Factors associated with smoking behaviour changes during the COVID-19 pandemic in Japan: a 6-month follow-up study

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ABSTRACT

Background Smoking behaviour may have changed due to the COVID-19 pandemic, the April 2020 revised smoke-free policy and the high prevalence of heated tobacco product (HTP) use in Japan (10.9% in 2020). This study examined the association between these three events and smoking behaviour changes using 6-month follow-up data from before and during the pandemic.

Method Using longitudinal data from an internet survey conducted in February 2020 (baseline) and follow-up in August to September 2020, prevalence ratios (PR) and 95% confidence intervals (95% CIs) for smoking behaviour changes (increase and quit) were calculated using multivariable Poisson regression with adjustments for potential covariates including three event-related five factors: fear of COVID-19, living in a COVID-19 endemic area, workplace smoking rules, self-imposed smoking rules at home and type of tobacco use (cigarette only/HTP only/dual use). A smoker who reported an increase in smoking intensity in the last month was defined as an increase. A smoker who had stopped both cigarettes and HTPs at follow-up was defined as a quit.

Results We analysed 1810 tobacco users (1448 males (80%); mean age 50.8 years±13.2 SD). At baseline, 930 participants used cigarettes only, 293 HTPs only and 587 both. While 214 (11.8%) users increased smoking intensity, 259 (14.3%) quit both tobacco products. Those who feared COVID-19 were less likely to quit (PR=0.77, 95% CI 0.68 to 0.95), while living in a COVID-19 endemic area was not associated with either smoking behaviour change. Workplace smoking rules were not associated with either smoking behaviour change, but those with no home smoking ban were less likely to quit. Compared with cigarette-only users, HTP-only users were more likely to quit (PR=1.57, 95% CI 1.17 to 2.11), while dual users were more likely to increase smoking intensity (PR=1.35, 95% CI 1.01 to 1.79).

Conclusion During the pandemic, dual cigarette and HTP use increased smoking intensity, whereas HTP-only use was associated with quitting but fear of COVID-19 and not having a home smoking ban made it harder to quit.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Smoking behaviour has changed bidirectionally during the COVID-19 pandemic.
⇒ Recent major events in Japan (COVID-19 pandemic, workplace smoke-free policy implementation and increased heated tobacco product (HTP) use) may be associated with smoking behaviour changes.
⇒ Few longitudinal studies have investigated this hypothesis.

WHAT THIS STUDY ADDS

⇒ During the COVID-19 pandemic, this longitudinal cohort study found that those who had a fear of COVID-19 infection (according to the Japanese version of Fear of COVID-19 Scale) were less likely to quit tobacco products (cigarettes and HTPs).
⇒ While workplace smoking rules were not associated, strict self-imposed home smoking rules were significantly associated with quitting smoking.
⇒ Additionally, smokers who used both cigarettes and HTPs were likely to increase their smoking intensity.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ To develop a smoke-free policy and further research, focusing on home smoking bans may become more important now that working from home is increasing in the era of COVID-19.

INTRODUCTION

The COVID-19 pandemic has impacted negatively on our society, damaging health and increasing stress and inequality.[1–3] Additionally, the COVID-19 pandemic may have had a bidirectional effect on smoking behaviour.[4] Smokers may increase their smoking intensity when stressed, believing that smoking is a stress reducer, and a previous study suggested that fear of COVID-19 also affects maintenance of smoking behaviour.[5] Smokers increased their frequency or amount of smoking in several countries (18.9% in the Netherlands,[4] 32.1% in Japan,[6] 40.9% in the USA[7] and 45.2% in Poland[8]). However, while smoking is determined as a risk factor for severe COVID-19 infection,[9 10] smokers may stop smoking (11.9% in Japan[6] and 31.1% in China[11]). Although the first COVID-19 state of emergency for all of Japan was implemented on 16 April 2020 (and lifted on 25 May 2020), little is known about how smoking behaviour changed due to this situation. During the state of emergency in Japan, the government requested its people to voluntarily stay home. They also requested pubs and other eating/drinking establishments to close and mass gathering events to be cancelled.[12] There was no penalty if businesses or people failed to comply

with these requests.[13] Visits to medical facilities, shopping for food and other daily necessities, essential workers going to their place of work, outdoor exercise and walking were exempt from these restrictions. Because grocery stores such as supermarkets, drugstores and convenience stores sell tobacco, smokers were able to buy cigarettes and tobacco products, including heated tobacco products (HTPs).

In addition to COVID-19-related issues, the revised Health Promotion Law (smoke-free policy) in April 2020 and the recent high prevalence of HTP use may have changed smoking behaviour in Japan. On 1 April 2020, the revised Health Promotion Law went into effect, and the workplace indoor smoking ban was implemented.[14] In 2020, the prevalence of HTP use was 10.9%[15] and smokers may have increased or maintained HTP use. Before the COVID-19 pandemic in Japan, the sales share of HTP accounted for 24% of tobacco products in 2019[16]; furthermore, from 2020 to 2021, the total HTP sales volume in Japan increased by 12.0%.[17] As these events occurred concurrently during the COVID-19 pandemic in 2020, no study has examined the association between these three events (the COVID-19 pandemic, a revised smoke-free policy and HTP proliferation) and changes in smoking behaviour. The purpose of this study was to longitudinally evaluate the impact of these three events on smoking behaviour change during the COVID-19 pandemic using 6-month follow-up data. Therefore, the following research design requirements had to be met. The baseline survey was conducted before the declaration of the state of emergency and the revised smoke-free policy (before April 2020); and a follow-up survey was conducted after the state of emergency was lifted (after June 2020).

METHODS

Data collection and preparation

We used data from a longitudinal 6-month follow-up survey. A baseline survey was conducted in February 2020 for the Japanese 'Society and New Tobacco' Internet Survey (JASTIS 2020 study) and a follow-up survey was conducted in August to September 2020 for the Japan 'COVID-19 and Society' Internet Survey (JACSIS 2020 study). The JASTIS study is the first study of HTP use in the world and e-cigarette use in Japan, and has been conducted annually since 2015. For more detailed information, please see the JASTIS study profile.[18] The JACSIS study collected information on HTP and e-cigarette use in Japan to estimate the health impact of the COVID-19 pandemic.

For the JASTIS 2020 survey, participants were selected from panellists at Rakuten Insight, a large internet research company with a pool of over 2 million panellists covering all social categories. Selection was randomised to prevent bias by region, gender or age. At registration, Rakuten panellists agree to participate in a variety of research surveys and to provide web-based written informed consent to participation. For minors, we conducted these surveys after obtaining their consent and a parent or guardian's digital approval.

As shown in figure 1, a large number of the 2497 smokers who participated in JASTIS 2020 also participated in the follow-up survey (JACSIS 2020). Participants who participated in both surveys and who smoked cigarettes or used HTPs at baseline (shown in figure 1) were selected. To prevent reporting bias, we excluded those who we believed had responded inaccurately to the survey (n=160) based on the previous study,[19] that is, those who responded incorrectly when asked to choose the second option from the bottom (n=125), those who answered 'yes' to every option in a set of questions about the drugs they took (n=33) and those answered 'yes' to every option in a set of questions about the chronic diseases they had (n=2). In both surveys, participation was voluntary, but panellists were required to answer all the questions to finish the survey. Thus, our survey data had no missing information.

Measurement: outcome variables

Increase in smoking intensity and quitting both cigarette and HTP use were used as outcome variables, defined by the change in smoking behaviour from before January 2020 until July to August 2020. Information on the increase in smoking intensity was gathered using the following question and response options: 'How has your amount or frequency of smoking changed in the last month compared to before January 2020?' Response options were: '1. Increased, 2. Same as before, and 3. Decreased'. An increase in smoking intensity was dichotomised as 'increased' (1) and 'not increased' (2 and 3).

We defined quitting tobacco products (quit and not) using participants' change in smoking status during the follow-up

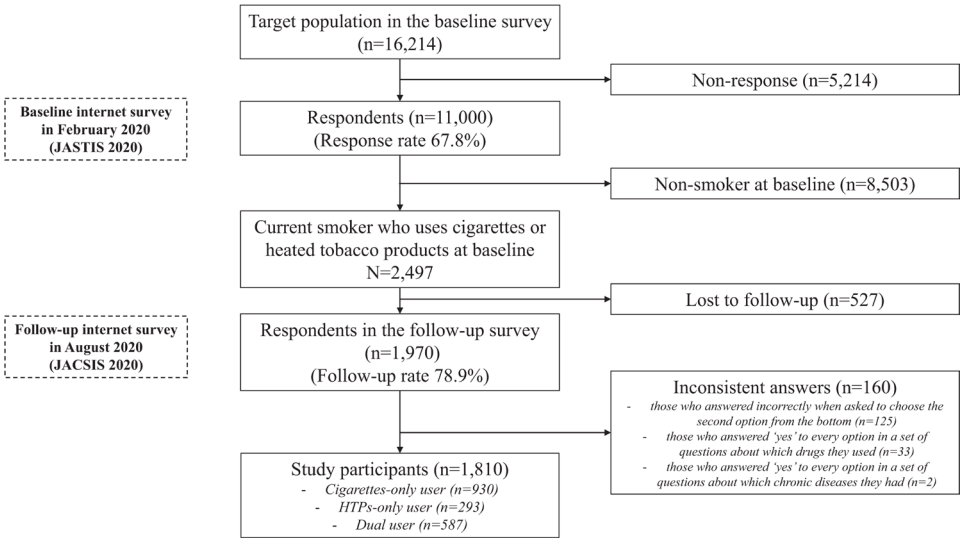

Figure 1 Study flow chart. HTP, heated tobacco product; JACSIS, Japan COVID-19 and Society Internet Survey; JASTIS, Japanese Society and New Tobacco Internet Survey.

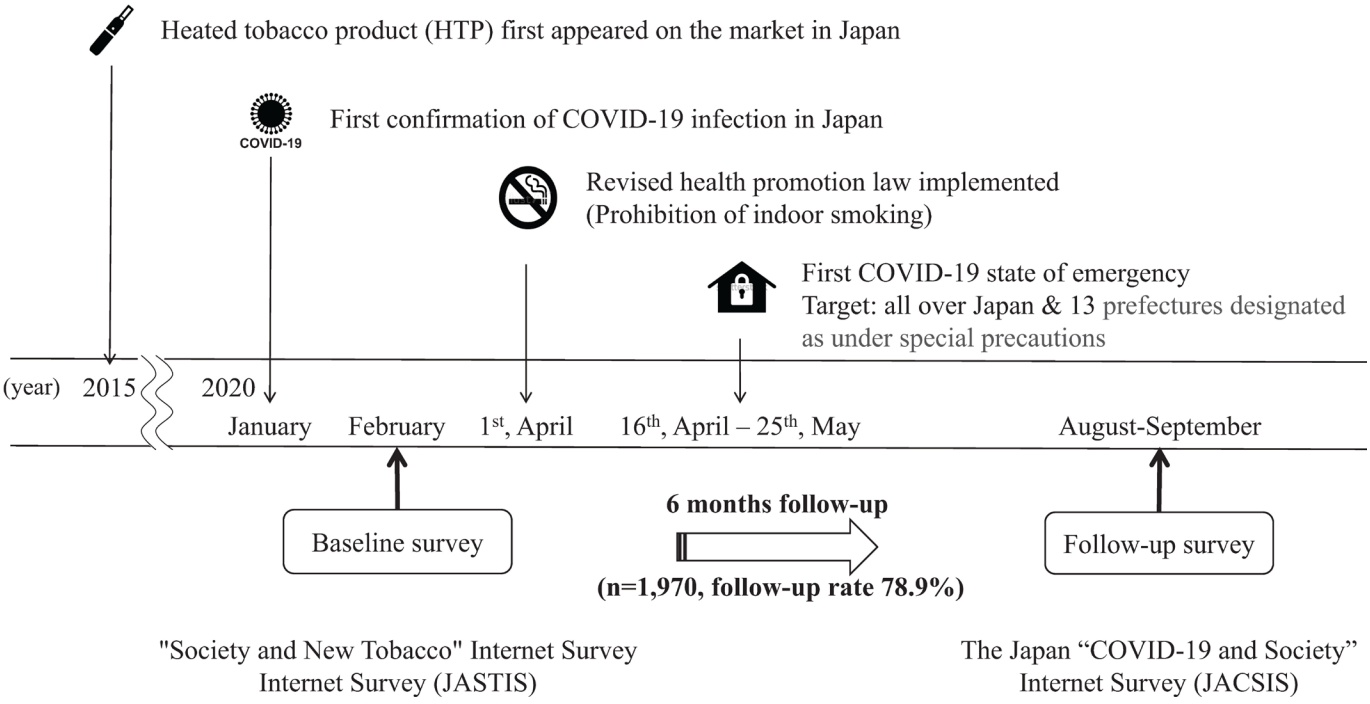

Figure 2 Timeline of the relevant major events related to this study.

period. Quit was defined as follows: (1) respondents who reported cigarette or HTP use at baseline (JASTIS), and (2) reported neither tobacco nor HTP use at follow-up (JACSIS).

Measurement: three events that might affect smoking behaviour change during the COVID-19 pandemic

Figure 2 shows the information timeline and related events that possibly affected smoking behaviour in this study. We used three events that might affect smoking behaviour change: the COVID-19 pandemic (fear of COVID-19 and living in one of the 13 prefectures designated under special precautions), a revised smoke-free policy (for the workplace) and self-imposed smoking rules at home during the pandemic, and HTP use (both cigarette and HTP use and HTP-use only).

We used fear of COVID-19 as an individual-level risk of change in smoking behaviour during the pandemic. A previous study suggested that smokers with a fear of COVID-19 continued to smoke.[5] Based on the previous study,[20] we defined fear of COVID-19 by asking: Are you afraid of COVID-19 infection (if you were to rate the level of fear between 0% and 100% where not afraid at all is 0% and very afraid is 100%)? The options of 'Not afraid at all (0%)', 'Not afraid (25%)' and 'Neutral (50%)' were defined as 'No', and 'Somewhat afraid (75%)' and 'Very afraid (100%)' were defined as 'Yes'. As an area-level risk of change in smoking behaviour during the pandemic, we used living in a prefecture designated as under special precautions during the first COVID-19 state of emergency. During this state of emergency (from 16 April 2020 to 25 May 2020), the Japanese government designated 13 prefectures, where the spread of the COVID-19 infection was of particular concern, as under special precautions. The prefectures were: Tokyo, Saitama, Chiba, Kanagawa, Osaka, Hyogo, Fukuoka, Hokkaido, Ibaraki, Ishikawa, Gifu, Aichi and Kyoto. Smokers who lived in these prefectures had more substantial behavioural restrictions during the COVID-19 state of emergency than those who did not. Living in a COVID-19 endemic area might also have influenced smokers to change their smoking behaviour. Living in a COVID-19 endemic area was divided into two categories (No, Yes).

Since implementation of the revised Health Promotion Law in April 2020, the rules regarding smoking in the workplace have changed. This change may have affected smoking behaviour. A previous study suggested that the smoke-free policy was associated with smoking cessation.[21] To estimate the effect of the revised Health Promotion Law on participants' smoking behaviour, we used variables from the JACSIS 2020 data when the smoking rules had already changed, based on the law. Current workplace smoking rules were used, divided into four categories: indoor smoking ban, partial smoking ban, no smoking ban and do not know. Self-imposed smoking rules at home were outside the scope of current smoke-free policy regulations. However, the COVID-19 pandemic may have led to increased smoking intensity at home due to the increase in telecommuting.[6] Smokers who have no rules for smoking at home might have increased their smoking intensity. Information about self-imposed smoking rules at home was gathered by asking: Which of the following best describes your rules for smoking in your home (indoors)? (Note that common spaces in apartment complexes are not included in the definition of home. HTPs include IQOS, glo, Ploom Tech, etc.) The options were divided into four categories: both cigarettes and HTPs prohibited at home, both cigarettes and HTPs allowed at home, HTPs only allowed at home and do not know.

We defined three categories of tobacco use: cigarette only, HTPs only and both cigarette and HTP use (dual use). Type of tobacco use at baseline was defined based on previous studies.[22 23] The HTPs identified in the longitudinal survey included those available in Japan at the time of the study (Ploom Tech, Ploom Tech+, Ploom S, IQOS, glo, glo sens, Pulze). Participants selected one of four possible responses for each type of tobacco product use: never use, quit, use occasionally but not every day and use almost every day. These four responses were combined to create a binary variable of do not use (never use, quit) and use (use occasionally but not every day, and use almost every day).

We created two variables according to the type of tobacco use: a history of cigarette use and of HTP use. Finally, these two variables were combined and used as the type of tobacco use.

Measurement: covariates

The following variables were used as covariates: sex, age, household income, self-rated health, marital status and alcohol use at baseline. Sex and age were included in the model as demographic variables. Household income was included in the model as socioeconomic status. A previous study showed that smoking behaviour and socioeconomic status were related.[24] We also used the adjusted self-rated health as a general health status covariate. Marital status has had a protective effect on increased health risk behaviours by reinforcing social networks.[25] Alcohol use was also included in the model as health risk behaviour.[26]

The categories of each variable were as follows: sex (male, female), age (15–29, 30–39, 40–49, 50–59, 60–69, 70–75), household income (less than JPY2 million (Japanese yen), JPY2–6 million, over JPY6 million, I prefer not to answer and do not know), self-rated health (good (excellent/very good/good), poor (fair/poor)), marital status (married, never married and divorced/widowed) and alcohol use (no/stopped, yes).

Statistical analyses

First, cross-tabulations and χ^2 tests were conducted to observe simple relationships between changes in smoking behaviour and participant characteristics. Next, a multivariate Poisson regression was performed to investigate the association between the recent event related to smoking (COVID-19 pandemic, revised smoke-free policy and HTP use) and changes in smoking behaviour. We calculated the prevalence ratio (PR) and 95% confidence intervals (95% CIs) for each change in smoking behaviour (increased, quit).

A sensitivity analysis was conducted with participants who had never worked from home to observe more closely the impact of the work smoke-free policy on changes in smoking behaviour.

All analyses were performed using Stata software (V.16.1; StataCorp, College Station, Texas). The threshold for significance was set at $p<0.05$, two tailed.

RESULTS

Figure 1 shows a flow chart of the participants in this survey. The number of current smokers at baseline was 2497. After 6 months, 1970 respondents participated in follow-up surveys (follow-up rate 78.9%). After excluding respondents who answered inconsistently (n=160), 1810 participants were included in the analysis. The mean age (±SD) was 50.8 (±13.2 years), and 80.0% were male. Nine hundred and thirty participants used cigarette only, 293 used HTPs only and 587 used both. Among the subjects who changed their smoking behaviour before and during the COVID-19 pandemic, 214 (11.8%) reported an increase in smoking intensity and 259 (14.3%) reported quitting use of smoking products (both cigarettes and HTPs). The characteristics of the participants are shown in table 1. After the χ^2 test, the variables associated with increased smoking intensity were: type of tobacco used during the baseline survey, the self-imposed smoking rules at home, age and self-rated health. Similarly, the variables associated with quitting were: type of tobacco use during the baseline survey, fear of COVID-19, current workplace smoking rules, the self-imposed smoking rules at home, sex, age and marital status.

The results of the Poisson regression analysis are shown in table 2. After adjusting for all covariates, compared with participants who did not fear COVID-19, those who did were not associated with increased smoking intensity but were negatively associated with quitting tobacco (stopped using cigarettes and HTPs) (PR=1.20, 95% CI 0.92 to 1.57 and PR=0.77, 95% CI 0.62 to 0.95, respectively). People living in a COVID-19 endemic area were not associated with changing their smoking behaviour compared with those in other areas (PR for increased=0.98, 95% CI 0.75 to 1.28 and PR for quit=0.85, 95% CI 0.68 to 1.06, respectively). Having workplace smoking rules was not associated with smoking behaviour changes compared with having an indoor smoking ban in the workplace (PR for increased=0.91, 95% CI 0.67 to 1.23 and PR for quit=1.05, 95% CI 0.78 to 1.41, respectively), no smoking ban (PR for increased=1.02, 95% CI 0.59 to 1.74 and PR for quit=0.86, 95% CI 0.44 to 1.66, respectively) and do not know (PR for increased=0.82, 95% CI 0.56 to 1.21 and PR for quit=1.32, 95% CI 0.98 to 1.77, respectively). Participants with no home smoking ban were less likely to quit compared with those with a ban on both cigarette and HTP use at home (both cigarettes and HTPs allowed at home PR=0.28, 95% CI 0.21 to 0.38, HTPs only allowed PR=0.26, 95% CI 0.16 to 0.42, do not know PR=1.57, 95% CI 1.17 to 2.11). HTP-only users were not associated with increased smoking intensity compared with cigarette-only users but were positively associated with quitting (PR=1.13, 95% CI 0.79 to 1.62 and PR=1.64, 95% CI 1.26 to 2.15, respectively). Dual users were positively associated with increased smoking intensity compared with cigarettes-only users, but not associated with quitting (PR=1.35, 95% CI 1.01 to 1.79 and PR=1.09, 95% CI 0.85 to 1.42, respectively).

In the sensitivity analysis, where we targeted participants who had never worked from home and estimated the association between smoking behaviour change (increased and quit) and current smoking rules in the workplace, we did not find an association with changes in smoking behaviour (online supplemental table S1).

DISCUSSION

COVID-19 pandemic and smoking behaviour

Smokers who fear COVID-19 were less likely to quit tobacco products (both cigarettes and HTPs) compared with smokers with no fear. A previous study showed that fear of COVID-19 made smokers maintain or increase their smoking level.[5] Smokers may continue smoking in the belief that it will relieve their stress during the COVID-19 pandemic. This is, however, a misconception since previous studies have shown that stress was increased by nicotine addiction,[27] while it was reduced by quitting smoking.[28] If this common misconception is explained, smokers who fear COVID-19 may try to quit using tobacco products.

Even though smoking was a risk factor for severe COVID-19,[9 10] living in a COVID-19 endemic area was not associated with favourable changes in smoking behaviour. A previous study has shown that smokers tend to underestimate their health risks,[29] and it may be that they also underestimate the risk of COVID-19 infection. Also, a previous study reported that increased perception of the risk of infection from COVID-19 was associated with a higher motivation to quit smoking.[30] One study reported that participants who were outpatients at a smoking cessation clinic had a higher success rate in smoking cessation during the COVID-19 pandemic than before.[11] Hence, during the pandemic, it may not be possible to achieve smoking cessation even with increased motivation to quit without appropriate cessation support. The government and researchers need

Table 1 Characteristics of study participants who used tobacco products (cigarettes or HTPs) at baseline (n=1810)

	Total n (%)*	Smoking behaviour change			
		Increased (n=214)		Quit (n=259)	
		Yes, n (%)	P value†	Yes, n (%)	P value†
Fear of COVID-19			0.37		0.00
No	745 (41.2)	82 (11.0)		135 (18.1)	
Yes	1065 (58.8)	132 (12.4)		124 (11.6)	
Living in a COVID-19 endemic area			0.59		0.30
No	538 (29.7)	67 (12.5)		84 (15.6)	
Yes	1272 (70.3)	147 (11.6)		175 (13.8)	
Current smoking rules in the workplace			0.054		0.00
Indoor smoking ban	835 (46.1)	111 (13.3)		106 (12.7)	
Partial smoking ban	410 (22.7)	52 (12.7)		51 (12.4)	
No smoking ban	105 (5.8)	13 (12.4)		8 (7.6)	
Do not know	460 (25.4)	38 (8.3)		94 (20.4)	
Self-imposed smoking rules at home			0.03		0.00
Both cigarettes and HTPs prohibited	448 (24.8)	57 (12.7)		107 (23.9)	
Both cigarettes and HTPs allowed	988 (54.6)	110 (11.1)		65 (6.6)	
HTPs only allowed	245 (13.5)	39 (15.9)		18 (7.4)	
Do not know	129 (7.1)	8 (6.2)		69 (53.5)	
Type of tobacco use during the baseline survey			0.00		0.00
Cigarettes only	930 (51.4)	88 (9.5)		120 (12.9)	
HTPs only	293 (16.2)	38 (13.0)		60 (20.5)	
Cigarettes and HTPs (dual use)	587 (32.4)	88 (15.0)		79 (13.5)	
Sex			0.34		0.04
Male	1448 (80.0)	166 (11.5)		195 (13.5)	
Female	362 (20.0)	48 (13.3)		64 (17.7)	
Age (years)			0.00		0.00
15–29‡	154 (8.5)	25 (16.2)		55 (35.7)	
30–39	186 (10.3)	33 (17.7)		37 (19.9)	
40–49	431 (23.8)	71 (16.5)		61 (14.2)	
50–59	516 (28.5)	53 (10.3)		58 (11.2)	
60–69	396 (21.9)	24 (6.1)		37 (9.3)	
70–75	127 (7.0)	8 (6.3)		11 (8.7)	
Household income			0.56		0.67
Less than JPY2 million	147 (8.1)	20 (13.6)		26 (17.7)	
JPY2–6 million	487 (26.9)	52 (10.7)		68 (14.0)	
Over JPY6 million	890 (49.2)	113 (12.7)		126 (14.2)	
Prefer not to answer	159 (8.8)	18 (11.3)		19 (12.0)	
Do not know	127 (7/0)	11 (8.7)		20 (15.8)	
Self-rated health			0.00		0.32
Good	1491 (82.4)	153 (10.3)		219 (14.7)	
Poor	319 (17.6)	61 (19.1)		40 (12.5)	
Marital status			0.07		0.00
Married	1074 (59.3)	112 (10.4)		142 (13.2)	
Never married	554 (30.6)	74 (13.4)		103 (18.6)	
Divorced/widowed	182 (10.1)	28 (15.4)		14 (7.7)	
Alcohol use			0.68		0.90
No/quit	495 (27.3)	56 (11.3)		70 (14.1)	
Yes	1315 (72.7)	158 (12.0)		189 (14.4)	

COVID-19 endemic areas were: Tokyo, Saitama, Chiba, Kanagawa, Osaka, Hyogo, Fukuoka, Hokkaido, Ibaraki, Ishikawa, Gifu, Aichi and Kyoto.
*The percentage in total (n, %) indicates the column ratio.
†χ^2 test.
‡Information on participants aged 15–19 is as follows: total (n=7, 0.4%), increased (n=1, 14.3%), quit (n=5, 71.4%). Information on participants aged 20–29 is as follows: total (n=147, 8.12%), increased (n=24, 16.3%), quit (n=50, 34.0%).
HTP, heated tobacco product; JPY, Japanese yen.

Table 2 Association between smoking behaviour changes and characteristics of current smokers before and during COVID-19 pandemic

		Increased PR (95% CI)*	Quit PR (95% CI)*
Fear of COVID-19	No (ref)	1.00	1.00
	Yes	1.20 (0.92 to 1.57)	**0.77 (0.62 to 0.95)**
Living in a COVID-19 endemic area	No (ref)	1.00	1.00
	Yes	0.98 (0.75 to 1.28)	0.85 (0.68 to 1.06)
Current smoking rules in the workplace	Indoor smoking ban (ref)	1.00	1.00
	Partial smoking ban	0.91 (0.67 to 1.23)	1.05 (0.78 to 1.41)
	No smoking ban	1.02 (0.59 to 1.74)	0.86 (0.44 to 1.66)
	Do not know	0.82 (0.56 to 1.21)	1.32 (0.98 to 1.77)
Self-imposed smoking rules at home	Both cigarettes and HTPs prohibited (ref)	1.00	1.00
	Both cigarettes and HTPs allowed	0.90 (0.66 to 1.22)	**0.28 (0.21 to 0.38)**
	HTPs allowed only	1.07 (0.73 to 1.56)	**0.26 (0.16 to 0.42)**
	Do not know	**0.45 (0.22 to 0.95)**	**1.57 (1.17 to 2.11)**
Current type of tobacco use	Cigarettes only (ref)	1.00	1.00
	HTPs only	1.13 (0.79 to 1.62)	**1.64 (1.26 to 2.15)**
	Cigarettes and HTPs (dual use)	**1.35 (1.01 to 1.79)**	1.09 (0.85 to 1.42)
Sex	Male (ref)	1.00	1.00
	Female	1.04 (0.77 to 1.41)	1.25 (0.96 to 1.62)
Age (years)	15–29	**1.96 (1.21 to 3.18)**	1.37 (0.95 to 2.00)
	30–39	**1.94 (1.29 to 2.93)**	1.12 (0.79 to 1.60)
	40–49	**1.71 (1.22 to 2.40)**	1.02 (0.73 to 1.41)
	50–59 (ref)	1.00	1.00
	60–69	**0.61 (0.38 to 0.98)**	0.81 (0.55 to 1.19)
	70–75	0.72 (0.34 to 1.52)	0.77 (0.42 to 1.41)
Household income	Less than JPY2 million	1.01 (0.62 to 1.64)	1.05 (0.71 to 1.57)
	JPY2–6 million	0.88 (0.64 to 1.22)	1.01 (0.77 to 1.32)
	Over JPY6 million (ref)	1.00	1.00
	Prefer not to answer	1.12 (0.71 to 1.75)	0.82 (0.54 to 1.24)
	Do not know	0.82 (0.46 to 1.46)	0.91 (0.61 to 1.38)
Self-rated health	Good (ref)	1.00	1.00
	Poor	**1.85 (1.40 to 2.44)**	0.84 (0.63 to 1.13)
Marital status	Married (ref)	1.00	1.00
	Never married	0.96 (0.70 to 1.30)	1.29 (0.99 to 1.68)
	Divorced/widowed	**1.64 (1.08 to 2.48)**	0.80 (0.48 to 1.32)
Alcohol use	No/quit (ref)	1.00	1.00
	Yes	1.02 (0.76 to 1.37)	1.14 (0.90 to 1.45)

Boldface=statistically significant with p<0.05.
COVID-19 endemic areas were: Tokyo, Saitama, Chiba, Kanagawa, Osaka, Hyogo, Fukuoka, Hokkaido, Ibaraki, Ishikawa, Gifu, Aichi and Kyoto.
*PR was estimated by a multivariate Poisson regression model with all variables simultaneously entered into the model.
CI, confidence interval; HTP, heated tobacco product; JPY, Japanese yen; PR, prevalence ratio; ref, reference.

to adequately inform smokers about these risks and offer cessation support.

Revised smoke-free policy, self-imposed smoking rules at home and smoking behaviour

In the present study, while workplace smoking rules were not associated with quitting tobacco product use, having strict self-imposed home smoking rules was significantly associated with quitting tobacco product use. This may be because, due to the pandemic, more smokers were telecommuting and spending more time at home than in the workplace thus increasing their opportunity to smoke.[6] Moreover, the tobacco industry had begun advertising to promote the use of HTP at home.[6 31] The present study indicated that 68.1% of smokers (54.6% dual users, 13.5% HTP-only users) were able to use HTPs at home (see table 1). Household rules that allow the use of HTP but not smoking in the home are likely to encourage HTP use.

HTP use and smoking behaviour changes

The present study showed that dual users (both cigarettes and HTPs) were more likely to increase smoking intensity than cigarette-only users. This result was consistent with a previous study which showed that dual users used more tobacco products than cigarette-only users.[32] In this study, questions regarding changes in smoking behaviour did not ask about individual tobacco products. Therefore, it was possible that smokers answered the question based on their own overall smoking status. The increase in smoking intensity may have been underestimated. For dual users in this study, 'quit' was defined only by quitting both cigarettes and HTPs. Thus, quitting smoking may be harder for dual users than for HTP-only users. Meanwhile, HTP-only users were more likely to quit tobacco products than cigarette-only users. This may be because of the nature of HTP-only users; that is, most current HTP-only users were not those who had never smoked but those who had been able to stop

smoking cigarettes in the past.[33] In this study, the number of HTP-only users (total n=293), according to their past 30-day smoking experience at baseline, was former smokers (n=282; 96.2%) and never smokers (n=11; 3.8%). Therefore, their success in stopping cigarette smoking might make it easier for them to stop HTP use.

Other variables

Sex, age, household income, self-rated health, marital status and alcohol use were not associated with quitting smoking, whereas younger, poor self-rated health and divorced/widowed were associated with increased smoking intensity. These factors were consistent with the results of previous studies (younger,[6] poor self-rated health[34] and divorced/widowed[6]). Public health interventions, such as increased social support, may be needed to protect people who have these characteristics from the adverse health effects of smoking.

Strength and limitations

One strength of our research was that by using participants' demographic characteristics and health status just before the COVID-19 outbreak in Japan, we addressed recall bias.

The study also has several limitations. First, these data were from an internet survey, and the generalisability of the study is limited. Second, the effect of changes in smoking behaviour among those who relapsed after baseline, those who started smoking or those who changed the type of tobacco products they used during the follow-up period was unknown. Finally, our main variables were self-reported without biomarker validation. However, self-reported smoking status has been used in previous studies[6 23 35] and was found to be highly reliable.[36]

CONCLUSION

During the COVID-19 pandemic, fear of COVID-19 and dual use of cigarettes and HTPs increased smoking intensity, whereas HTP-only use was associated with quitting but not having a home smoking ban made it harder to quit tobacco. Home smoking bans may become more important now that working from home is increasing in the era of COVID-19.

Contributors TYa and TT had full access to all of the study data and took responsibility for the integrity of the data and the accuracy of the data analysis. TYa and TT were involved in the study conception and design and the analysis and interpretation of data. Acquisition of data was performed by TT. TYa and TT drafted the manuscript. HA, MK and TYo contributed to the critical revision of the manuscript. HA contributed to the English language editing. All authors gave final approval and agreed to be accountable for all aspects of the work.

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Patient consent for publication Not applicable.

Ethics approval This study involves human participants. The JASTIS study was reviewed and approved by the Research Ethics Committee of the Osaka International Cancer Institute (1412175183). The JACSIS study was approved by the Institutional Review Board of the Osaka International Cancer Institute (20084). Participants gave informed consent to participate in the study before taking part.

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