was higher for subsidy program participants compared with younger non-participants, whereas the incidence rates did not differ between participants and non-participants among those aged 65-79 years (p for interaction = 0.03). We found no systemic difference in patterns regarding the association between subsidy program participation and COVID-19-like symptoms for the stratified analyses by the presence of comorbidity and gender (**Tables A6 and A7**).

Discussion

Using the data from a large cross-sectional internet survey that included more than 25,000 adults in Japan, we found that individuals who participated in the government's subsidy program for domestic travel experienced a higher incidence of COVID-19-like symptoms compared with those who did not participate. This association was also observed for the incidence of smell and taste disorder, which is a highly specific symptom of the COVID-19 infection [17,31]. These findings were qualitatively unaffected by additional adjustments for preventive measures, indicating that the systemic differences in participants and non-participants in the subsidy program regarding risky behaviors do not explain the observed associations between the subsidy program and the higher incidence of COVID-19-like symptoms. This increased incidence of COVID-19-like-symptoms was salient among individuals aged <65 years, but not for those aged ≥ 65 years, suggesting that the non-elderly generation may be contributing to the spread of COVID-19 infection associated with this program. Given that the Japanese government is debating whether to continue or halt this subsidy program due to concerns about increased risks of COVID-19 infections, and that other countries are actively considering similar policies to stimulate their economies [6-10], our findings should be informative for designing policies that could increase economic activities without exacerbating the COVID-19 pandemic.

There are several mechanisms through which participation in this subsidy program for domestic travel was associated with a higher incidence of COVID-19-like symptoms. First, increased contact with people while dining and sightseeing at the destination in traveling may have led to a higher risk of incidence of COVID-19 (causal effect). This explanation is supported by a recent genome epidemiological study of SARS-CoV-2 in Japan that found the possibility that the COVID-19 clusters in the Tokyo metropolitan areas might have spread throughout Japan after lifting movement restrictions [32]. This hypothesis is supported by a study from the US that found the volume of domestic airline travel around the Thanksgiving holiday was positively associated with the spread of seasonal influenza [33]. Second, subsidy program participants might have been more likely to engage in behaviors that placed them at greater risk of contracting COVID-19 than non-participants (selection effect). However, the fact that our results remained statistically significant after additional adjustment for preventive behaviors suggests that this explanation alone may be insufficient to explain the observed relationship between participation in this program and a higher likelihood of experiencing COVID-19-like symptoms. Furthermore, even if the findings were to be explained by this selection effect, our findings indicate that the subsidy program may be incentivizing those with higher risks of COVID-19 transmission to travel across the nation, leading to the expansion of the outbreaks across regions (e.g., from the urban to the rural tourist spots). A better policy may be to incentivize individuals with a lower risk of contracting COVID-19 to travel and those with a higher risk to stay at home.

Analysis after excluding individuals who avoided travels in the past month also showed that program participants were more likely to experience some COVID-19-like symptoms. This finding suggests the possibility that participants and non-participants may have different behavioral patterns in traveling, including the destination, the frequency and duration of travel (more often or longer for participants), and the method of travel (participants might be more likely to use public transportation [vs. private vehicle] because the program subsidized the expense of public transportation for travel). Also, program participants might have more opportunities to allocate the money saved by discounts to activities such as eating and shopping, which might increase the rate of infection.

Strengths and limitations of this study

The main strengths of this study were its use of large-size nationwide data and a unique setting in which a large nationwide government subsidy for travel was initiated before the spread of COVID-19 was contained.

Our study has limitations. First, as with any observational study, we could not fully account for unmeasured confounders, and our study was unable to identify the exact mechanisms of the association between subsidy program participation and increased incidence rates of COVID-19-like symptoms. Second, given the cross-sectional design of our study, we could not identify the temporal relationship between the subsidy program and the incidence of COVID-19-like symptoms. Instead of the government subsidy causing infections of COVID-19, it was also possible that individuals who experienced COVID-19-like symptoms were more likely to utilize the program and travel domestically. However, this explanation may be unlikely given that travel agents and hotels have introduced strict protocols to ensure that no one with COVID-19-like symptoms uses their services. Also, individuals who spread the virus are likely to face criticism and stigma in Japan, which incentivizes people with suspected symptoms to stay at home [34]. Third, it is likely that some individuals who reported five COVID-19-like symptoms had illnesses that were not COVID-19, as we were unable to collect data on confirmed diagnoses of COVID-19 infection (e.g., diagnoses using the PCR test). However, smell and taste disorders, one of the outcomes we used, are known to be highly specific (90% specificity) to a COVID-19 diagnosis [17,31], suggesting that these symptoms would be good proxies for the incidence of COVID-19. Moreover, symptom-based measures would supplement the PCR test-based surveillance to inform a population-level picture of COVID-19 infection [18,19] because PCR testing underestimates the true number of infections (not everyone with symptoms indicative of

COVID-19 is tested). Fourth, our findings may be affected by the possibility that individuals who presented with COVID-19-like symptoms might recall and report using the subsidy program for domestic travel (as the cause of their symptoms) compared with individuals without such symptoms (recall bias). However, the questions on the program participation and COVID-19-like symptoms were located in a remote part of the questionnaire among the more than 100 other questions asked (and therefore certainly considered irrelevant to the respondents), and this recall bias problem would be minimal. Finally, because our study sample was collected through a web-based survey, our findings may not be generalizable to the population with limited access to and/or literacy about the internet. Nevertheless, we used weighted analysis to minimize the difference in demographics, SES, and health-related characteristics between respondents of the current internet survey and the nationally representative survey, and thus would approximate our estimates to national estimates.

Comparison with other studies

Our findings were consistent with those from a limited set of empirical studies on the association between domestic travel and the COVID-19 spread. Studies in China at the early stage of the COVID-19 epidemic found a positive association between domestic passenger travel volume from Wuhan City and the confirmed COVID-19 cases within the other ten cities in China [35,36]. Another study showed a preventive effect of a travel ban from Wuhan against the COVID-19 spread [37]. A recent study in 149 countries found that a combination of stay-at-home regulations and restrictions on movements within a country reduce the COVID-19 spread, but this study did not examine an independent effect of domestic travels [4]. To our knowledge, there have been no studies that have investigated the impact of government subsidies for travel, which is a unique economic policy introduced in Japan, on the spread of COVID-19 infections.

CONCLUSION

Using a large-scale, concurrent, nationwide internet survey in Japan, we found that participants in the government subsidy program for domestic travel in Japan had higher incidence rates of COVID-19-like symptoms compared to non-participants. Our findings suggest that the implementation of the subsidy program for domestic travel might have contributed to increased cases of COVID-19 infections. In the midst of an economic recession due to the COVID-19 pandemic, economic stimulus policies should incentivize individuals with low-risk of the COVID-19 infection to engage in economic activities while encouraging high-risk individuals to stay at home.

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Ethical Approval: This study was approved by the Institutional Review Board of the Osaka International Cancer Institute (No. 20084).

Author Contributions

Atsushi Miyawaki: conceptualisation, data curation, formal analysis, investigation, methodology, resources, software, and visualisation, writing – original draft.

Takahiro Tabuchi: data curation, funding acquisition, investigation, methodology, project administration, resources, validation, and writing – review & editing.

Yasutake Tomata: data curation, funding acquisition, investigation, methodology, resources, validation, and writing – review & editing.

Yusuke Tsugawa: conceptualisation, investigation, methodology, resources, software, supervision, and visualisation, writing – original draft, and writing – review & editing.

Data Statement: The data used in this study are unsuitable for public deposition because of ethical restrictions and the legal framework in Japan. Specifically, it is prohibited by the Act on the Protection of Personal Information (Act No. 57 of May 30, 2003, amended on September 9, 2015) to publicly deposit data containing personal information. All relevant data are available upon request to the corresponding author via e-mail (YTsugawa@mednet.ucla.edu).

Declaration of Competing Interest: The authors have declared that no competing interests exist.

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Table 1. Sociodemographic and Health-Related Characteristics of Respondents by Participation in the Subsidy Program for Domestic Travel

Characteristics		Total (N=25,482)	Participants (N=3,289)	Non-participants (N=22,193)	P value
Female		12,809 (50.3)	1,534 (46.6)	11,275 (50.8)	0.29
Age, mean (SD), yr		48.4 (17.4)	45.0 (17.9)	49.4 (17.3)	0.02
Academic attainment	College or higher	12,701 (49.8)	1,973 (60.0)	10,728 (48.3)	<0.001
	High school or lower	12,781 (50.2)	1,316 (40.0)	11,465 (51.7)	
Income level	Lower	7,336 (28.8)	867 (26.4)	6,469 (29.1)	<0.001
	Intermediate	6,817 (26.8)	804 (24.4)	6,013 (27.1)	
	Higher	5,733 (22.5)	1,144 (34.8)	4,589 (20.7)	
	Not answered	5,595 (22.0)	474 (14.4)	5,121 (23.1)	
Household size	1	4,117 (16.2)	665 (20.2)	3,452 (15.6)	0.43
	2	8,574 (33.7)	1,091 (33.2)	7,482 (33.7)	
	3	5,927 (23.3)	766 (23.3)	5,160 (23.3)	
	4	4,532 (17.1)	499 (15.2)	3,853 (17.4)	
	5+	2,513 (9.9)	268 (8.1)	2,245 (10.1)	
Marital status	Married	16,100 (63.2)	2,025 (61.6)	14,075 (63.4)	0.20
	Never married	6,046 (23.7)	707 (21.5)	5,339 (24.1)	
	Widowed	1,949 (7.7)	427 (13.0)	1,522 (6.9)	
	Separated	1,387 (5.4)	131 (4.0)	1,256 (5.7)	
Employment	Employer	1,007 (4.0)	262 (8.0)	746 (3.4)	0.10
	Self-employed	2,008 (7.9)	305 (9.3)	1,703 (7.7)	
	Employee	12,745 (50.0)	1,725 (52.4)	11,020 (49.7)	
	Unemployed	9,272 (38.2)	998 (30.3)	8,724 (39.3)	
Smoking status	Never	12,959 (50.9)	1,531 (46.5)	11,429 (51.5)	0.47
	Ever	1,638 (30.0)	1,108 (33.7)	6,530 (29.4)	
	Current	4,885 (19.2)	651 (19.8)	4,234 (19.1)	
Walking disability		3,543 (13.9)	644 (19.6)	2,900 (13.1)	0.18
Comorbidities	Overweight	5,185 (20.4)	884 (26.9)	43,01 (19.4)	0.04
	Hypertension	6,963 (27.3)	1,071 (32.6)	5,891 (26.5)	0.17
	Diabetes	2,711 (10.6)	515 (15.7)	2,196 (9.9)	0.16
	Asthma	3,573 (14.0)	647 (19.7)	2,926 (13.2)	0.11
	Coronary disease	1,686 (6.6)	401 (12.2)	1,285 (5.8)	0.09
	Stroke	1,228 (5.1)	352 (10.7)	936 (4.2)	0.07
	COPD	1,103 (4.3)	338 (10.3)	766 (3.5)	0.05
	Cancer	2,185 (8.6)	374 (11.4)	1,811 (8.2)	0.38

SD: standard deviation. COPD: chronic obstructive pulmonary disease. The analyses were weighted to account for selection in an internet survey. Because of weighting, the sum of participants and non-participants did not necessarily equal the number of total respondents. The numbers are No. (%), except for age. P values are calculated using an adjusted Wald test for age and chi-square tests for other categorical variables. The analyses of this table were for the purpose of simple description and did not account for multiple comparisons in the presentation of the P values. Comorbidities of hypertension, diabetes, asthma, coronary heart disease, stroke, COPD, and cancer was defined as having a past medical history of these conditions.

Table 2. Preventive Measures of Respondents by Participation in the Subsidy Program for Domestic Travel

Characteristics	Total (N=25,482)	Participants (N=3,289)	Non-participants (N=22,193)	P value
Personal Preventive Actions				
Social distancing	21,359 (83.8)	2,776 (84.4)	18,582 (83.7)	0.85
Wearing masks	24,018 (94.3)	3,074 (93.5)	20,944 (94.4)	0.80
Avoiding closed spaces	20,728 (81.3)	2,574 (78.3)	18,154 (81.8)	0.43
Avoiding crowded spaces	22,949 (90.1)	3,028 (92.1)	19,921 (89.8)	0.08
Avoiding close contact settings	20,152 (79.1)	2,381 (72.4)	17,771 (80.1)	0.09
Handwashing	22,191 (87.1)	2,956 (89.9)	19,235 (86.7)	0.02
Avoiding touching face	19,591 (76.9)	2,511 (76.3)	17,080 (77.0)	0.87
Respiratory hygiene	22,037 (86.5)	2,856 (86.8)	19,182 (86.4)	0.92
Surface disinfection	13,340 (52.4)	1,625 (49.4)	11,715 (52.8)	0.40
High-Risk Behavior Patterns				
Visiting restaurants	6,674 (26.3)	1,305 (39.7)	5,369 (24.2)	<0.001
Visiting bars/nightclubs	4,185 (16.4)	1,013 (30.8)	3,172 (14.3)	<0.001
Visiting karaoke bars	2,645 (9.7)	630 (19.2)	1,836 (8.3)	0.01
Visiting fitness clubs	2,712 (10.6)	736 (22.4)	1,976 (8.9)	<0.001
Visiting brothels	1,885 (7.4)	438 (13.3)	1,447 (6.5)	0.08
Proxies of Other Preventive Measures				
Use of contact-tracing app	4,331 (17.0)	996 (30.3)	3,336 (15.0)	<0.001
Support for stay-at-home requests	19,825 (77.8)	2,668 (81.1)	17,158 (77.3)	0.32
Flu vaccine in the last season	8,791 (34.5)	1,403 (42.7)	7,389 (33.3)	0.03

The analyses were weighted to account for selection in an internet survey. Because of weighting, the sum of participants and non-participants did not necessarily equal the number of total respondents. The numbers are No. (%). Personal preventive actions included nine personal protective measures recommended by the World Health Organization. High-risk behavior patterns included five risky behaviors for COVID-19 during the state of emergency. P values are calculated chi-square test. The analyses of this table were for the purpose of simple description and did not account for multiple comparisons in the presentation of the P values.

Table 3. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms

Subsidy Program Participation	Weighted sample, No.	Weighted incidence, n (%)	Model 1: adjusted for demographics, SES, health, and prefecture fixed effects			Model 2: adjusted for the adjustment variables in Model 1 + preventive measures		
			Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
High Fever								
Participants	3,289	327 (9.9)	4.8 (4.2, 5.3)	1.90 (1.42, 2.54)	<0.001	4.4 (3.9, 4.9)	1.58 (1.11, 2.24)	0.03
Non-participants	22,193	633 (2.9)	3.7 (3.6, 3.8)	Reference		3.7 (3.6, 3.8)	Reference	
Sore Throat								
Participants	3,289	790 (24.0)	19.8 (15.1, 24.6)	2.09 (1.37, 3.20)	0.002	18.7 (15.0, 22.5)	1.91 (1.35, 2.72)	0.001
Non-participants	22,193	2406 (10.8)	11.3 (10.5, 12.1)	Reference		11.5 (10.8, 12.1)	Reference	
Cough								
Participants	3,289	728 (22.1)	19.1 (14.3, 24.0)	1.96 (1.27, 3.02)	0.007	17.4 (14.0, 20.8)	1.70 (1.22, 2.38)	0.007
Non-participants	22,193	2417 (10.9)	11.2 (10.5, 12.0)	Reference		11.5 (10.9, 12.1)	Reference	
Headache								
Participants	3,289	1,009 (30.7)	29.1 (26.9, 31.3)	1.24 (1.07, 1.43)	0.007	28.1 (26.2, 30.0)	1.16 (1.02, 1.33)	0.03
Non-participants	22,193	5,612 (25.3)	25.5 (25.2, 25.8)	Reference		25.7 (25.4, 25.9)	Reference	
Smell and Taste Disorder								
Participants	3,289	167 (5.1)	2.6 (2.0, 3.1)	1.98 (1.15, 3.40)	0.01	2.4 (2.0, 2.7)	1.63 (1.10, 2.40)	0.03
Non-participants	22,193	287 (1.3)	1.8 (1.6, 1.9)	Reference		1.8 (1.7, 1.9)	Reference	

OR: odds ratio. CI: confidence interval. We examined the association of participation in the government subsidy program for domestic travel in the past 1-2 months with the incidence of the five COVID-19-like symptoms within the past month of the survey. For each outcome, we constructed a weighted multivariable logistic regression model with standard errors clustered at the prefecture-level. Model 1 adjusted for the respondents' sociodemographic characteristics, health-related characteristics, and prefecture indicator variables. Model 2 adjusted for all the variables included in Model 1 plus the preventive measures. We weighted the regression models using IPW to account for "being a respondent in an internet survey." Adjusted rates were calculated using marginal standardization. Adjusted P values using the Holm method for multiple testing were shown (the adjusted p value < 0.05 was considered to be statistically significant).

Supplementary Materials

Association between Participation in the Government Subsidy Program for Domestic Travel and Symptoms Indicative of COVID-19 Infection in Japan

Atsushi Miyawaki, Takahiro Tabuchi, Yasutake Tomata, Yusuke Tsugawa

Method A1. Inverse Probability Weighting

Internet surveys have several advantages over traditional surveys. However, the potential disadvantage is that they may not be representative of the population of interest because subpopulations with internet access may be specific. Previous studies have used inverse probability weighting (IPW) (derived from propensity scores calculated by a logistic regression model using basic demographic and socio-economic factors such as education and length of home-ownership) obtained from an internet-accessible convenience sample and the nationally-representative sample. It has been suggested that the parameter estimates calculated using IPW are similar, or at least less different, than the population-based estimates [1].

In the current study, we used a population-based sample representative of the Japanese population from the 2016 Comprehensive Survey of Living Conditions (CSLC) to correct for sample selectivity in the internet survey. The CSLC has been conducted every three years by the Japanese Ministry of Health, Labour and Welfare (MHLW) and collects information on health-related factors, such as self-rated health and smoking behavior [2]. Out of inhabited census tracts (sampling unit for the national census in 2010), 5410 were randomly sampled across Japan in 2016 to collect data from all household members within each census tract. Data were available for 224,208 households (response rate; 77.5%) in 2016. Data from the 2016 CSLC were used because the 2019 CSLC was not yet available at the time of analysis. Data were used with permission from MHLW. CSLC has been used in several studies [3-5].

We pooled and combined data from the two surveys (the current internet survey and CSLC) and ran a multivariable logistic regression model to estimate the probability of "being an internet survey respondent," or propensity score. Propensity scores were calculated for each group stratified by gender and age (15-19, 20-29, ..., 70-79) (gender x age stratification = 14 strata). We used variables available in both surveys (the current internet survey and CSLC) as covariates for the models. For men and women aged 20-79 years, we included socio-economic status (residence area, marital status, education level, and home-ownership) and health-related characteristics (self-rated health and smoking status) in the model. For men and women aged 15-19 years, we included socio-economic status (residence area, education level, and home-ownership) and self-rated health in the model, because they were too young to have a different distribution of marital status, and the CSLC did not ask teenagers about their smoking status. A standardized weight was used to keep the total number of respondents included constant.

Table A1. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Additionally Adjusting for Fear against the COVID-19 Infection

We adjusted for all the adjustment variables in Model 2 plus the fear against the COVID-19 infection, which was measured on a five-point scale of "not afraid at all (0%)," "not afraid (25%)," "neutral (50%)," "somewhat afraid (75%)," and "very afraid (100%)" to the question "Are you afraid of the COVID-19 infection?"). See the main text of the manuscript for more details.

Subsidy Program Participation	Weighted sample, No.	Weighted incidence, n (%)	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
High Fever					
Participants	3,289	327 (9.9)	4.4 (3.9, 4.9)	1.56 (1.09, 2.23)	0.03
Non-participants	22,193	633 (2.9)	3.7 (3.6, 3.8)	Reference	
Sore Throat					
Participants	3,289	790 (24.0)	18.4 (15.1, 21.6)	1.87 (1.36, 2.56)	<0.001
Non-participants	22,193	2406 (10.8)	11.6 (11.0, 12.1)	Reference	
Cough					
Participants	3,289	728 (22.1)	17.2 (14.0, 20.3)	1.67 (1.22, 2.29)	0.005
Non-participants	22,193	2417 (10.9)	11.6 (11.0, 12.1)	Reference	
Headache					
Participants	3,289	1,009 (30.7)	28.4 (26.4, 30.3)	1.18 (1.04, 1.35)	0.04
Non-participants	22,193	5,612 (25.3)	25.6 (25.3, 25.9)	Reference	
Smell and Taste Disorder					
Participants	3,289	167 (5.1)	2.4 (1.9, 2.7)	1.58 (1.06, 2.35)	0.02
Non-participants	22,193	287 (1.3)	1.8 (1.7, 1.9)	Reference	

Table A2. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, after Excluding Those Who Were Living in Tokyo

Subsidy Program Participation	Weighted sample, No.	Weighted incidence, n (%)	Model 1: adjusted for demographics, SES, health, and prefecture fixed effects			Model 2: adjusted for the adjustment variables in Model 1 + preventive measures		
			Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
High Fever								
Participants	2,959	308 (10.4)	4.8 (4.4, 5.3)	1.81 (1.34, 2.45)	<0.001	4.7 (4.1, 5.2)	1.63 (1.15, 2.31)	0.02
Non-participants	19,604	584 (3.0)	3.9 (3.8, 4.0)	Reference		3.9 (3.8, 4.0)	Reference	
Sore Throat								
Participants	2,959	622 (21.0)	17.3 (13.2, 21.4)	1.76 (1.19, 2.61)	0.01	15.9 (13.2, 18.6)	1.55 (1.17, 2.05)	0.009
Non-participants	19,604	2,100 (10.7)	11.1 (10.5, 11.8)	Reference		11.4 (10.9, 11.8)	Reference	
Cough								
Participants	2,959	564 (19.1)	16.3 (12.3, 20.3)	1.61 (1.09, 2.39)	0.04	14.5 (12.3, 16.7)	1.35 (1.06, 1.72)	0.04
Non-participants	19,604	2,107 (10.7)	11.1 (10.5, 11.7)	Reference		11.4 (11.0, 11.7)	Reference	
Headache								
Participants	2,959	941 (31.8)	29.6 (27.6, 31.7)	1.25 (1.09, 1.43)	0.004	28.6 (26.6, 30.5)	1.17 (1.02, 1.34)	0.03
Non-participants	19,604	5003 (25.5)	25.8 (25.5, 26.1)	Reference		26.0 (25.7, 26.3)	Reference	
Smell and Taste Disorder								
Participants	2,959	157 (5.3)	2.7 (2.1, 3.3)	1.95 (1.11, 3.33)	0.02	2.4 (2.1, 2.9)	1.59 (1.06, 2.37)	0.048
Non-participants	19,604	267 (1.4)	1.9 (1.7, 2.0)	Reference		1.9 (1.8, 2.0)	Reference	

SES: socio-economic status. OR: odds ratio. CI: confidence interval. We analyzed 22,563 respondents after excluding 2,919 respondents living in Tokyo. See Table 3's legend for more details.

Table A3. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Using the Unweighted Logistic Regression Models

Subsidy Program Participation	Unweighted sample, No.	Unweighted incidence, n (%)	Model 1: adjusted for demographics, SES, health, and prefecture fixed effects			Model 2: adjusted for the adjustment variables in Model 1 + preventive measures		
			Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
High Fever								
Participants	3,306	111 (3.4)	2.4 (2.0, 2.8)	1.54 (1.20, 1.97)	0.001	2.2 (1.8, 2.6)	1.37 (1.05, 1.79)	0.02
Non-participants	22,176	331 (1.5)	1.6 (1.5, 1.7)	Reference		1.7 (1.6, 1.7)	Reference	
Sore Throat								
Participants	3,306	462 (14.0)	12.8 (11.8, 13.8)	1.23 (1.10, 1.38)	<0.001	12.4 (11.4, 13.5)	1.19 (1.07, 1.34)	0.01
Non-participants	22,176	2,338 (10.5)	10.7 (10.5, 10.9)	Reference		10.7 (10.6, 10.9)	Reference	
Cough								
Participants	3,306	455 (13.8)	13.4 (12.4, 14.4)	1.23 (1.10, 1.36)	<0.001	13.1 (12.1, 14.1)	1.19 (1.07, 1.33)	0.01
Non-participants	22,176	2,489 (11.2)	11.3 (11.1, 11.4)	Reference		11.3 (11.2, 11.5)	Reference	
Headache								
Participants	3,306	988 (29.9)	27.5 (26.5, 28.5)	1.14 (1.07, 1.22)	<0.001	27.0 (26.0, 28.0)	1.11 (1.04, 1.19)	0.01
Non-participants	22,176	5,509 (24.8)	25.2 (25.0, 25.3)	Reference		25.3 (25.1, 25.4)	Reference	
Smell and Taste Disorder								
Participants	3,306	63 (1.9)	1.4 (1.1, 1.7)	1.54 (1.15, 2.07)	0.004	1.3 (1.1, 1.6)	1.51 (1.12, 2.03)	0.01
Non-participants	22,176	180 (0.8)	0.9 (0.9, 1.0)	Reference		0.9 (0.9, 1.0)	Reference	

SES: socio-economic status. OR: odds ratio. CI: confidence interval. We showed the results of the analyses using unweighted logistic regression models. See Table 3's legend for more details.

Table A4. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, after Excluding Individuals Who Avoided Travels in the Past Month

Subsidy Program Participation	Weighted sample, No.	Weighted incidence, n (%)	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
High Fever								
Participants	1,872	162 (8.7)	6.9 (6.3, 7.5)	1.22 (0.76, 1.96)	0.42	6.6 (6.1, 7.1)	0.91 (0.58,1.45)	0.70
Non-participants	5,565	333 (6.0)	6.6 (6.4, 6.8)	Reference		6.7 (6.5, 7.0)	Reference	
Sore Throat								
Participants	1,872	463 (24.7)	19.1 (15.7, 22.5)	2.00 (1.27, 3.16)	0.01	18.1 (15.3, 20.9)	1.80 (1.21,2.69)	0.02
Non-participants	5,565	593 (10.7)	12.3 (11.0, 13.6)	Reference		12.7 (11.6, 13.7)	Reference	
Cough								
Participants	1,872	446 (23.8)	18.8 (15.6, 22.0)	1.90 (1.28, 2.81)	0.007	17.1 (14.9, 19.3)	1.59 (1.18,2.15)	0.01
Non-participants	5,565	578 (10.4)	12.0 (10.9, 13.0)	Reference		12.5 (11.8, 13.3)	Reference	
Headache								
Participants	1,872	477 (25.5)	26.8 (24.1, 29.5)	1.40 (1.10, 1.78)	0.02	24.9 (22.4, 27.4)	1.19 (0.94,1.52)	0.15
Non-participants	5,565	1244 (22.4)	21.9 (21.0, 22.8)	Reference		22.5 (21.6, 23.4)	Reference	
Smell and Taste Disorder								
Participants	1,872	142 (7.6)	5.3 (4.7, 5.9)	1.56 (0.66, 3.71)	0.31	5.3 (4.7, 5.9)	1.62 (0.67,3.90)	0.28
Non-participants	5,565	154 (2.8)	4.9 (4.6, 5.1)	Reference		4.9 (4.6, 5.1)	Reference	

We analyzed 7,437 respondents after excluding 18,045 respondents who avoided travels in the past month (defined as individuals who answered that they had avoided any travels in the past month to the question "Have you avoided travels in the past one month?"). For Holm-adjusted P values, we multiplied the *i*-th smallest unadjusted P values by $(5 - i + 1)$ times if the unadjusted P value < 0.05, and simply showed the unadjusted P values if ≥ 0.05. See Table 3's legend for more details.

Table A5. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Stratified by Age

	Age < 65 yrs (n=19,174)			Age ≥ 65 yrs (n=6,308)		
	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
Model 1						
High Fever						
Participants	6.1 (5.5, 6.8)	2.01 (1.47, 2.74)	<0.001	0.8 (-0.5, 2.1)	1.04 (0.16, 6.68)	0.96
Non-participants	4.7 (4.6, 4.8)	Reference		0.8 (0.7, 0.9)	Reference	
Sore Throat						
Participants	23.4 (18.4, 28.4)	2.29 (1.53, 3.43)	<0.001	8.3 (3.1, 13.4)	1.24 (0.48, 3.20)	0.65
Non-participants	12.6 (11.8, 13.5)	Reference		7.1 (6.7, 7.5)	Reference	
Cough						
Participants	21.6 (16.1, 27.1)	2.18 (1.38, 3.44)	0.003	8.1 (4.5, 11.6)	0.80 (0.44, 1.45)	0.46
Non-participants	11.8 (10.9, 12.7)	Reference		9.7 (9.3, 9.9)	Reference	
Headache						
Participants	35.6 (33.2, 38.0)	1.27 (1.10, 1.46)	0.001	10.5 (7.0, 13.9)	1.23 (0.75, 2.03)	0.42
Non-participants	30.9 (30.5, 31.3)	Reference		9.0 (8.7, 9.3)		
Smell and Taste Disorder						
Participants	3.4 (2.7, 4.1)	2.00 (1.15, 3.48)	0.01	0.3 (0, 0.6)	0.52 (0.20, 1.38)	0.19
Non-participants	2.4 (2.2, 2.6)	Reference		0.6 (0.6, 0.6)	Reference	
Model 2						
High Fever						
Participants	5.7 (5.0, 6.4)	1.65 (1.14, 2.40)	0.02	1.0 (-0.2, 2.2)	1.47 (0.33, 6.52)	0.61
Non-participants	4.8 (4.6, 4.9)	Reference		0.8 (0.7, 0.9)	Reference	
Sore Throat						
Participants	21.8 (18.2, 25.4)	2.04 (1.50, 2.78)	<0.001	8.5 (3.8, 13.1)	1.29 (0.54, 3.09)	0.57
Non-participants	12.9 (12.3, 13.5)	Reference		7.1 (6.6, 7.5)	Reference	
Cough						
Participants	19.5 (16.0, 23.0)	1.86 (1.34, 2.59)	<0.001	8.1 (4.6, 11.6)	0.80 (0.44, 1.46)	0.46
Non-participants	12.2 (11.6, 12.8)	Reference		9.6 (9.3, 9.9)	Reference	
Headache						
Participants	34.3 (32.0, 36.5)	1.18 (1.03, 1.35)	0.03	11.5 (8.1, 14.9)	1.45 (0.88, 2.37)	0.14
Non-participants	31.1 (30.8, 31.5)	Reference		8.9 (8.7, 9.2)	Reference	
Smell and Taste Disorder						
Participants	3.1 (2.6, 3.7)	1.70 (1.10, 2.63)	0.02	0.4 (0, 0.9)	0.73 (0.22, 2.48)	0.62
Non-participants	2.5 (2.3, 2.6)	Reference		0.6 (0.5, 0.6)	Reference	

We stratified the respondents by age (15-64 years and 65-79 years) and separately repeated the analyses using the same models as in the main analyses. For Holm-adjusted P values, we multiplied the *i*-th smallest unadjusted P values by $(5 - i + 1)$ times if the unadjusted P value < 0.05, and simply showed the unadjusted P values if ≥ 0.05. P for interaction (Wald test, not adjusted for multiple testing) between subsidy program participation and age group were 0.28 and 0.41 for high fever, 0.09 and 0.11 for sore throat, 0.006 and 0.007 for cough, 0.18 and 0.27 for headache, and 0.02 and 0.03 for smell and taste disorder, respectively. See Table 3's legend for more details.

Table A6. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Stratified by the Presence of Comorbidities

	Individuals without comorbidities (n=12,749)			Individuals with comorbidities (n=12,733)		
	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
Model 1						
High Fever						
Participants	2.7 (1.7, 3.7)	2.67 (1.58, 4.51)	<0.001	7.2 (6.6, 7.7)	1.30 (0.89, 1.90)	0.18
Non-participants	1.0 (0.9, .12)	Reference		6.7 (6.6, 6.9)	Reference	
Sore Throat						
Participants	11.6 (9.8, 13.5)	1.36 (1.10, 1.68)	0.02	25.9 (18.8 33.0)	2.55 (1.43, 4.53)	0.005
Non-participants	8.9 (8.7, 9.2)	Reference		13.8 (12.4, 15.1)	Reference	
Cough						
Participants	10.6 (8.5, 12.6)	1.31 (1.01, 1.69)	0.08	25.6 (18.1, 33.1)	2.24 (1.26, 3.98)	0.02
Non-participants	8.3 (8.1, 8.6)	Reference		14.3 (12.9, 15.6)	Reference	
Headache						
Participants	31.8 (28.8, 34.8)	1.40 (1.17, 1.67)	<0.001	26.2 (23.5, 28.9)	1.05 (0.85, 1.29)	0.67
Non-participants	25.6 (25.3, 26.0)	Reference		25.5 (25.0, 26.0)	Reference	
Smell and Taste Disorder						
Participants	1.5 (0.6, 2.3)	1.87 (0.84, 4.13)	0.13	4.4 (2.7, 3.1)	2.47 (1.30, 4.69)	0.02
Non-participants	0.8 (0.7, 1.0)	Reference		2.9 (3.6, 5.2)	Reference	
Model 2						
High Fever						
Participants	2.5 (1.5, 3.5)	2.50 (1.42, 4.40)	0.006	7.0 (6.4, 7.5)	1.15 (0.73, 1.80)	0.55
Non-participants	1.1 (0.9, 1.2)	Reference		6.8 (6.6, 6.9)	Reference	
Sore Throat						
Participants	11.5 (9.7, 13.4)	1.34 (1.07, 1.68)	0.03	24.0 (18.4, 29.6)	2.22 (1.37, 3.60)	0.005
Non-participants	9.0 (8.7, 9.2)	Reference		14.1 (13.1, 15.2)	Reference	
Cough						
Participants	10.3 (8.3, 12.4)	1.27 (0.98, 1.65)	0.07	22.8 (17.6, 27.9)	1.84 (1.19, 2.85)	0.02
Non-participants	8.4 (8.1, 8.6)	Reference		14.8 (13.9, 15.7)	Reference	
Headache						
Participants	31.1 (28.1, 34.0)	1.35 (1.13, 1.62)	0.005	25.4 (23.3, 27.6)	0.99 (0.83, 1.18)	0.88
Non-participants	25.7 (25.3, 26.1)	Reference		25.6 (25.3, 26.0)	Reference	
Smell and Taste Disorder						
Participants	1.5 (0.7, 2.2)	1.94 (0.91, 4.15)	0.09	3.9 (3.2, 4.5)	1.76 (0.99, 3.14)	0.06
Non-participants	0.8 (0.7, 1.0)	Reference		3.1 (2.9, 3.3)	Reference	

We stratified the respondents by the presence of comorbidities and separately repeated the analyses using the same model as in the main analyses. For Holm-adjusted P values, we multiplied the *i*-th smallest unadjusted P values by $(5 - i + 1)$ times if the unadjusted P value < 0.05, and simply showed the unadjusted P values if ≥ 0.05. P for interaction (Wald test, not adjusted for multiple testing) between subsidy program participation and age group were 0.06 (Model 1) and 0.07 (Model 2) for high fever, 0.03 and 0.02 for sore throat, 0.09 and 0.16 for cough, 0.08 and 0.02 for headache, and 0.67 and 0.85 for smell and taste disorder, respectively. See Table 3's legend for more details.

Table A7. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Stratified by Gender

	Men (n=12,673)			Women (n=12,809)		
	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
Model 1						
High Fever						
Participants	7.6 (6.7, 8.5)	1.82 (1.09, 3.02)	0.06	2.7 (1.6, 3.7)	2.50 (1.43, 4.35)	0.005
Non-participants	6.5 (6.2, 6.7)	Reference		1.2 (1.1, 1.3)	Reference	
Sore Throat						
Participants	24.7 (18.1, 31.3)	3.54 (2.00, 6.28)	<0.001	13.5 (11.1, 16.0)	1.10 (0.84, 1.43)	0.49
Non-participants	9.9 (8.8, 11.1)	Reference		12.6 (12.2, 12.9)	Reference	
Cough						
Participants	25.4 (18.1, 32.7)	2.76 (1.56, 4.91)	0.002	11.4 (9.8, 13.0)	1.10 (0.90, 1.33)	0.35
Non-participants	11.9 (10.87 13.2)	Reference		10.6 (10.4, 10.8)	Reference	
Headache						
Participants	21.9 (18.9, 24.9)	1.24 (0.97, 1.59)	0.09	36.8 (33.6, 39.9)	1.28 (1.07, 1.54)	0.03
Non-participants	18.9 (18.5, 19.4)	Reference		32.0 (31.6, 32.4)	Reference	
Smell and Taste Disorder						
Participants	3.9 (3.2, 4.6)	1.68 (0.94, 2.99)	0.08	1.7 (0.7, 2.6)	1.99 (0.90, 4.40)	0.09
Non-participants	3.2 (3.0, 3.4)	Reference		0.9 (0.8, 1.0)	Reference	
Model 2						
High Fever						
Participants	7.2 (6.3, 8.0)	1.47 (0.83, 2.59)	0.19	2.4 (1.4, 3.3)	2.18 (1.24, 3.85)	0.04
Non-participants	6.5 (6.3, 6.8)	Reference		1.2 (1.1, 1.3)	Reference	
Sore Throat						
Participants	22.0 (17.4, 26.6)	2.89 (1.86, 4.52)	<0.001	13.6 (11.3, 16.0)	1.11 (0.86, 1.43)	0.43
Non-participants	10.4 (9.6, 11.2)	Reference		12.6 (12.2, 12.9)	Reference	
Cough						
Participants	21.7 (17.2, 26.3)	2.14 (1.41, 3.25)	<0.001	11.3 (9.8, 12.8)	1.09 (0.91, 1.31)	0.37
Non-participants	12.6 (11.8, 13.3)	Reference		10.6 (10.4, 10.8)	Reference	
Headache						
Participants	20.5 (18.0, 23.1)	1.11 (0.90, 1.39)	0.35	36.5 (33.5, 39.6)	1.27 (1.06, 1.52)	0.04
Non-participants	19.1 (18.7, 19.6)	Reference		32.0 (31.6, 32.4)	Reference	
Smell and Taste Disorder						
Participants	3.7 (3.2, 4.2)	1.40 (0.85, 2.31)	0.18	1.7 (0.9, 2.5)	2.18 (1.06, 4.45)	0.10
Non-participants	3.3 (3.1 3.4)	Reference		0.9 (0.8, 1.0)	Reference	

We stratified the respondents by gender and separately repeated the analyses using the same model as the main analyses. For Holm-adjusted P values, we multiplied the i-th smallest unadjusted P values by $(5 - i + 1)$ times if the unadjusted P value < 0.05, and simply showed the unadjusted P values if ≥ 0.05. P for interaction (Wald test, not adjusted for multiple testing) between subsidy program participation and age group was 0.78 (Model 1) and 0.92 (Model 2) for high fever, 0.001 and <0.001 for sore throat, 0.01 and 0.02 for cough, 0.69 and 0.27 for headache, and 0.35 and 0.71 for smell and taste disorder, respectively. See Table 3's legend for more details.

Supplementary Reference

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Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectionalreporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	3
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	3,4
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	6,7
Objectives	#3	State specific objectives, including any prespecified hypotheses	8
Methods			
Study design	#4	Present key elements of study design early in the paper	8
Setting	#5	Describe the setting, locations, and relevant dates, including periods	8

		of recruitment, exposure, follow-up, and data collection	
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	8
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-11
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	9-11
Bias	#9	Describe any efforts to address potential sources of bias	9-11
Study size	#10	Explain how the study size was arrived at	8
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	9-11
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	11-12
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	12-13
Statistical methods	#12c	Explain how missing data were addressed	8
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	11
Statistical methods	#12e	Describe any sensitivity analyses	12-13
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	8,14
Participants	#13b	Give reasons for non-participation at each stage	8

Participants	#13c	Consider use of a flow diagram	n/a. We described it in P8.
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	14
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	8
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	14
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14
Main results	#16b	Report category boundaries when continuous variables were categorized	n/a
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	14
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	15
Discussion			
Key results	#18	Summarise key results with reference to study objectives	15,16
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	17-19
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	16-17, 19-20
Generalisability	#21	Discuss the generalisability (external validity) of the study results	19
Other			

Information

Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

Notes:

- 13c: n/a. We described it in P8.
- 20: 16-17, 19-20 The STROBE checklist is distributed under the terms of the Creative Commons Attribution License CC-BY. This checklist was completed on 16. January 2021 using https://www.goodreports.org/, a tool made by the EQUATOR Network in collaboration with Penelope.ai

BMJ Open

Association between Participation in the Government Subsidy Program for Domestic Travel and Symptoms Indicative of COVID-19 Infection in Japan: Cross-sectional Study

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Association between Participation in the Government Subsidy Program for Domestic Travel and Symptoms Indicative of COVID-19 Infection in Japan: Cross-Sectional Study

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ABSTRACT

Objective: To investigate the association between participation in government subsidies for domestic travel (subsidize up to 50% of all travel expenses) introduced nationally in Japan on July 22, 2020, and the incidence of symptoms indicative of COVID-19 infections.

Design: Cross-sectional analysis of nationally-representative survey data.

Setting: Internet survey conducted between August 25 and September 30, 2020, in Japan. Sampling weights were used to calculate national estimates.

Participants: 25,482 survey respondents (50.3% [12,809] women; mean [SD] age, 48.4 [17.4] years).

Main Outcome Measures: Incidence rate of five symptoms indicative of the COVID-19 infection (high fever, sore throat, cough, headache, and smell and taste disorder) within the past month of the survey, after adjustment for characteristics of individuals and prefecture fixed effects (effectively comparing individuals living in the same prefecture).

Results: At the time of the survey, 3,289 (12.9%) participated in the subsidy program. After adjusting for potential confounders, we found that participants in the subsidy program exhibited higher incidence of high fever (adjusted rate, 4.7% for participants vs. 3.7% for non-participants; adjusted odds ratio [aOR], 1.83; 95%CI, 1.34-2.48; p<0.001), sore throat (19.8% vs. 11.3%; aOR, 2.09; 95%CI, 1.37-3.19; p=0.002), cough (19.0% vs. 11.3%; aOR 1.96; 95%CI, 1.26-3.01; p=0.008), headache (29.2% vs. 25.5%; aOR, 1.24; 95%CI, 1.08-1.44; p=0.006), and smell and taste disorder (2.6% vs. 1.8%; aOR 1.98; 95%CI; 1.15-3.40; p=0.01) compared with non-participants. These findings remained qualitatively unaffected by additional adjustment for the use of 17 preventative measures (e.g., social distancing, wearing masks, and handwashing) and fear against the COVID-19 infection.

Conclusions: The participation of the government subsidy program for domestic travel was associated with a higher probability of exhibiting symptoms indicative of the COVID-19 infection.

Keywords: Pandemic; coronavirus; COVID-19; public policy; economic stimulus

ARTICLE SUMMARY

Strengths and limitations of this study

- This is the first study that investigates the association between the participation in the government subsidy program for domestic travel and the incidence of symptoms indicative of the COVID-19 infection ("COVID-19 like symptoms"), using data from a large nationwide internet survey conducted in Japan.
- We used a unique setting in which a large nationwide government subsidy for travel was initiated before the COVID-19 pandemic was fully under control.
- Given the cross-sectional design of our study, we could not identify the temporal relationship between the subsidy program and the incidence of COVID-19-like symptoms.
- Our findings may be affected by the possibility that individuals who presented with COVID-19-like symptoms might recall and report using the subsidy program for domestic travel (recall bias).

INTRODUCTION

As of the end of December 2020, 81 million people have been infected by the coronavirus disease 2019 (COVID-19), and 1.8 million have died from this infection [1]. To tackle this unprecedented pandemic, many countries have implemented public health measures — also known as non-pharmaceutical interventions (NPIs) — to control the spread of the virus, including lockdowns, movement restrictions, quarantines, and border controls [2]. Given that the number of infections and deaths due to COVID-19 has resurged this winter, these NPIs are likely to be implemented intermittently [3], until effective vaccines are developed and become widely available. While these NPIs have been shown to be effective in reducing the spread of COVID-19 infections [2,4], they have a substantial negative impact on economies [5]. As a countermeasure against the economic downturns due to the NPIs, many countries have introduced, or are actively considering, financial incentives such as government subsidies to engage in economic activities, such as using restaurants or traveling domestically [6-10].

Evidence is limited as to whether the government interventions to financially incentivize economic activities, such as using restaurants or traveling, impact the COVID-19 infection rate. For example, the United Kingdom implemented the "*Eat out to Help out*" campaign, in which the government subsidized up to 50% of the expenses of food and non-alcoholic drinks for immediate consumption at restaurants using a budget of around £500 million throughout August 2020 [9]. A recent study using ecological data on COVID-19 infections by region suggested that regions that implemented this campaign experienced 8-17 percentage points higher number of COVID-19 clusters [11]. However, an ecological association does not imply that the same association would be observed at the individual level (the “ecological fallacy”), and therefore, it remains unknown as to whether this policy actually led to an increased number of individuals infected by COVID-19. Indeed, to our knowledge, no study to date has evaluated the impact of such an economic policy on the risk of contracting the COVID-19 infection using individual-level data. Moreover, it remains unknown as to how similar policies implemented in other countries that incentivize economic activities (e.g., eating out, travel) affected the COVID-19 pandemic.

Japan implemented a large-scale, nationwide government subsidy program for domestic travel (called the "*Go-To Travel*" Campaign) [8] on July 22, 2020 (announced on July 10, 2020) to revive the travel industry, which has been hit hard by a substantial decrease in the number of foreign tourists visiting Japan. This program incentivizes people to travel domestically by subsidizing up to 50% of transportation and accommodation expenses for travelers. As of the end of October 2020, more than 200 billion Japanese yen (JPY) (approximately 2 billion US dollars (USD), using an exchange rate of 100 JPY per USD) have been used to subsidize a total of 40 million people who traveled domestically [12]. However, as the number of COVID-19 infected cases has resurged, the Japanese government faced fierce criticisms from those speculating that increased mobility and human interactions due to the "*Go-To Travel*" program might be causing the increase in the number of COVID-19 infections [13]. As a result, the Japanese government has suspended this subsidy program since December 28, 2020, but is considering resuming it (as of March 2021) [14]. Yet, empirical evidence is lacking as to whether the introduction of this program is associated with an increased risk of contracting the COVID-19 infection. Japan's experience from this social experiment provides a unique opportunity to understand the impact of government subsidies for travel on the spread of COVID-19 infections.

In this context, using data from a large internet survey conducted in Japan between August 25 and September 30, 2020, we examined whether individuals who used subsidies experienced a higher incidence of symptoms indicative of the COVID-19 infection (COVID-19-like symptoms).

METHODS

Study design, setting, and data sources

We analyzed data from the *Japan "COVID-19 and Society" Internet Survey (JACSIS)* study, a cross-sectional, web-based, self-reported questionnaire survey administered by a large internet research agency (Rakuten Insight, Inc.). Rakuten Insight, Inc. is a research agency with a survey panel of approximately 2.2 million registered individuals in 2019. For the purpose of this study, we collaborated with this company to reach out to registered individuals in a way that could be analyzed as a nationally-representative sample [15]. This internet research agency has been used in previous studies [16,17], and the registered individuals are assured through annual updates of demographic information and the exclusion of individuals with concerns about incorrect information. This study collected a wide range of socio-demographic, lifestyle, and health measures from individuals aged 15-79 years. The questionnaires were distributed to 224,389 individuals selected by gender, age, and prefecture category using simple random sampling and covering all 47 prefectures (first-tier administrative districts in Japan). Individuals who consented to participate in the survey accessed the designated website and responded to questionnaires. They also had the option not to respond or to discontinue at any point in the survey; in such cases, they were regarded as not having consented to participate in the survey and were not counted as respondents. Questionnaires were distributed from August 25, 2020, until September 30, 2020, when the target number of respondents for each gender, age, and prefecture category were met. These target numbers had been determined in advance according to the population distribution in 2019 as 28,000 respondents and a response rate of 12.5% (28,000/224,389). Although there was no missing value due to the survey design described above (if any item was not responded, the survey could not be completed), there was still a possibility of unnatural or inconsistent responses. We excluded 2,518 individuals showing unnatural or inconsistent responses using the algorithm we developed (see **Method A1** for details) [18]. The final sample size was 25,482 respondents (91.0% of the total survey respondents).

Exposure variables

The primary exposure variable was participating at least once in travel or accommodation funded by the subsidy program for domestic travel, which was announced on July 10, 2020, and implemented on July 22, 2020.

Outcome variables

Our outcome variable was the incidence of five self-reported COVID-19-like symptoms (high fever, sore throat, cough, headache, and smell and taste disorder) within the past month of the survey. These symptoms are reported to have high sensitivity (50% for high fever and 70% for cough) or specificity (70% for sore throat, 80% for headache, and 90% or higher for smell and taste disorder) [19]. Self-reported COVID-19-like symptoms have been reported as a useful measure to monitor the spread of COVID-19 infections [20,21].

Adjustment variables

We adjusted for the respondents' demographics [22], socio-economic status (SES) [23], health-related characteristics [22], use of preventive measures (see below for details), perceived fear against the COVID-19 infection, and prefecture fixed effects. The demographics included age (categorized as 15-19, 20-29, …, 70-79) and gender. The SES included academic attainment (graduated from college or institutions of higher education vs. high school or lower institutions), income level (categorized using the tertiles of household equivalent income ["low" = less than 2.5 million JPY, "medium" = 2.5 to 4.3 million JPY, and "high" = more than 4.3 million JPY], and an indicator for those who refused to respond to this question), household size (number of household members: 1, 2, 3, 4 and 5+), employment status (employer, self-employed, employee, and unemployed), marital status (married, never married, widowed, and separated), and receipt of lay-off or unemployment benefits after April 2020. The household equivalized income was calculated as the gross (pre-tax) income in 2019, divided by the square root of the number of household members. Health-related characteristics included smoking status (never, ever, and current smokers), walking disability (whether the person is experiencing difficulties in walking), and eight comorbidities (overweight [body mass index ≥ 25 kg/m^2] and seven self-reported past medical histories of hypertension, diabetes, asthma, coronary disease, stroke, chronic obstructive pulmonary disease, and cancer). Body mass index was calculated by dividing self-reported body weight by self-reported body height squared (m^2).

As for preventive measures, the personal preventive actions included indicators of whether the respondent implemented each of the nine personal protective measures (1 = always/sometimes, 0 = rarely/never) recommended by the World Health Organization (WHO) [24]: social distancing, wearing masks, avoiding closed spaces, avoiding crowded spaces, avoiding close contact settings, handwashing, avoiding touching face, respiratory hygiene, and surface disinfection. High-risk behavior patterns included indicators of whether the respondent visited restaurants, bars/nightclubs, karaoke bars, fitness clubs, and brothels during the state of emergency in April-May (1 = frequently, occasionally, at least once, 0 = never) [25]. Proxy variables of other preventive measures included indicators of the use of the contact-tracing application [26], support for stay-at-home requests (1 = very/somewhat, 0 = slightly/never), and influenza vaccination in the last season (as a proxy for the likelihood of receiving the COVID-19 vaccination when it becomes available).

The perceived fear against the COVID-19 infection was adjusted for to test whether the difference in the risk preference between participants and non-participants could explain the differences in the incidence of the COVID-19-like symptoms. It was measured on a five-point scale of “not afraid at all (0% if I were to rate the level of fear between 0% and 100%),” “not afraid (25%), ”neutral (50%),” “somewhat afraid (75%),” and “very afraid (100%)” to the question “Are you afraid of the COVID-19 infection?”

Prefecture fixed effects are indicator variables for each prefecture, which account for both measured and unmeasured characteristics of the prefecture (Japan consists of 47 prefectures, which are the country’s first jurisdiction and administrative division levels). The inclusion of prefecture fixed effects allows us to effectively compare participants vs. non-participants of the program living in the same prefecture.

Statistical analysis

First, we compared the demographics, SES, health-related characteristics, preventive measures, and fear against the COVID-19 infection employed by participants in the subsidy program for domestic travel vs. non-participants. To account for the possibility that those who participated and responded to the internet-based survey may differ from the general population (e.g., a younger population may be more likely to participate and respond to an internet-based survey), we applied an inverse probability weighting (IPW) approach throughout the analyses [27]. The weights (the inverse of propensity scores representing the estimated probability of participating in the survey) were calculated by fitting a logistic regression model using demographics, SES, and health-related characteristics to adjust for the difference in respondents between the current internet survey and a widely-used nationwide representative survey (i.e., the 2016 Comprehensive Survey of Living Conditions [28,29]) (see **Method A2** for details).

Second, we examined the association between participation in the subsidy program for domestic travel and the incidence rates of COVID-19-like symptoms. For each outcome, we constructed two regression models to control for potential confounders. Model 1 adjusted for the respondents' sociodemographic characteristics, health-related characteristics, and prefecture fixed effects. Model 2 adjusted for all the variables included in Model 1 plus the use of preventive measures and fear against the COVID-19 infection, to investigate whether these factors could explain the observed differences in the incidence of symptoms related to COVID-19. We used weighted multivariable logistic regression models, with standard errors clustered at the prefecture-level, to account for the potential correlation of respondents within the same prefecture. To calculate risk-adjusted incidence rates of COVID-19-like symptoms, we used marginal standardization (also known as predictive margins or margins of response) [30]. For each respondent, we calculated predicted probabilities of the incidence of COVID-19-like symptoms with participation in the subsidy program fixed at each category and then averaged over the distribution of covariates in our sample.

To adjust for multiple comparisons of having five outcome variables using the Holm method [31], which sequentially compares the i-th smallest P value (for $i = 1, \ldots, 5$) among the five original P values with progressively less restrictive alpha levels ($= 0.05/(5 - i + 1)$). To make the interpretation easier, we calculated the adjusted P value by multiplying the unadjusted P values by $(5 - i + 1)$ times, and considered the adjusted P value < 0.05 to be statistically significant [32].

Sensitivity analysis

First, travelers to and from Tokyo were ineligible for the subsidy program until September 15, due to a large number of COVID-19 cases in Tokyo [8]. To assess whether our findings were sensitive to the inclusion of Tokyo residents (we included these individuals in our main analyses as they could still participate in the subsidy program if their companion lived in prefectures other than Tokyo), we reanalyzed the data after excluding those respondents living in Tokyo prefecture. Second, we repeated the analyses without using IPW to examine how the use of this approach affected our findings. Third, it is possible that we were comparing individuals who were more versus less likely to travel regardless of the existence of the government subsidy program for travel. To test this hypothesis, we reanalyzed the data restricting to individuals who did not eliminate the possibility of traveling in the past month (excluded individuals who reported that they had avoided any travels in the past month to the question “Have you avoided travels in the past one month?"). Fourth, to test whether the impact of the subsidy program varied by respondents' characteristics, we conducted stratified analyses by age (15-64 years and 65-79 years), the presence of comorbidities (no comorbidities vs. having at least one comorbidity), and gender. Finally, we ran separate analyses for five regions to ascertain whether the relationship between the subsidy program participation and COVID-19-like symptoms varied regionally.

All analyses were conducted using Stata version 15 (College Station, TX; StataCorp LLC.).

Patient and public involvement

No respondents were involved in setting the research question or the outcome measures, nor were they involved in the design, implementation, interpretation of the study. All respondents gave informed consent to enroll in the study.

RESULTS

Characteristics of respondents

Of the 25,482 respondents, 3,289 (12.9%) had participated in the subsidy program for domestic travel at the time of the survey. Participants in the subsidy program were younger; had higher education and income levels; and were more likely to be overweight (**Table 1**). We found no systemic patterns regarding the implementation of preventive actions recommended by WHO (**Table 2**). Notably, participants in the subsidy program were more likely than non-participants to engage in risky behavior patterns (visiting restaurants, bars/nightclubs, karaoke bars, or fitness clubs at least once) during the state of emergency. As for other preventive measures, participants in the subsidy program were more likely to use the contact-tracing application and to have received the flu vaccine in the prior year.

Participation in the subsidy program for domestic travel and COVID-19-like symptoms

After adjusting for demographics, SES, health-related characteristics and indicators of prefectures (Model 1 in **Table 3**), we found that the adjusted incidence rates of COVID-19-like symptoms were higher for subsidy program participants compared with non-participants for high fever (adjusted rate, 4.7% for participants vs. 3.7% for non-participants; adjusted odds ratio [aOR], 1.83; 95%CI, 1.34-2.48; p<0.001), sore throat (19.8% vs. 11.3%; aOR, 2.09; 95%CI, 1.37-3.19; p=0.002), cough (19.0% vs. 11.3%; aOR 1.96; 95%CI, 1.26-3.01; p=0.008), headache (29.2% vs. 25.5%; aOR, 1.24; 95%CI, 1.08-1.44; p=0.006), and smell and taste disorder (2.6% vs. 1.8%; aOR 1.98; 95%CI; 1.15-3.40; p=0.01). These findings remained largely unchanged after additional adjustments for the use of preventive measures and fear against the COVID-19 infection in Model 2: the adjusted incidence rates of COVID-19-like symptoms were higher for subsidy program participants compared with non-participants for high fever (4.4% vs. 3.7%; aOR, 1.56; 95%CI, 1.09-2.23; p=0.04), sore throat (18.2% vs. 11.6%; aOR, 1.84; 95%CI, 1.35-2.52; p<0.001), cough (17.1% vs. 11.5%; aOR 1.66; 95%CI, 1.21-2.26; p=0.006), headache (28.2% vs. 25.7%; aOR, 1.17; 95%CI, 1.02-1.34; p=0.04), and smell and taste disorder (2.3% vs. 1.8%; aOR 1.56; 95%CI; 1.05-2.30; p=0.03).

Sensitivity analysis

Our findings were largely unaffected by excluding respondents living in Tokyo (**Table A1**) and using unweighted regression models (**Table A2**). The results of the analysis excluding individuals who avoided travels in the past month showed higher incidence rates of sore throat and cough among subsidy program participants compared with non-participants (**Table A3**). However, we found no evidence that the incidence of the other three symptoms differed between these two groups. The result of the stratified analyses by age showed that the higher incidence rates of COVID-19-like symptoms were more salient among young respondents (**Table A4**). For example, among respondents aged 15-64 years, the adjusted incidence rate of smell and taste disorder was higher for subsidy program participants compared with younger non-participants, whereas the incidence rates did not differ between participants and non-participants among those aged 65-79 years (p for interaction = 0.04). We found no systemic difference in patterns regarding the association between subsidy program participation and COVID-19-like symptoms for the stratified analyses by the presence of comorbidity and gender (**Tables A5 and A6**). There were no consistent regional variations in the relationships between the subsidy program participation and COVID-19-like symptoms (**Table A7**).

Discussion

Using the data from a large cross-sectional internet survey that included more than 25,000 adults in Japan, we found that individuals who participated in the government's subsidy program for domestic travel experienced a higher incidence of COVID-19-like symptoms compared with those who did not participate. This association was also observed for the incidence of smell and taste disorder, which is a highly specific symptom of the COVID-19 infection [19,33]. These findings were qualitatively unaffected by additional adjustments for preventive measures and fear against the COVID-19 infection, indicating that the systemic differences in participants and non-participants in the subsidy program regarding risky behaviors do not explain the observed associations between the subsidy program and the higher incidence of COVID-19-like symptoms. This increased incidence of COVID-19-like-symptoms was salient among individuals aged <65 years, but not for those aged ≥ 65 years, suggesting that the non-elderly generation may be contributing to the spread of COVID-19 infection associated with this program. Given that the Japanese government is debating the implementation of this subsidy program due to concerns about increased risks of COVID-19 infections, and that other countries are actively considering similar policies to stimulate their economies [6-10], our findings should be informative for designing policies that could increase economic activities without exacerbating the COVID-19 pandemic.

There are several mechanisms through which participation in this subsidy program for domestic travel was associated with a higher incidence of COVID-19-like symptoms. First, increased contact with people while dining and sightseeing at the destination in traveling may have led to a higher risk of incidence of COVID-19 (causal effect). This explanation is supported by a recent genome epidemiological study of SARS-CoV-2 in Japan that found the possibility that the COVID-19 clusters in the Tokyo metropolitan areas might have spread throughout Japan after lifting movement restrictions [34]. This hypothesis is supported by a study from the US that found the volume of domestic airline travel around the Thanksgiving holiday was positively associated with the spread of seasonal influenza [35]. Second, subsidy program participants might have been more likely to engage in behaviors that placed them at greater risk of contracting COVID-19 than non-participants (selection effect). However, the fact that our results remained statistically significant after additional adjustment for preventive behaviors suggests that this explanation alone may be insufficient to explain the observed relationship between participation in this program and a higher likelihood of experiencing COVID-19-like symptoms. Furthermore, even if the findings were to be explained by this selection effect, our findings indicate that the subsidy program may be incentivizing those with higher risks of COVID-19 transmission to travel across the nation, leading to the expansion of the outbreaks across regions (e.g., from the urban to the rural tourist spots). A better policy may be to directly provide financial assistance to affected sectors (e.g., travel industries) and encourage all individuals to stay at home until vaccinated.

Analysis after excluding individuals who avoided travels in the past month also showed that program participants were more likely to experience some COVID-19-like symptoms. This finding suggests the possibility that participants and non-participants may have different behavioral patterns in traveling, including the destination, the frequency and duration of travel (more often or longer for participants), and the method of travel (participants might be more likely to use public transportation [vs. private vehicle] because the program subsidized the expense of public transportation for travel). Also, program participants might have more opportunities to allocate the money saved by discounts to activities such as eating and shopping, which might increase the rate of infection.

Strengths and limitations of this study

The main strengths of this study were its use of large-size nationwide data and a unique setting in which a large nationwide government subsidy for travel was initiated before the spread of COVID-19 was contained.

Our study has limitations. First, as with any observational study, we could not fully account for unmeasured confounders, and our study was unable to identify the exact mechanisms of the association between subsidy program participation and increased incidence rates of COVID-19-like symptoms. Second, given the cross-sectional design of our study, we could not identify the temporal relationship between the subsidy program and the incidence of COVID-19-like symptoms. Instead of the government subsidy causing infections of COVID-19, it was also possible that individuals who experienced COVID-19-like symptoms were more likely to utilize the program and travel domestically. However, this explanation may be unlikely given that travel agents and hotels have introduced strict protocols to ensure that no one with COVID-19-like symptoms uses their services. Also, individuals who spread the virus are likely to face criticism and stigma in Japan, which incentivizes people with suspected symptoms to stay at home [36]. Third, it is likely that some individuals who reported five COVID-19-like symptoms had illnesses that were not COVID-19, as we were unable to collect data on confirmed diagnoses of COVID-19 infection (e.g., diagnoses using the PCR test). However, smell and taste disorders, one of the outcomes we used, are known to be highly specific (90% specificity) to a COVID-19 diagnosis [19,33], suggesting that these symptoms would be good proxies for the incidence of COVID-19. Moreover, symptom-based measures would supplement the PCR test-based surveillance to inform a population-level picture of COVID-19 infection [20,21] because PCR testing underestimates the true number of infections (not everyone with symptoms indicative of COVID-19 is tested). Nevertheless, further prospective studies that investigate the association between the participation in the subsidy program for domestic travel and COVID-19 incidence (identified by PCR test or administrative data) warrant. Fourth, our findings may be affected by the possibility that individuals who presented with COVID-19-like symptoms might recall and report using the subsidy program for domestic travel (as the cause of their symptoms) compared with individuals without such symptoms (recall bias). However, the questions on the program participation and COVID-19-like symptoms were located in a remote part of the questionnaire among the more than 100 other questions asked (and therefore certainly considered irrelevant to the respondents), and this recall bias problem would be minimal. Conversely, it is also possible that those participating in the subsidy program may under-report COVID-19-like symptoms. However, if this is the case, this would bias our estimates towards the null, and the true difference in COVID-19-like symptoms between the participants and non-participants of the subsidy program would be larger than what we have estimated. Fifth, the information on how many times the respondents traveled was unavailable, and we could not distinguish one-time travelers from frequent travelers. Finally, we used the weighted analyses to address the issue that the participants were recruited from the survey panel of registered individuals in the internet research agency (to minimizing the difference in demographics, SES, and health-related characteristics between respondents of the current internet survey and the nationally representative sample). However, it is still possible that individuals included in our analyses differed from the general population in unmeasurable ways, and therefore, our findings may not be generalizable to other populations, such as the population with limited access to and literacy about the internet.

Comparison with other studies

Our findings were consistent with those from a limited set of empirical studies on the association between domestic travel and the COVID-19 spread. Studies in China at the early stage of the COVID-19 epidemic found a positive association between domestic passenger travel volume from Wuhan City and the confirmed COVID-19 cases within the other ten cities in China [37,38]. Another study showed a preventive effect of a travel ban from Wuhan against the COVID-19 spread [39]. A recent study in 149 countries found that a combination of stay-at-home regulations and restrictions on movements within a country reduce the COVID-19 spread, but this study did not examine an independent effect of domestic travels [4]. To our knowledge, there have been no studies that have investigated the impact of government subsidies for travel, which is a unique economic policy introduced in Japan, on the spread of COVID-19 infections. Anzai and Nishiura have recently reported an increase in the number of travel-related COVID-19 confirmed cases in the month just after the introduction of this program than in the month before [40]. However, their study found that non-travel-related cases also increased to the same extent and the association between the subsidy program and the spread of COVID-19 was unclear.

CONCLUSION

Using a large-scale, concurrent, nationwide internet survey in Japan, we found that participants in the government subsidy program for domestic travel in Japan had higher incidence rates of COVID-19-like symptoms compared to non-participants. Our findings suggest that the implementation of the subsidy program for domestic travel might have contributed to increased cases of COVID-19 infections. In the midst of an economic recession due to the COVID-19 pandemic, economic stimulus policies should take the form of directly subsidizing financial loss of affected sectors or incentivizing economic activities that do not involve increase physical interactions, rather than incentivizing individuals to travel more or use restaurants.

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Ethical Approval: This study was approved by the Institutional Review Board of the Osaka International Cancer Institute (No. 20084).

Author Contributions

Atsushi Miyawaki: conceptualisation, data curation, formal analysis, investigation, methodology, resources, software, and visualisation, writing – original draft.

Takahiro Tabuchi: data curation, funding acquisition, investigation, methodology, project administration, resources, validation, and writing – review & editing.

Yasutake Tomata: data curation, funding acquisition, investigation, methodology, resources, validation, and writing – review & editing.

Yusuke Tsugawa: conceptualisation, investigation, methodology, resources, software, supervision, and visualisation, writing – original draft, and writing – review & editing.

Data Statement: The data used in this study are unsuitable for public deposition because of ethical restrictions and the legal framework in Japan. Specifically, it is prohibited by the Act on the Protection of Personal Information (Act No. 57 of May 30, 2003, amended on September 9, 2015) to publicly deposit data containing personal information. All relevant data are available upon request to the corresponding author via e-mail (YTsugawa@mednet.ucla.edu).

Declaration of Competing Interest: The authors have declared that no competing interests exist.

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Table 1. Sociodemographic and Health-Related Characteristics of Respondents by Participation in the Subsidy Program for Domestic Travel

Characteristics		Total (N=25,482)	Participants (N=3,289)	Non-participants (N=22,193)	P value
Female		12,809 (50.3)	1,534 (46.6)	11,275 (50.8)	0.29
Age, mean (SD), yr		48.4 (17.4)	45.0 (17.9)	49.4 (17.3)	0.02
Academic attainment	College or higher	12,701 (49.8)	1,973 (60.0)	10,728 (48.3)	<0.001
	High school or lower	12,781 (50.2)	1,316 (40.0)	11,465 (51.7)	
Income level	Lower	7,336 (28.8)	867 (26.4)	6,469 (29.1)	<0.001
	Intermediate	6,817 (26.8)	804 (24.4)	6,013 (27.1)	
	Higher	5,733 (22.5)	1,144 (34.8)	4,589 (20.7)	
	Not answered	5,595 (22.0)	474 (14.4)	5,121 (23.1)	
Household size	1	4,117 (16.2)	665 (20.2)	3,452 (15.6)	0.43
	2	8,574 (33.7)	1,091 (33.2)	7,482 (33.7)	
	3	5,927 (23.3)	766 (23.3)	5,160 (23.3)	
	4	4,532 (17.1)	499 (15.2)	3,853 (17.4)	
	5+	2,513 (9.9)	268 (8.1)	2,245 (10.1)	
Marital status	Married	16,100 (63.2)	2,025 (61.6)	14,075 (63.4)	0.20
	Never married	6,046 (23.7)	707 (21.5)	5,339 (24.1)	
	Widowed	1,949 (7.7)	427 (13.0)	1,522 (6.9)	
	Separated	1,387 (5.4)	131 (4.0)	1,256 (5.7)	
Employment	Employer	1,007 (4.0)	262 (8.0)	746 (3.4)	0.10
	Self-employed	2,008 (7.9)	305 (9.3)	1,703 (7.7)	
	Employee	12,745 (50.0)	1,725 (52.4)	11,020 (49.7)	
	Unemployed	9,272 (38.2)	998 (30.3)	8,724 (39.3)	
Lay-off or unemployment benefits		937 (3.7)	292 (8.9)	645 (2.9)	0.02
Smoking status	Never	12,959 (50.9)	1,531 (46.5)	11,429 (51.5)	0.47
	Ever	1,638 (30.0)	1,108 (33.7)	6,530 (29.4)	
	Current	4,885 (19.2)	651 (19.8)	4,234 (19.1)	
Walking disability		3,543 (13.9)	644 (19.6)	2,900 (13.1)	0.18
Comorbidities	Overweight	5,185 (20.4)	884 (26.9)	43,01 (19.4)	0.04
	Hypertension	6,963 (27.3)	1,071 (32.6)	5,891 (26.5)	0.17
	Diabetes	2,711 (10.6)	515 (15.7)	2,196 (9.9)	0.16
	Asthma	3,573 (14.0)	647 (19.7)	2,926 (13.2)	0.11
	Coronary disease	1,686 (6.6)	401 (12.2)	1,285 (5.8)	0.09
	Stroke	1,228 (5.1)	352 (10.7)	936 (4.2)	0.07
	COPD	1,103 (4.3)	338 (10.3)	766 (3.5)	0.05
	Cancer	2,185 (8.6)	374 (11.4)	1,811 (8.2)	0.38

SD: standard deviation. COPD: chronic obstructive pulmonary disease. The analyses were weighted to account for selection in an internet survey. Because of weighting, the sum of participants and non-participants did not necessarily equal the number of total respondents. The numbers are No. (%), except for age. P values are calculated using an adjusted Wald test for age and chi-square tests for other categorical variables. The analyses of this table were for the purpose of simple description and did not account for multiple comparisons in the presentation of the P values. Comorbidities of hypertension, diabetes, asthma, coronary heart disease, stroke, COPD, and cancer was defined as having a past medical history of these conditions.

Table 2. Preventive Measures and Fear Against the COVID-19 Infection of Respondents by Participation in the Subsidy Program for Domestic Travel

Characteristics	Total (N=25,482)	Participants (N=3,289)	Non-participants (N=22,193)	P value
Preventive Measures				
Personal Preventive Actions				
Social distancing	21,359 (83.8)	2,776 (84.4)	18,582 (83.7)	0.85
Wearing masks	24,018 (94.3)	3,074 (93.5)	20,944 (94.4)	0.80
Avoiding closed spaces	20,728 (81.3)	2,574 (78.3)	18,154 (81.8)	0.43
Avoiding crowded spaces	22,949 (90.1)	3,028 (92.1)	19,921 (89.8)	0.08
Avoiding close contact settings	20,152 (79.1)	2,381 (72.4)	17,771 (80.1)	0.09
Handwashing	22,191 (87.1)	2,956 (89.9)	19,235 (86.7)	0.02
Avoiding touching face	19,591 (76.9)	2,511 (76.3)	17,080 (77.0)	0.87
Respiratory hygiene	22,037 (86.5)	2,856 (86.8)	19,182 (86.4)	0.92
Surface disinfection	13,340 (52.4)	1,625 (49.4)	11,715 (52.8)	0.40
High-Risk Behavior Patterns				
Visiting restaurants	6,674 (26.3)	1,305 (39.7)	5,369 (24.2)	<0.001
Visiting bars/nightclubs	4,185 (16.4)	1,013 (30.8)	3,172 (14.3)	<0.001
Visiting karaoke bars	2,645 (9.7)	630 (19.2)	1,836 (8.3)	0.01
Visiting fitness clubs	2,712 (10.6)	736 (22.4)	1,976 (8.9)	<0.001
Visiting brothels	1,885 (7.4)	438 (13.3)	1,447 (6.5)	0.08
Proxies of Other Preventive Measures				
Use of contact-tracing app	4,331 (17.0)	996 (30.3)	3,336 (15.0)	<0.001
Support for stay-at-home requests	19,825 (77.8)	2,668 (81.1)	17,158 (77.3)	0.32
Flu vaccine in the last season	8,791 (34.5)	1,403 (42.7)	7,389 (33.3)	0.03
Fear against the COVID-19 Infection				
Not afraid at all	1,641 (6.4)	217 (6.6)	1,424 (6.4)	0.71
Not afraid	1,910 (7.5)	317 (9.6)	1,592 (7.2)	
Neutral	5,793 (22.7)	786 (23.9)	5,007 (22.6)	
Somewhat afraid	9,423 (37.0)	1,122 (34.1)	8,302 (37.4)	
Very afraid	6,715 (26.4)	847 (25.8)	5,868 (26.4)	

The analyses were weighted to account for selection in an internet survey. Because of weighting, the sum of participants and non-participants did not necessarily equal the number of total respondents. The numbers are No. (%). Personal preventive actions included nine personal protective measures recommended by the World Health Organization. High-risk behavior patterns included five risky behaviors for COVID-19 during the state of emergency. The fear against the COVID-19 infection was measured on a five-point scale of "not afraid at all (0% if I were to rate the level of fear between 0% and 100%)," "not afraid (25%), "neutral (50%)," "somewhat afraid (75%)," and "very afraid (100%)" to the question "Are you afraid of the COVID-19 infection?" P values are calculated chi-square test. The analyses of this table were for the purpose of simple description and did not account for multiple comparisons in the presentation of the P values.

Table 3. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms

Subsidy Program Participation	Weighted sample, No.	Weighted incidence, n (%)	Model 1: adjusted for demographics, SES, health, and prefecture fixed effects			Model 2: adjusted for the adjustment variables in Model 1 + preventive measures & fear against COVID-19		
			Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
High Fever								
Participants	3,289	327 (9.9)	4.7 (4.2, 5.2)	1.83 (1.34, 2.48)	<0.001	4.4 (3.9, 4.9)	1.56 (1.09, 2.23)	0.04
Non-participants	22,193	633 (2.9)	3.7 (3.6, 3.8)	Reference		3.7 (3.6, 3.8)	Reference	
Sore Throat								
Participants	3,289	790 (24.0)	19.8 (15.0, 24.6)	2.09 (1.37, 3.19)	0.002	18.2 (15.0, 21.4)	1.84 (1.35, 2.52)	<0.001
Non-participants	22,193	2406 (10.8)	11.3 (10.5, 12.1)	Reference		11.6 (11.1, 12.1)	Reference	
Cough								
Participants	3,289	728 (22.1)	19.0 (14.2, 23.9)	1.96 (1.26, 3.01)	0.008	17.1 (13.9, 20.2)	1.66 (1.21, 2.26)	0.006
Non-participants	22,193	2417 (10.9)	11.3 (10.5, 12.0)	Reference		11.5 (11.0, 12.1)	Reference	
Headache								
Participants	3,289	1,009 (30.7)	29.2 (27.0, 31.4)	1.24 (1.08, 1.44)	0.006	28.2 (26.3, 30.2)	1.17 (1.02, 1.34)	0.04
Non-participants	22,193	5,612 (25.3)	25.5 (25.2, 25.8)	Reference		25.7 (25.4, 25.9)	Reference	
Smell and Taste Disorder								
Participants	3,289	167 (5.1)	2.6 (2.0, 3.1)	1.98 (1.15, 3.40)	0.01	2.3 (1.9, 2.6)	1.56 (1.05, 2.30)	0.03
Non-participants	22,193	287 (1.3)	1.8 (1.6, 1.9)	Reference		1.8 (1.7, 1.9)	Reference	

OR: odds ratio. CI: confidence interval. We examined the association of participation in the government subsidy program for domestic travel in the past 1-2 months with the incidence of the five COVID-19-like symptoms within the past month of the survey. For each outcome, we constructed a weighted multivariable logistic regression model with standard errors clustered at the prefecture-level. Model 1 adjusted for the respondents' sociodemographic characteristics, health-related characteristics, and prefecture indicator variables. Model 2 adjusted for all the variables included in Model 1 plus the preventive measures and fear against the COVID-19 infection. We weighted the regression models using IPW to account for "being a respondent in an internet survey." Adjusted rates were calculated using marginal standardization. Adjusted P values using the Holm method for multiple testing were shown (the adjusted p value < 0.05 was considered to be statistically significant).

Supplementary Materials

Association between Participation in the Government Subsidy Program for Domestic Travel and Symptoms Indicative of COVID-19 Infection in Japan: Cross-Sectional Study

Atsushi Miyawaki, Takahiro Tabuchi, Yasutake Tomata, Yusuke Tsugawa

Method A1. Management of data quality
To validate data quality, we excluded respondents showing unnatural or inconsistent responses.

(A) We excluded those who answered incorrectly for the survey item

Please choose the second from the bottom of the following options.
A
B
C
D
E
*The correct answer is D.

(B) We excluded those participants who answered "almost every day" or "several times per week" (as opposed to "once a week," "once a month," or "never") to all nine questions asking about the use of the following substances: (1) alcohol, (2) sleeping pills/anti-anxiety drugs, (3) prescribed narcotics for cancer pain, (4) prescribed narcotics for non-cancer pain, (5) non-prescribed narcotics, (6) inhalation of organic solvents such as paint thinner or toluene, (7) illegal herbs/magic mushrooms, (8) cannabis (marijuana), and (9) methamphetamine/cocaine/heroin.

(C) We excluded those participants who answered "currently have this condition and receiving treatment" or " currently have this condition but not receiving treatment" (as opposed to "never in the past" or "not now, but existed in the past") to all 16 questions asking about the presence of the following chronic conditions:
(1) hypertension, (2) diabetes, (3) asthma, (4) bronchitis/pneumonia, (5) atopic dermatitis, (6) periodontal disease, (7) caries, (8) otitis media, (9) angina pectoris, (10) myocardial infarction, (11) stroke, (12) chronic obstructive pulmonary disease, (13) cancer/malignant tumor, (14) chronic pain, (15) depression, and (16) mental disorder other than depression.

Method A2. Inverse Probability Weighting

Internet surveys have several advantages over traditional surveys. However, the potential disadvantage is that they may not be representative of the population of interest because subpopulations with internet access may be specific. Previous studies have used inverse probability weighting (IPW) (derived from propensity scores calculated by a logistic regression model using basic demographic and socio-economic factors such as education and length of home-ownership) obtained from an internet-accessible convenience sample and the nationally-representative sample. It has been suggested that the parameter estimates calculated using IPW are similar, or at least less different, than the population-based estimates [1].

In the current study, we used a population-based sample representative of the Japanese population from the 2016 Comprehensive Survey of Living Conditions (CSLC) to correct for sample selectivity in the internet survey. The CSLC has been conducted every three years by the Japanese Ministry of Health, Labour and Welfare (MHLW) and collects information on health-related factors, such as self-rated health and smoking behavior [2]. Out of inhabited census tracts (sampling unit for the national census in 2010), 5410 were randomly sampled across Japan in 2016 to collect data from all household members within each census tract. Data were available for 224,208 households (response rate; 77.5%) in 2016. Data from the 2016 CSLC were used because the 2019 CSLC was not yet available at the time of analysis. Data were used with permission from MHLW. CSLC has been used in several studies [3-5].

We pooled and combined data from the two surveys (the current internet survey and CSLC) and ran a multivariable logistic regression model to estimate the probability of "being an internet survey respondent," or propensity score. Propensity scores were calculated for each group stratified by gender and age (15-19, 20-29, ..., 70-79) (gender x age stratification = 14 strata). We used variables available in both surveys (the current internet survey and CSLC) as covariates for the models. For men and women aged 20-79 years, we included socio-economic status (residence area, marital status, education level, and home-ownership) and health-related characteristics (self-rated health and smoking status) in the model. For men and women aged 15-19 years, we included socio-economic status (residence area, education level, and home-ownership) and self-rated health in the model, because they were too young to have a different distribution of marital status, and the CSLC did not ask teenagers about their smoking status. A standardized weight was used to keep the total number of respondents included constant.

Table A1. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, after Excluding Those Who Were Living in Tokyo

Subsidy Program Participation	Weighted sample, No.	Weighted incidence, n (%)	Model 1: adjusted for demographics, SES, health, and prefecture fixed effects			Model 2: adjusted for the adjustment variables in Model 1 + preventive measures & fear against COVID-19		
			Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
High Fever								
Participants	2,959	308 (10.4)	4.8 (4.3, 5.3)	1.77 (1.30, 2.40)	0.002	4.6 (4.1, 5.1)	1.61 (1.14, 2.29)	0.03
Non-participants	19,604	584 (3.0)	3.9 (3.8, 4.0)	Reference		3.9 (3.8, 4.0)	Reference	
Sore Throat								
Participants	2,959	622 (21.0)	17.3 (13.2, 21.4)	1.76 (1.19, 2.61)	0.01	15.7 (13.4, 17.9)	1.52 (1.19, 1.93)	0.003
Non-participants	19,604	2,100 (10.7)	11.1 (10.5, 11.8)	Reference		11.5 (11.1, 11.8)	Reference	
Cough								
Participants	2,959	564 (19.1)	16.2 (12.1, 20.3)	1.60 (1.07, 2.39)	0.02	14.2 (12.3, 16.2)	1.32 (1.06, 1.65)	0.04
Non-participants	19,604	2,107 (10.7)	11.1 (10.5, 11.8)	Reference		11.4 (11.1, 11.7)	Reference	
Headache								
Participants	2,959	941 (31.8)	29.8 (27.7, 31.8)	1.26 (1.10, 1.44)	0.004	28.7 (26.7, 30.7)	1.18 (1.03, 1.35)	0.04
Non-participants	19,604	5003 (25.5)	25.8 (25.5, 26.1)	Reference		26.0 (25.7, 26.3)	Reference	
Smell and Taste Disorder								
Participants	2,959	157 (5.3)	2.7 (2.1, 3.3)	1.95 (1.11, 3.44)	0.04	2.4 (2.0, 2.9)	1.54 (1.03, 2.30)	0.03
Non-participants	19,604	267 (1.4)	1.9 (1.7, 2.0)	Reference		2.0 (1.9, 2.0)	Reference	

SES: socio-economic status. OR: odds ratio. CI: confidence interval. We analyzed 22,563 respondents after excluding 2,919 respondents living in Tokyo. See Table 3's legend for more details.

Table A2. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Using the Unweighted Logistic Regression Models

Subsidy Program Participation	Unweighted sample, No.	Unweighted incidence, n (%)	Model 1: adjusted for demographics, SES, health, and prefecture fixed effects			Model 2: adjusted for the adjustment variables in Model 1 + preventive measures & fear against COVID-19		
			Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
High Fever								
Participants	3,306	111 (3.4)	2.4 (2.0, 2.8)	1.51 (1.18, 1.93)	0.002	2.2 (1.8, 2.6)	1.36 (1.04, 1.78)	0.0 3
Non-participants	22,176	331 (1.5)	1.6 (1.5, 1.7)	Reference		1.7 (1.6, 1.7)	Reference	
Sore Throat								
Participants	3,306	462 (14.0)	12.8 (11.8, 13.8)	1.23 (1.10, 1.38)	<0.001	12.6 (11.5, 13.6)	1.21 (1.07, 1.36)	0.005
Non-participants	22,176	2,338 (10.5)	10.7 (10.5, 10.9)	Reference		10.7 (10.6, 10.9)	Reference	
Cough								
Participants	3,306	455 (13.8)	13.4 (12.3, 14.4)	1.22 (1.10, 1.36)	<0.001	13.1 (12.1, 14.2)	1.20 (1.07, 1.33)	0.004
Non-participants	22,176	2,489 (11.2)	11.3 (11.1, 11.4)	Reference		11.3 (11.2, 11.5)	Reference	
Headache								
Participants	3,306	988 (29.9)	27.4 (26.4, 28.4)	1.17 (1.08, 1.28)	<0.001	27.2 (26.2, 28.1)	1.12 (1.05, 1.20)	0.003
Non-participants	22,176	5,509 (24.8)	25.2 (2501, 25.3)	Reference		25.2 (25.1, 25.4)	Reference	
Smell and Taste Disorder								
Participants	3,306	63 (1.9)	1.4 (1.1, 1.7)	1.53 (1.14, 2.06)	0.005	1.3 (1.1, 1.6)	1.51 (1.12, 2.03)	0.01
Non-participants	22,176	180 (0.8)	0.9 (0.9, 1.0)	Reference		0.9 (0.9, 1.0)	Reference	

SES: socio-economic status. OR: odds ratio. CI: confidence interval. We showed the results of the analyses using unweighted logistic regression models. See Table 3's legend for more details.

Table A3. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, after Excluding Individuals Who Avoided Travels in the Past Month

Subsidy Program Participation	Weighted sample, No.	Weighted incidence, n (%)	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
High Fever								
Participants	1,872	162 (8.7)	6.9 (6.3, 7.4)	1.14 (0.72, 1.83)	0.57	6.6 (6.1, 7.0)	0.87 (0.56, 1.37)	0.56
Non-participants	5,565	333 (6.0)	6.6 (6.4, 6.8)	Reference		6.8 (6.5, 7.0)	Reference	
Sore Throat								
Participants	1,872	463 (24.7)	18.9 (15.5, 22.3)	1.95 (1.24, 3.08)	0.02	17.3 (14.8, 19.8)	1.64 (1.13, 2.38)	0.04
Non-participants	5,565	593 (10.7)	12.4 (11.1, 13.6)	Reference		12.9 (12.0, 13.9)	Reference	
Cough								
Participants	1,872	446 (23.8)	18.6 (15.4, 21.7)	1.85 (1.25, 2.73)	0.01	16.5 (14.7, 18.3)	1.48 (1.14, 1.92)	0.02
Non-participants	5,565	578 (10.4)	12.0 (11.0, 13.1)	Reference		12.7 (12.1, 13.4)	Reference	
Headache								
Participants	1,872	477 (25.5)	27.0 (24.3, 29.6)	1.42 (1.13, 1.80)	0.01	25.0 (22.6, 27.4)	1.20 (0.95, 1.52)	0.12
Non-participants	5,565	1244 (22.4)	21.9 (21.0, 22.7)	Reference		22.4 (21.6, 23.3)	Reference	
Smell and Taste Disorder								
Participants	1,872	142 (7.6)	5.3 (4.7, 5.9)	1.50 (0.64, 3.47)	0.35	5.2 (4.6, 5.7)	1.34 (0.56, 3.20)	0.51
Non-participants	5,565	154 (2.8)	4.9 (4.6, 5.1)	Reference		4.9 (4.7, 5.2)	Reference	

We analyzed 7,437 respondents after excluding 18,045 respondents who avoided travels in the past month (defined as individuals who answered that they had avoided any travels in the past month to the question "Have you avoided travels in the past one month?"). For Holm-adjusted P values, we multiplied the *i*-th smallest unadjusted P values by $(5 - i + 1)$ times if the unadjusted P value < 0.05, and simply showed the unadjusted P values if ≥ 0.05. See Table 3's legend for more details.

Table A4. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Stratified by Age

	Age < 65 yrs (n=19,174)			**Age ≥ 65 yrs (n=6,308)**		
	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
Model 1						
High Fever						
Participants	6.0 (5.4, 6.7)	1.95 (1.41, 2.69)	<0.001	0.8 (-0.2, 1.8)	0.96 (0.20, 4.61)	0.96
Non-participants	4.7 (4.6, 4.8)	Reference		0.8 (0.7, 0.9)	Reference	
Sore Throat						
Participants	23.3 (18.3, 28.4)	2.29 (1.53, 3.43)	<0.001	8.2 (3.1, 13.4)	1.23 (0.48, 3.18)	0.67
Non-participants	12.6 (11.8, 13.5)	Reference		7.1 (6.6, 7.5)	Reference	
Cough						
Participants	21.6 (16.1, 27.1)	2.18 (1.38, 3.44)	0.002	7.9 (4.3, 11.5)	0.78 (0.42, 1.43)	0.42
Non-participants	11.8 (10.9, 12.8)	Reference		9.6 (9.3, 10.0)	Reference	
Headache						
Participants	35.7 (33.2, 38.1)	1.27 (1.11, 1.47)	0.002	10.4 (7.0, 13.8)	1.21 (0.73, 2.02)	0.45
Non-participants	30.9 (30.5, 31.3)	Reference		9.0 (8.7, 9.3)		
Smell and Taste Disorder						
Participants	3.4 (2.7, 4.1)	2.00 (1.14, 3.49)	0.02	0.3 (0, 0.6)	0.49 (0.18, 1.33)	0.16
Non-participants	2.4 (2.2, 2.6)	Reference		0.6 (0.6, 0.6)	Reference	
Model 2						
High Fever						
Participants	5.6 (5.0, 6.3)	1.63 (1.11, 2.38)	0.04	1.0 (0, 2.1)	1.38 (0.35, 5.40)	0.65
Non-participants	4.8 (4.6, 4.9)	Reference		0.8 (0.7, 0.9)	Reference	
Sore Throat						
Participants	21.0 (17.9, 24.2)	1.93 (1.46, 2.56)	<0.001	8.6 (4.7, 12.4)	1.34 (0.64, 2.81)	0.44
Non-participants	13.0 (12.5, 13.6)	Reference		7.0 (6.7, 7.4)	Reference	
Cough						
Participants	19.8 (15.8, 22.5)	1.82 (1.33, 2.48)	<0.001	8.2 (4.6, 11.9)	0.82 (0.44, 1.52)	0.52
Non-participants	12.2 (11.7, 12.8)	Reference		9.6 (9.3, 9.9)	Reference	
Headache						
Participants	34.3 (32.1, 36.5)	1.18 (1.04, 1.35)	0.03	11.6 (8.0, 15.1)	1.46 (0.87, 2.44)	0.15
Non-participants	31.1 (30.8, 31.5)	Reference		8.9 (8.7, 9.2)	Reference	
Smell and Taste Disorder						
Participants	3.1 (2.6, 3.6)	1.60 (1.04, 2.45)	0.03	0.3 (0, 0.9)	0.49 (0.10, 2.40)	0.38
Non-participants	2.5 (2.4, 2.6)	Reference		0.6 (0.5, 0.7)	Reference	

We stratified the respondents by age (15-64 years and 65-79 years) and separately repeated the analyses using the same models as in the main analyses. For Holm-adjusted P values, we multiplied the i-th smallest unadjusted P values by $(5 - i + 1)$ times if the unadjusted P value < 0.05, and simply showed the unadjusted P values if ≥ 0.05. P for interaction (Wald test, not adjusted for multiple testing) between subsidy program participation and age group were 0.26 and 0.39 for high fever, 0.09 and 0.18 for sore throat, 0.005 and 0.008 for cough, 0.21 and 0.32 for headache, and 0.02 and 0.04 for smell and taste disorder, respectively. See Table 3's legend for more details.

Table A5. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Stratified by the Presence of Comorbidities

	Individuals without comorbidities (n=12,749)			Individuals with comorbidities (n=12,733)		
	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
Model 1						
High Fever						
Participants	2.6 (1.6, 3.6)	2.63 (1.54, 4.48)	0.002	7.1 (6.6, 7.6)	1.26 (0.86, 1.84)	0.24
Non-participants	1.0 (0.9, .12)	Reference		6.7 (6.6, 6.9)	Reference	
Sore Throat						
Participants	11.6 (9.8, 13.3)	1.35 (1.09, 1.67)	0.02	26.0 (18.9, 33.0)	2.56 (1.45, 4.52)	0.006
Non-participants	8.9 (8.7, 9.2)	Reference		13.8 (12.5, 15.1)	Reference	
Cough						
Participants	10.5 (8.5, 12.5)	1.30 (1.01, 1.68)	0.09	25.5 (18.0, 33.0)	2.23 (1.25, 3.97)	0.02
Non-participants	8.3 (8.1, 8.6)	Reference		14.3 (13.0, 15.7)	Reference	
Headache						
Participants	31.7 (28.7, 34.7)	1.39 (1.17, 1.67)	0.002	26.4 (23.7, 29.0)	1.06 (0.86, 1.31)	0.58
Non-participants	25.7 (25.3, 26.0)	Reference		25.5 (25.0, 25.9)	Reference	
Smell and Taste Disorder						
Participants	1.5 (0.6, 2.3)	1.86 (0.84, 4.13)	0.13	4.4 (3.6, 5.2)	2.47 (1.29, 4.73)	0.02
Non-participants	0.8 (0.7, 1.0)	Reference		2.9 (2.7, 3.2)	Reference	
Model 2						
High Fever						
Participants	2.4 (1.4, 3.5)	2.43 (1.38, 4.28)	0.009	7.0 (6.4, 7.5)	1.13 (0.73, 1.76)	0.58
Non-participants	1.1 (0.9, 1.2)	Reference		6.8 (6.6, 6.9)	Reference	
Sore Throat						
Participants	11.6 (9.8, 13.4)	1.36 (1.10, 1.68)	0.02	22.9 (18.2, 27.6)	2.04 (1.33, 3.13)	0.005
Non-participants	8.4 (8.1, 8.6)	Reference		14.4 (13.6, 15.3)	Reference	
Cough						
Participants	10.4 (8.4, 12.5)	1.29 (0.99, 1.67)	0.06	21.8 (17.3, 26.2)	1.71 (1.16, 2.53)	0.03
Non-participants	8.4 (8.1, 8.6)	Reference		15.0 (14.3, 15.8)	Reference	
Headache						
Participants	31.1 (28.2, 34.0)	1.36 (1.13, 1.63)	0.005	25.6 (23.3, 27.8)	1.00 (0.83, 1.20)	1.00
Non-participants	25.7 (25.3, 26.1)	Reference		25.6 (25.2, 26.0)	Reference	
Smell and Taste Disorder						
Participants	1.5 (0.7, 2.2)	1.95 (0.92, 4.15)	0.08	3.8 (3.2, 4.4)	1.65 (0.93, 2.92)	0.09
Non-participants	0.8 (0.7, 1.0)	Reference		3.2 (3.0, 3.3)	Reference	

We stratified the respondents by the presence of comorbidities and separately repeated the analyses using the same model as in the main analyses. For Holm-adjusted P values, we multiplied the i-th smallest unadjusted P values by $(5 - i + 1)$ times if the unadjusted P value < 0.05, and simply showed the unadjusted P values if ≥ 0.05. P for interaction (Wald test, not adjusted for multiple testing) between subsidy program participation and age group were 0.07 (Model 1) and 0.08 (Model 2) for high fever, 0.03 and 0.04 for sore throat, 0.10 and 0.23 for cough, 0.08 and 0.02 for headache, and 0.67 and 0.73 for smell and taste disorder, respectively. See Table 3's legend for more details.

Table A6. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Stratified by Gender

	Men (n=12,673)			Women (n=12,809)		
	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value	Adjusted rate, % (95%CI)	Adjusted OR (95%CI)	Adjusted P value
Model 1						
High Fever						
Participants	7.5 (6.6, 8.4)	1.76 (1.07, 2.91)	0.08	2.6 (1.6, 3.7)	2.44 (1.41, 4.20)	0.007
Non-participants	6.5 (6.3, 6.7)	Reference		1.2 (1.1, 1.3)	Reference	
Sore Throat						
Participants	24.7 (18.1, 31.3)	3.54 (2.00, 6.28)	<0.001	13.4 (11.0, 15.9)	1.09 (0.83, 1.42)	0.54
Non-participants	9.9 (8.8, 11.1)	Reference		12.6 (12.2, 12.9)	Reference	
Cough						
Participants	25.4 (18.1, 32.7)	2.76 (1.55, 4.92)	0.002	11.3 (9.7, 12.8)	1.08 (0.89, 1.31)	0.43
Non-participants	12.0 (10.7 13.2)	Reference		10.6 (10.4, 10.8)	Reference	
Headache						
Participants	21.9 (18.9, 25.0)	1.25 (0.97, 1.60)	0.08	36.7 (33.6, 39.9)	1.28 (1.07, 1.53)	0.03
Non-participants	18.9 (18.5, 19.4)	Reference		32.0 (31.6, 32.4)	Reference	
Smell and Taste Disorder						
Participants	3.9 (3.2, 4.6)	1.67 (0.93, 3.00)	0.09	1.7 (0.7, 2.6)	1.98 (0.89, 4.38)	0.09
Non-participants	3.2 (3.0, 3.4)	Reference		0.9 (0.8, 1.0)	Reference	
Model 2						
High Fever						
Participants	7.2 (6.4, 8.0)	1.46 (0.83, 2.57)	0.20	2.4 (1.4, 3.3)	2.17 (1.24, 3.78)	0.03
Non-participants	6.6 (6.3, 6.8)	Reference		1.2 (1.1, 1.3)	Reference	
Sore Throat						
Participants	20.9 (17.0, 24.9)	2.69 (1.80, 4.01)	<0.001	13.9 (11.5, 16.2)	1.14 (0.89, 1.46)	0.31
Non-participants	10.7 (10.0, 11.3)	Reference		12.5 (12.2, 12.9)	Reference	
Cough						
Participants	20.9 (16.8, 25.0)	2.01 (1.37, 2.96)	0.002	11.4 (9.9, 12.8)	1.09 (0.91, 1.31)	0.33
Non-participants	12.8 (12.1, 13.4)	Reference		10.6 (10.4, 10.8)	Reference	
Headache						
Participants	20.6 (18.1, 23.2)	1.12 (0.90, 1.41)	0.31	36.7 (33.6, 39.7)	1.28 (1.07, 1.54)	0.03
Non-participants	19.1 (18.7, 19.5)	Reference		32.0 (31.6, 32.4)	Reference	
Smell and Taste Disorder						
Participants	3.6 (3.1, 4.1)	1.31 (0.79, 2.18)	0.30	1.6 (0.9, 2.4)	2.06 (1.00, 4.23)	0.14
Non-participants	3.3 (3.1 3.4)	Reference		0.9 (0.8, 1.0)	Reference	

We stratified the respondents by gender and separately repeated the analyses using the same model as the main analyses. For Holm-adjusted P values, we multiplied the *i*-th smallest unadjusted P values by $(5 - i + 1)$ times if the unadjusted P value < 0.05, and simply showed the unadjusted P values if ≥ 0.05. P for interaction (Wald test, not adjusted for multiple testing) between subsidy program participation and age group was 0.70 (Model 1) and 0.95 (Model 2) for high fever, 0.001 and 0.001 for sore throat, 0.01 and 0.03 for cough, 0.68 and 0.25 for headache, and 0.35 and 0.84 for smell and taste disorder, respectively. See Table 3's legend for more details.

Table A7. Association between Participation in the Subsidy Program for Domestic Travel and Incidence of COVID-19-Like Symptoms, Stratified by Region

	Region 1 (n=3,750)	Region 2 (n=5,589)	Region 3 (n=5,390)	Region 4 (n=3,884)	Region 5 (n=6,869)
Total conformed cases of COVID-19 as of September 1, 2020 (/ million)*	169.0	790.2	339.1	663.0	394.3
High Fever					
Adjusted odds ratios (95%CI)	5.20 (1.45, 18.6)	1.19 (0.72, 1.96)	1.58 (0.73, 3.43)	2.42 (1.24, 4.72)	1.50 (0.52, 4.30)
Adjusted P value	0.04	0.49	0.24	0.048	0.45
Sore Throat					
Adjusted odds ratios (95%CI)	1.45 (0.90, 2.32)	2.23 (1.60, 3.12)	1.56 (1.08, 2.24)	1.65 (1.13, 2.40)	1.04 (0.71, 1.52)
Adjusted P value	0.13	<0.001	0.09	0.03	0.84
Cough					
Adjusted odds ratios (95%CI)	1.13 (0.72, 1.77)	2.00 (1.44, 2.77)	1.05 (0.69, 1.62)	1.27 (0.88, 1.84)	1.11 (0.77, 1.59)
Adjusted P value	0.59	<0.001	0.81	0.21	0.59
Headache					
Adjusted odds ratios (95%CI)	1.62 (1.11, 2.38)	1.42 (1.10, 1.82)	1.44 (1.05, 1.97)	0.97 (0.73, 1.30)	1.00 (0.76, 1.32)
Adjusted P value	0.052	0.02	0.10	0.86	0.98
Smell and Taste Disorder					
Adjusted odds ratios (95%CI)	0.57 (0.17, 1.93)	1.04 (0.47, 2.28)	0.40 (0.16, 1.03)	2.83 (1.30, 6.13)	3.98 (1.49, 10.6)
Adjusted P value	0.37	0.92	0.06	0.04	0.03

Division 1: Seven prefectures in Hokkaido and Tohoku District (northern region in Japan). Division 2: seven prefectures in Kanto District (Tokyo metropolitan area). Division 3: nine prefectures in Tokai and Hokuriku District (central region). Division 4: seven prefectures in Kinki District (mid-west region). Division 5: 17 prefectures in Chugoku, Shikoku, Kyusyu, and Okinawa District (southwest region). For Holm-adjusted P values, we multiplied the i-th smallest unadjusted P values by $(5 - i + 1)$ times if the unadjusted P value < 0.05, and simply showed the unadjusted P values if ≥ 0.05. We showed adjusted odds ratio of COVID-19-like symptoms for the participation in the domestic travel subsidy program (Model 2). See Table 3's legend for more details.

* For reference, we described the number of total confirmed cases of COVID-19 per million as of September 1 (at the time of the survey), which was calculated from the government official data.

Supplementary Reference

1. Schonlau M, van Soest A, Kapteyn A, Couper M. Selection bias in web surveys and the use of propensity scores. Sociological Methods & Research. 2009;37(3):291–318.
2. Ministry of Health, Labour and Welfare. Comprehensive Survey of Living Conditions. 2019 [cited 2020 Jan 1]. Available from: https://www.mhlw.go.jp/toukei/list/20-21.html
3. Shibuya K, Hashimoto H, Yano E. Individual income, income distribution, and self rated health in Japan: cross sectional analysis of nationally representative sample. BMJ. 2002 Jan 5;324(7328):16.
4. Fu R, Noguchi H, Kawamura A, Takahashi H, Tamiya N. Spillover effect of Japanese long-term care insurance as an employment promotion policy for family caregivers. J Health Econ. 2017;56:103–12.
5. Miyawaki A, Kobayashi Y, Noguchi H, Watanabe T, Takahashi H, Tamiya N. Effect of reduced formal care availability on formal/informal care patterns and caregiver health: a quasi-experimental study using the Japanese long-term care insurance reform. BMC Geriatr. 2020 Dec;20(1):207.

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectionalreporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	3
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	3,4
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	6,7
Objectives	#3	State specific objectives, including any prespecified hypotheses	8
Methods			
Study design	#4	Present key elements of study design early in the paper	8
Setting	#5	Describe the setting, locations, and relevant dates, including periods	8

		of recruitment, exposure, follow-up, and data collection	
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	8
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-11
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	9-11
Bias	#9	Describe any efforts to address potential sources of bias	9-11
Study size	#10	Explain how the study size was arrived at	8
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	9-11
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	11-12
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	12-13
Statistical methods	#12c	Explain how missing data were addressed	8
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	11
Statistical methods	#12e	Describe any sensitivity analyses	12-13
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	8,14
Participants	#13b	Give reasons for non-participation at each stage	8

Participants	#13c	Consider use of a flow diagram	n/a. We described it in P8.
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	14
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	8
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	14
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	14
Main results	#16b	Report category boundaries when continuous variables were categorized	n/a
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	14
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	15
Discussion			
Key results	#18	Summarise key results with reference to study objectives	15,16
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	17-19
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	16-17, 19-20
Generalisability	#21	Discuss the generalisability (external validity) of the study results	19
Other			

Information

Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

Notes:

- 13c: n/a. We described it in P8.
- 20: 16-17, 19-20 The STROBE checklist is distributed under the terms of the Creative Commons Attribution License CC-BY. This checklist was completed on 16. January 2021 using https://www.goodreports.org/, a tool made by the EQUATOR Network in collaboration with Penelope.ai