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Association between participation in the government subsidy programme 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 (subsidise up to 50% of all travel expenses) introduced nationally in Japan on 22 July 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 25 August and 30 September 2020 in Japan. Sampling weights were used to calculate national estimates.

Participants 25 482 survey respondents (50.3% (12 809) women; mean (SD) age, 48.8 (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, 3289 (12.9%) participated in the subsidy programme. After adjusting for potential confounders, we found that participants in the subsidy programme exhibited higher incidence of high fever (adjusted rate, 4.7% for participants vs 3.7% for non-participants; adjusted OR (aOR) 1.83; 95% CI 1.34 to 2.48; p<0.001), sore throat (19.8% vs 11.3%; aOR 2.09; 95% CI 1.37 to 3.19; p=0.002), cough (19.0% vs 11.3%; aOR 1.96; 95% CI 1.26 to 3.01; p=0.008), headache (29.2% vs 25.5%; aOR 1.24; 95% CI 1.08 to 1.44; p=0.006) and smell and taste disorder (2.6% vs 1.8%; aOR 1.98; 95% CI 1.15 to 3.40; p=0.01) compared with non-participants. These findings remained qualitatively unaffected by additional adjustment for the use of 17 preventative measures (eg, social distancing, wearing masks and handwashing) and fear against the COVID-19 infection.

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

Strengths and limitations of this study

- ► This is the first study that investigates the association between the participation in the government subsidy programme 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 programme 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 programme for domestic travel (recall bias).

INTRODUCTION

As of the end of December 2020, 81 million people have been infected by the 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 travelling domestically.[6–10]

Evidence is limited as to whether the government interventions to financially incentivise economic activities, such as using restaurants or travelling, impact the COVID-19 infection rate. For example, the UK implemented the '*Eat out to Help out*' campaign, in which the government subsidised 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 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 incentivise economic activities (eg, eating out and travel) affected the COVID-19 pandemic.

Japan implemented a large-scale, nationwide government subsidy programme for domestic travel (called the '*Go-To Travel*' Campaign)[8] on 22 July 2020 (announced on 10 July 2020) to revive the travel industry, which has been hit hard by a substantial decrease in the number of foreign tourists visiting Japan. This programme incentivises people to travel domestically by subsidising up to 50% of transportation and accommodation expenses for travellers. As of the end of October 2020, more than 200 billion Japanese yen (approximately US$2 billion), using an exchange rate of 100 Japanese yen per US$) have been used to subsidise a total of 40 million people who travelled 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*' programme might be causing the increase in the number of COVID-19 infections.[13] As a result, the Japanese government has suspended this subsidy programme since 28 December 2020 but is considering resuming it (as of March 2021).[14] Yet, empirical evidence is lacking as to whether the introduction of this programme 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 25 August and 30 September 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 analysed 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 analysed 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 sociodemographic, 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 25 August 2020 to 30 September 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 previously (if any item was not responded, the survey could not be completed), there was still a possibility of unnatural or inconsistent responses. We excluded 2518 individuals showing unnatural or inconsistent responses using the algorithm we developed (see online supplemental 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 programme for domestic travel, which was announced on 10 July 2020 and implemented on 22 July 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] socioeconomic status (SES),[23] health-related characteristics,[22] use of preventive measures (see further for details), perceived fear against the COVID-19 infection and prefecture fixed effects. The demographics included age (categorised 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 (categorised using the tertiles of household equivalent income ('low'=less than 2.5 million Japanese yen, 'medium'=2.5–4.3 million Japanese yen and 'high'=more than 4.3 million Japanese yen) 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 equivalised income was calculated as the gross (pretax) 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 $\geq$25 kg/m^2) and seven self-reported 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 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 behaviour 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 and at least once, and 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 versus non-participants of the programme 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 programme for domestic travel versus non-participants. To account for the possibility that those who participated and responded to the internet-based survey may differ from the general population (eg, 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 (ie, the 2016 Comprehensive Survey of Living Conditions[28 29]) (see online supplemental method A2 for details).

Second, we examined the association between participation in the subsidy programme 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 SEs 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 standardisation (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 programme 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, …, 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, travellers to and from Tokyo were ineligible for the subsidy programme until 15 September, 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 programme if their companion lived in prefectures other than Tokyo), we reanalysed 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 programme for travel. To test this hypothesis, we reanalysed the data restricting to individuals who did not eliminate the possibility of travelling 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 programme 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 programme participation and COVID-19 like symptoms varied regionally.

All analyses were conducted using Stata V.15 (StataCorp LLC, College Station, Texas, USA).

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 and interpretation of the study. All respondents gave informed consent to enrol in the study.

RESULTS

Characteristics of respondents

Of the 25 482 respondents, 3289 (12.9%) had participated in the subsidy programme for domestic travel at the time of the survey. Participants in the subsidy programme 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 programme were more likely than non-participants to engage in risky behaviour 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 programme were more likely to use the contact-tracing application and to have received the influenza vaccine in the prior year.

Participation in the subsidy programme 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 programme participants compared with non-participants for high fever (adjusted rate, 4.7% for participants vs 3.7% for non-participants; adjusted OR (aOR) 1.83; 95% CI 1.34 to 2.48; p<0.001), sore throat (19.8% vs 11.3%; aOR 2.09; 95% CI 1.37 to 3.19; p=0.002), cough (19.0% vs 11.3%; aOR 1.96; 95% CI 1.26 to 3.01; p=0.008), headache (29.2% vs 25.5%; aOR 1.24; 95% CI 1.08 to 1.44; p=0.006) and smell and taste disorder (2.6% vs 1.8%; aOR 1.98; 95% CI 1.15 to 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 programme participants compared with non-participants for high fever (4.4% vs 3.7%; aOR 1.56; 95% CI 1.09 to 2.23; p=0.04), sore throat (18.2% vs 11.6%; aOR 1.84; 95% CI 1.35 to 2.52; p<0.001), cough (17.1% vs 11.5%; aOR 1.66; 95% CI 1.21 to 2.26; p=0.006), headache (28.2% vs 25.7%; aOR 1.17; 95% CI 1.02 to 1.34; p=0.04) and smell and taste disorder (2.3% vs 1.8%; aOR 1.56; 95% CI 1.05 to 2.30; p=0.03).

Sensitivity analysis

Our findings were largely unaffected by excluding respondents living in Tokyo (online supplemental table A1) and using unweighted regression models (online supplemental 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 programme participants compared with non-participants (online supplemental 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 (online supplemental table A4). For example, among respondents aged 15–64 years, the adjusted incidence rate of smell and

Table 1 Sociodemographic and health-related characteristics of respondents by participation in the subsidy programme for domestic travel

Characteristics		Total (N=25 482)	Participants (N=3289)	Non-participants (N=22 193)	P value
Female		12 809 (50.3)	1534 (46.6)	11 275 (50.8)	0.29
Age, mean (SD), year		48.8 (17.4)	45.0 (17.9)	49.4 (17.3)	0.02
Academic attainment	College or higher	12 701 (49.8)	1973 (60.0)	10 728 (48.3)	<0.001
	High school or lower	12 781 (50.2)	1316 (40.0)	11 465 (51.7)	
Income level	Lower	7336 (28.8)	867 (26.4)	6469 (29.1)	<0.001
	Intermediate	6817 (26.8)	804 (24.4)	6013 (27.1)	
	Higher	5733 (22.5)	1144 (34.8)	4589 (20.7)	
	Not answered	5595 (22.0)	474 (14.4)	5121 (23.1)	
Household size	1	4117 (16.2)	665 (20.2)	3452 (15.6)	0.43
	2	8574 (33.7)	1091 (33.2)	7482 (33.7)	
	3	5927 (23.3)	766 (23.3)	5160 (23.3)	
	4	4352 (17.1)	499 (15.2)	3853 (17.4)	
	5+	2513 (9.9)	268 (8.1)	2245 (10.1)	
Marital status	Married	16 100 (63.2)	2025 (61.6)	14 075 (63.4)	0.20
	Never married	6046 (23.7)	707 (21.5)	5339 (24.1)	
	Widowed	1949 (7.7)	427 (13.0)	1522 (6.9)	
	Separated	1387 (5.4)	131 (4.0)	1256 (5.7)	
Employment	Employer	1007 (4.0)	262 (8.0)	746 (3.4)	0.10
	Self-employed	2008 (7.9)	305 (9.3)	1703 (7.7)	
	Employee	12 745 (50.0)	1725 (52.4)	11 020 (49.7)	
	Unemployed	9722 (38.2)	998 (30.3)	8724 (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)	1531 (46.5)	11 429 (51.5)	0.47
	Ever	1638 (30.0)	1108 (33.7)	6530 (29.4)	
	Current	4885 (19.2)	651 (19.8)	4234 (19.1)	
Walking disability		3543 (13.9)	644 (19.6)	2900 (13.1)	0.18
Comorbidities	Overweight	5185 (20.4)	884 (26.9)	4301 (19.4)	0.04
	Hypertension	6963 (27.3)	1071 (32.6)	5891 (26.5)	0.17
	Diabetes	2711 (10.6)	515 (15.7)	2196 (9.9)	0.16
	Asthma	3573 (14.0)	647 (19.7)	2926 (13.2)	0.11
	Coronary disease	1686 (6.6)	401 (12.2)	1285 (5.8)	0.09
	Stroke	1288 (5.1)	352 (10.7)	936 (4.2)	0.07
	COPD	1103 (4.3)	338 (10.3)	766 (3.5)	0.05
	Cancer	2185 (8.6)	374 (11.4)	1811 (8.2)	0.38

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 χ^2 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 medical history of these conditions.
COPD, chronic obstructive pulmonary disease.;

taste disorder was higher for subsidy programme 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 programme participation and COVID-19 like symptoms for the stratified analyses by the presence of comorbidity

Table 2 Preventive measures and fear against the COVID-19 infection of respondents by participation in the subsidy programme for domestic travel

Characteristics	Total (N=25 482)	Participants (N=3289)	Non-participants (N=22 193)	P value
Preventive measures				
Personal preventive actions				
Social distancing	21 359 (83.8)	2776 (84.4)	18 582 (83.7)	0.85
Wearing masks	24 018 (94.3)	3074 (93.5)	20 944 (94.4)	0.80
Avoiding closed spaces	20 728 (81.3)	2574 (78.3)	18 154 (81.8)	0.43
Avoiding crowded spaces	22 949 (90.1)	3028 (92.1)	19 921 (89.8)	0.08
Avoiding close contact settings	20 152 (79.1)	2381 (72.4)	17 771 (80.1)	0.09
Handwashing	22 191 (87.1)	2956 (89.9)	19 235 (86.7)	0.02
Avoiding touching face	19 591 (76.9)	2511 (76.3)	17 080 (77.0)	0.87
Respiratory hygiene	22 037 (86.5)	2856 (86.8)	19 182 (86.4)	0.92
Surface disinfection	13 340 (52.4)	1625 (49.4)	11 715 (52.8)	0.40
High-risk behaviour patterns				
Visiting restaurants	6674 (26.3)	1305 (39.7)	5369 (24.2)	<0.001
Visiting bars/nightclubs	4185 (16.4)	1013 (30.8)	3172 (14.3)	<0.001
Visiting karaoke bars	2465 (9.7)	630 (19.2)	1836 (8.3)	0.01
Visiting fitness clubs	2712 (10.6)	736 (22.4)	1976 (8.9)	<0.001
Visiting brothels	1885 (7.4)	438 (13.3)	1447 (6.5)	0.08
Proxies of other preventive measures				
Use of contact-tracing app	4331 (17.0)	996 (30.3)	3336 (15.0)	<0.001
Support for stay-at-home requests	19 825 (77.8)	2668 (81.1)	17 158 (77.3)	0.32
Influenza vaccine in the last season	8791 (34.5)	1403 (42.7)	7389 (33.3)	0.03
Fear against the COVID-19 infection				
Not afraid at all	1641 (6.4)	217 (6.6)	1424 (6.4)	0.71
Not afraid	1910 (7.5)	317 (9.6)	1592 (7.2)	
Neutral	5793 (22.7)	786 (23.9)	5007 (22.6)	
Somewhat afraid	9423 (37.0)	1122 (34.1)	8302 (37.4)	
Very afraid	6715 (26.4)	847 (25.8)	5868 (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 WHO. High-risk behaviour patterns included five risky behaviours 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 X^2 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.

and gender (online supplemental tables A5 and A6). There were no consistent regional variations in the relationships between the subsidy programme participation and COVID-19 like symptoms (online supplemental 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 programme 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 programme regarding risky behaviours do not explain the observed associations between the subsidy programme 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

Table 3 Association between participation in the subsidy programme for domestic travel and incidence of COVID-19 like symptoms

Subsidy programme 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 and 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	3289	327 (9.9)	4.7 (4.2 to 5.2)	1.83 (1.34 to 2.48)	<0.001	4.4 (3.9 to 4.9)	1.56 (1.09 to 2.23)	0.04
Non-participants	22 193	633 (2.9)	3.7 (3.6 to 3.8)	Reference		3.7 (3.6 to 3.8)	Reference	
Sore throat								
Participants	3289	790 (24.0)	19.8 (15.0 to 24.6)	2.09 (1.37 to 3.19)	0.002	18.2 (15.0 to 21.4)	1.84 (1.35 to 2.52)	<0.001
Non-participants	22 193	2406 (10.8)	11.3 (10.5 to 12.1)	Reference		11.6 (11.1 to 12.1)	Reference	
Cough								
Participants	3289	728 (22.1)	19.0 (14.2 to 23.9)	1.96 (1.26 to 3.01)	0.008	17.1 (13.9 to 20.2)	1.66 (1.21 to 2.26)	0.006
Non-participants	22 193	2417 (10.9)	11.3 (10.5 to 12.0)	Reference		11.5 (11.0 to 12.1)	Reference	
Headache								
Participants	3289	1009 (30.7)	29.2 (27.0 to 31.4)	1.24 (1.08 to 1.44)	0.006	28.2 (26.3 to 30.2)	1.17 (1.02 to 1.34)	0.04
Non-participants	22 193	5612 (25.3)	25.5 (25.2 to 25.8)	Reference		25.7 (25.4 to 25.9)	Reference	
Smell and taste disorder								
Participants	3289	167 (5.1)	2.6 (2.0 to 3.1)	1.98 (1.15 to 3.40)	0.01	2.3 (1.9 to 2.6)	1.56 (1.05 to 2.30)	0.03
Non-participants	22 193	287 (1.3)	1.8 (1.6 to 1.9)	Reference		1.8 (1.7 to 1.9)	Reference	

We examined the association of participation in the government subsidy programme 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 SEs 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 standardisation. Adjusted p values using the Holm method for multiple testing were shown (the adjusted p value <0.05 was considered to be statistically significant).
IPW, inverse probability weighting.

of COVID-19 infection associated with this programme. Given that the Japanese government is debating the implementation of this subsidy programme 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 programme 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 travelling 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 USA that found the volume of domestic airline travel around the Thanksgiving holiday was positively associated with the spread of seasonal influenza.[35] Second, subsidy programme participants might have been more likely to engage in behaviours 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 behaviours suggests that this explanation alone may be insufficient to explain the observed relationship between participation in this programme 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 programme may be incentivising those with higher risks of COVID-19 transmission to travel across the nation, leading to the expansion of the outbreaks across regions (eg, from the urban to the rural tourist spots). A better policy may be to directly provide financial assistance to affected sectors (eg, 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 programme participants were more likely to experience some COVID-19 like symptoms. This finding suggests the possibility that participants and non-participants may have different behavioural patterns in travelling, 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 programme subsidised the expense of public transportation for travel). Also, programme 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-sized 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 programme 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 programme 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 use the programme 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 incentivises 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 (eg, 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, prospective studies that investigate the association between the participation in the subsidy programme 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 programme for domestic travel (as the cause of their symptoms) compared with individuals without such symptoms (recall bias). However, the questions on the programme 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 programme 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 programme would be larger than what we have estimated. Fifth, the information on how many times the respondents travelled was unavailable, and we could not distinguish one-time travellers from frequent travellers. 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 minimising 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 generalisable 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 10 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[40] have recently reported an increase in the number of travel-related COVID-19 confirmed cases in the month just after the introduction of this programme than in the month before. However, their study found that non-travel-related cases also increased to the same extent, and the association between the subsidy programme 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 programme for domestic travel in Japan had higher incidence rates of COVID-19 like symptoms compared with non-participants. Our findings suggest that the implementation of the subsidy programme 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 subsidising financial loss of affected sectors or incentivising economic activities that do not involve increase physical interactions, rather than incentivising individuals to travel more or use restaurants.

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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

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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

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