

# Use of heated tobacco products in smoke-free locations in Japan: the JASTIS 2019 study

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## ABSTRACT

**Objective** We aimed to examine the use of heated tobacco products (HTPs) in locations where cigarette smoking was not allowed, and to explore the factors associated with such use among Japanese HTP users.

**Methods** An internet-based self-reported questionnaire survey was conducted in 2019 as part of the Japan Society and New Tobacco Internet Survey. The study subjects were respondents who self-reported having used HTPs in the last year. The proportions of those who had ever used or frequently used HTPs in locations where tobacco smoking was not allowed in the last year were calculated. These locations included home, restaurants and workplaces. Furthermore, potential factors associated with HTP use in such smoke-free locations were examined using multivariable logistic regression analyses.

**Results** The proportion of HTP users who had ever used HTPs in smoke-free locations in the last year was 20.7% (148/716) at home, 11.8% (128/1081) in restaurants and 11.9% (113/950) in workplaces. The proportion of those who had frequently used HTPs in those locations was 9.5% (68/716) at home, 4.8% (52/1081) in restaurants and 8.0% (76/950) in workplaces. The statistically significant factors associated with HTP use varied by location. Generally, respondents who thought HTP use was not forbidden in places where tobacco smoking is forbidden were likely to use HTPs in such locations.

**Conclusion** In Japan, a considerable number of people used HTPs in locations where tobacco smoking was not allowed. Policymakers should establish clear rules about use of HTPs in smoke-free environments.

## INTRODUCTION

Heated tobacco products (HTPs) are electronic devices that heat tobacco leaf and mainly produce nicotine aerosols, although with traces of smoke from limited combustion activity,<sup>1</sup> and have been increasing their market share in recent years in Japan.<sup>2</sup> The multinational cigarette manufacturing company, Japan Tobacco, started sales of the HTP, 'Ploom' via the internet in December 2013 and launched a new model 'Ploom Tech' in March 2016 in Japan. Philip Morris also developed a new HTP, 'IQOS' which was introduced to the market in November 2014 and British American Tobacco began to sell 'glo' in December 2016. Remarkably, Japan became the only country where a national roll-out of IQOS had occurred, and Japan's worldwide share of IQOS sales reached more than 90% in 2016.<sup>3</sup> According to a recent study using a nationwide internet research panel, the prevalence of IQOS users increased from 0.3% in 2015 to 0.6%

in 2016, 3.6% in 2017 and up to 6.9% in 2018 in Japan.<sup>2</sup>

Legal restrictions on new tobacco products, such as HTPs and electronic cigarettes (e-cigarettes), are complex in Japan. HTPs are legally regarded as tobacco products and are regulated by the Tobacco Industries Act. Therefore, their sale to minors is prohibited alike with combustible tobacco products. In contrast, the sale of e-cigarettes containing nicotine has been banned since 2010 by the Pharmaceutical Affairs Act, and e-cigarettes that do not contain nicotine are not legally regulated. Therefore, the use of e-cigarettes containing nicotine in Japan is limited to privately imported products, whereas e-cigarettes that do not contain nicotine are widely sold in Japanese marketplaces, even to minors.

There is a concern that, despite the fact that HTP combust tobacco and produce measurable levels of tobacco smoke, HTPs are used as means to evade smoke-free policies.<sup>4–5</sup> In addition, the potential risk of dual use of both combustible tobaccos and HTPs has also been concerned.<sup>6</sup> Nevertheless, as a previous paper indicated, tobacco companies may use the claim that, since the tobacco is purportedly heated instead of burned, HTPs can be excluded from indoor smoke-free policies.<sup>7</sup> For example, Japan Tobacco introduced a 'No Smoking, Ploom TECH Only' concept to increase acceptance and normalise the use of Ploom TECH in indoor public spaces.<sup>8</sup> The original aim of the implementation of smoke-free policies was to protect non-smokers from exposure to environmental tobacco smoke. Such policies have also been instrumental in denormalising smoking, lowering smoking prevalence, increasing quit-attempts and reducing tobacco consumption.<sup>9</sup> If HTP use is allowed in smoke-free environments, it could potentially renormalise tobacco smoking, sustain the dual use of HTP and combustible tobacco, maintain nicotine addiction and complicate enforcement of smoke-free policies.<sup>9–11</sup> Therefore, as with combustible tobacco smoking, use of HTPs indoors should ideally be restricted.

As a smoke-free policy in Japan, obligation to make efforts to prevent exposure to secondhand smoke in public locations were prescribed by Health Promotion Law in 2003. However, this regulation did not include any penal provisions, and tobacco control measures in Japan were considered the weakest in the developed world.<sup>12</sup> In 2018, Health Promotion Law was revised to include smoke-free regulation with penalties. This amendment was partly implemented in July 2019 and completed in April 2020. Importantly, the regulation of HTP use was mentioned in this amendment for the first



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time. Thus, as of February 2019, there was no national/local regulation of the use of HTPs in Japan, and some public locations have voluntarily adopted their own smoke-free rules as to HTP use.<sup>13</sup> It is therefore ambiguous whether the smoke-free rule also covered HTP use, unless each facility specifically stated. This ambiguity may itself indicate that the implementation of smoke-free policy was already confused and undermined by the advent of HTPs.

Considering the recent increase in the prevalence of HTP use worldwide as well as in Japan,<sup>2 14</sup> monitoring of HTP use in smoke-free locations is needed in order to examine its impact on existing tobacco control measures. However, to our best knowledge, no study has investigated the current situation of HTP use in smoke-free locations. Therefore, the present study aimed to reveal the actual use of HTPs in locations where tobacco smoking was not allowed and to explore the factors associated with such use among Japanese HTP users. The main focus of this study was to investigate the proportion of HTP users who have experience of HTP use in locations where smoking was not allowed, even though they themselves perceive them to be 'smoke-free'.

## METHODS

### Study design

The Japan 'Society and New Tobacco' Internet Survey (JASTIS) is a longitudinal internet-based cohort study which was designed to investigate perception, attitude and use of HTPs, e-cigarettes and combustible tobacco products in Japan. Details of the JASTIS have been described previously.<sup>15</sup> Briefly, participants in the JASTIS were recruited from a large survey panel managed by a nationwide internet research agency, Rakuten Insight, which has a pool of 2.3 million panellists covering various social categories, such as education, housing tenure and marital status, defined by the Japanese census.<sup>15</sup> The JASTIS was launched in 2015 and an internet-based self-reported questionnaire survey was conducted once a year among panellists who were randomly selected and/or invited for follow-up. Each survey was closed when the target number of respondents who had answered the questionnaire was met. In the present study, we used cross-sectional data from the survey conducted on 11 000 people in February 2019.

### Selection of study subjects and quality control

The subjects of this study were the respondents to the 2019 JASTIS survey, who had ever used any type of HTP (ie, IQOS, Ploom TECH, or glo) in the last year. Since some people may not be able to tell the difference between HTPs and e-cigarettes, those who reported having experience of e-cigarette use in the last year were excluded in order to avoid confusion. Furthermore, because of the nature of the internet-based questionnaire survey, it was important to consider reporting bias as revealed in incorrect and contradictory answers.<sup>16 17</sup> To reduce the potential risk of overestimation or underestimation of outcome measures and to improve the data quality, invalid responses were excluded from the dataset. We confirmed response consistency by checking closely related questions within the same survey to identify erroneous data. We also excluded respondents who replied that they did not know about HTPs, had never tried HTPs and had never used HTPs in any of the listed places.

### Outcome measure

The outcome of this study was experience of HTP use in locations where tobacco smoking was not allowed in the last year. This was assessed using the question: 'How frequently do (did) you use HTPs in the following places where tobacco smoking

was not allowed in the last year? (except for areas where HTP use is explicitly stated to be allowed)' (最近1年間に、喫煙が禁止された場所で、加熱式タバコを使うことがありましたか。ただし、加熱式タバコはOKだと明示された禁煙の場所は除きます。) In the context of this question, the definition of 'smoke-free locations' in this study referred to locations where use of combustible tobacco is not allowed but where HTP use is not explicitly mentioned. Respondents were asked to answer this question regarding home, restaurants (excluding bars, nightclubs and izakaya (Japanese style pub)) and workplaces (excluding restaurants), by the following options: 'never (全くなかった)', 'seldom (ほとんどなかった(1回~数回程度))', 'occasionally (ときどきあった)', 'frequently (よくあった)' or 'smoking was permitted in these locations (この場所では喫煙が禁止されていなかった)'. Individuals who replied 'seldom', 'occasionally', or 'frequently' were considered as 'ever-users of HTPs in smoke-free locations', and those who replied 'frequently' were defined as 'frequent users of HTPs in smoke-free locations'. Since there was no official regulation with penal provision in Japan at the time of survey, smoke-free rules at home were probably set voluntarily by the respondents themselves or by family members, and those in restaurants and workplaces were set by each facility.

### Other collected data

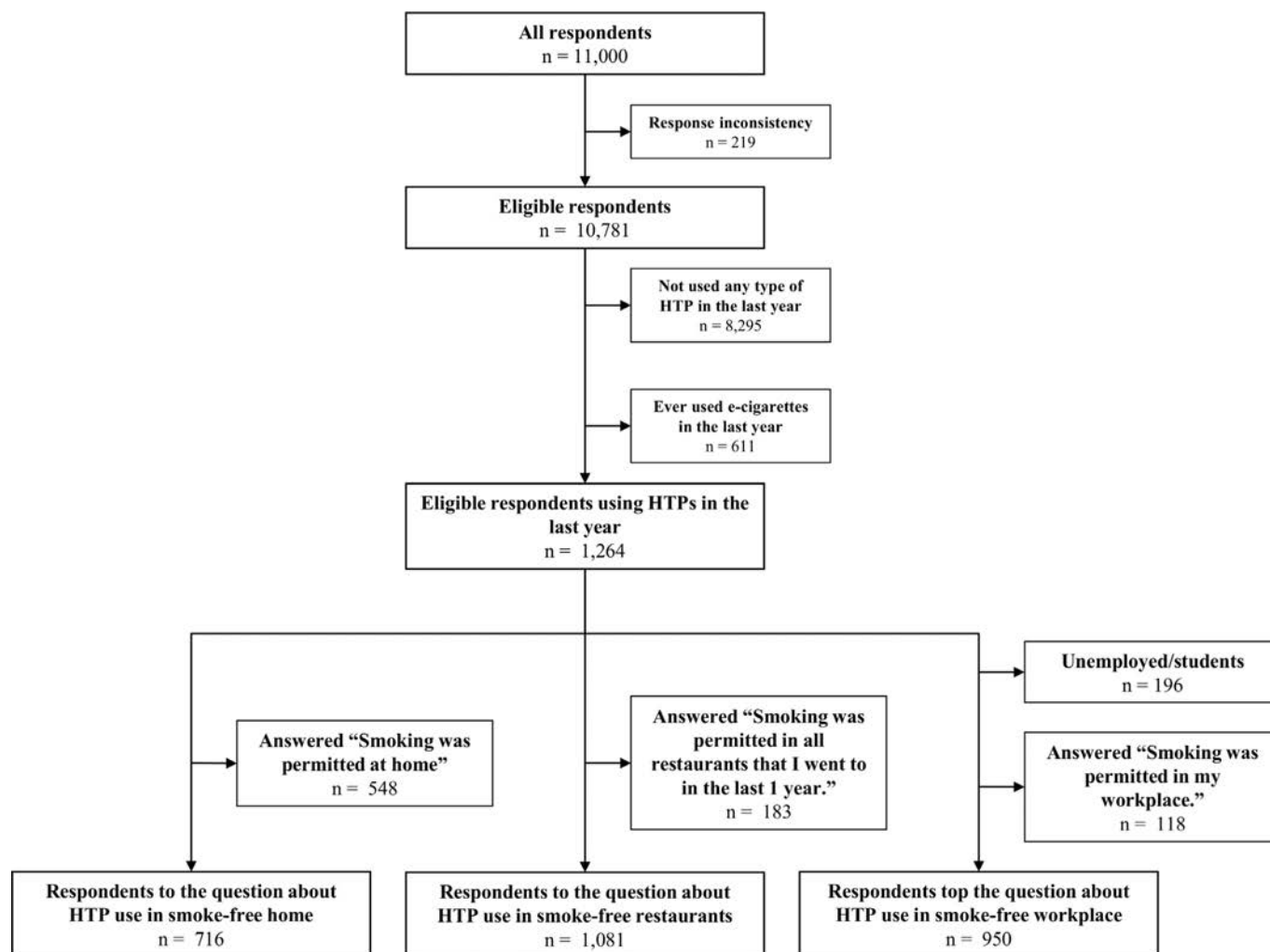
As background characteristics, respondents were asked their sex (male or female), age ( $\leq 29$ , 30–39, 40–49, 50–59,  $\geq 60$ ), education (lower or higher than college degree) and combustible tobacco smoking status in the last year (ever smoker or non-smoker). Moreover, respondents were asked to give a 'yes' or 'no' response to each of the following questions: 'Do you think HTP use is also forbidden in places where tobacco smoking is forbidden?' and 'Do you think passive smoking of HTPs is harmful?'.

### Statistical methods

The proportion of respondents who had ever or frequently used HTPs in smoke-free locations in the last year was calculated separately by home, restaurants and workplaces. Considering the focus of this study, those who answered that smoking was permitted in those locations were excluded from the analyses. For the analysis of workplaces, those who were students or unemployed were also excluded. In addition, multivariable logistic regression analyses were performed to explore the potential factors associated with their HTP use in smoke-free locations; ORs and their 95% CIs were calculated. The independent variables of the models included all items listed above by using forced entry. All statistical analyses were performed with the SPSS statistical package V.25.0J (IBM Corp, Armonk, New York, USA). All tests were two-tailed, and values of  $p < 0.05$  were considered statistically significant.

### Ethics

The study was reviewed and approved by the Research Ethics Committee of the Osaka International Cancer Institute (no. 1412175183) and the National Institute of Public Health (NIPH-IBRA#12112). The internet panellists of Rakuten Insight had already agreed to their participation in different research surveys at the time of previous surveys. They had the option to not respond to any part of the questionnaire and the option to discontinue the survey at any point. They were identified by research-specific numbers, and no personal identifiers were collected in this survey. Minors provided their consent with approval from their parents or guardians.



**Figure 1** Selection of study subjects from the JASTIS survey conducted in 2019. HTPs, heated tobacco products; JASTIS, Japan Society and New Tobacco Internet Survey.

## RESULTS

### Study flow

Figure 1 shows the selection of study subjects from the 2019 JASTIS. Out of 11 000 respondents, individuals who were not confirmed by the response consistency check ( $n=219$ ), who did not use any type of HTP in the last year ( $n=8295$ ) and who had ever used e-cigarettes in the last year ( $n=611$ ) were excluded. After excluding individuals who answered that smoking was permitted in each location, the number of the eligible respondents were 716 for home, 1081 for restaurants and 950 for workplaces.

### HTP use at smoke-free home

Table 1 shows the experience of HTP use in the last year in homes where combustible tobacco smoking was not allowed. Overall, the proportion of respondents who had ever and frequently used HTPs was 20.7% (148/716) and 9.5% (68/716), respectively. In the multivariable analysis, the proportion of ever-use was significantly higher among those who thought passive smoking of HTP is not harmful (adjusted OR 1.49; 95% CI, 1.03 to 2.14;  $p=0.033$ ). The proportion of frequent use was significantly higher among those with a lower educational level (adjusted OR 1.69; 95% CI, 1.00 to 2.85;  $p=0.049$ ).

### HTP use at smoke-free restaurants

Table 2 shows the experience of HTP use in the last year in restaurants where combustible tobacco smoking was not allowed. Overall, the proportion of respondents who had ever and frequently used HTPs was 11.8% (128/1,081) and 4.8% (52/1,081), respectively. In the multivariable analysis, the proportion of ever-use was significantly higher among those who thought HTP use was not forbidden in smoke-free places (adjusted OR 1.80, 95% CI 1.21 to 2.67;  $p=0.004$ ). The proportion of frequent use was significantly lower among those with a lower educational level (adjusted OR 0.48; 95% CI, 0.26 to 0.89;  $p=0.020$ ) and higher among those who thought HTP use was not forbidden in smoke-free places (adjusted OR 2.35, 95% CI 1.31 to 4.19;  $p=0.004$ ).

### HTP use at smoke-free workplaces

Table 3 shows the experience of HTP use in the last year in workplaces where combustible tobacco smoking was not allowed. Overall, the proportion of respondents who had ever and frequently used HTPs was 11.9% (113/950) and 4.8% (76/950), respectively. In the multivariable analysis, the proportion of ever use was significantly higher among those who thought HTP use was not forbidden in smoke-free places (adjusted OR 1.72, 95% CI 1.14 to 2.61;  $p=0.010$ ). On the other hand, no statistically

**Table 1** Experience of use of HTPs at home where smoking was not permitted in the last year

		Ever use					Frequent use				
		n/N (%)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value	n/N (%)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Sex	Male	115/585 –19.70	0.73 (0.47 to 1.13)	0.159	0.68 (0.42 to 1.12)	0.128	49/585 –8.40	0.54 (0.31 to 0.95)	0.033	0.58 (0.31 to 1.09)	0.090
	Female	33/131 –25.20	Reference		Reference		19/131 –14.50	Reference		Reference	
Age	16–29	18/97 –18.60	0.83 (0.43 to 1.61)	0.585	0.76 (0.37 to 1.54)	0.442	10/97 –10.30	1.3 (0.53 to 3.18)	0.572	1.01 (0.38 to 2.67)	0.990
	30–39	19/131 –14.50	0.62 (0.33 to 1.17)	0.141	0.62 (0.32 to 1.20)	0.155	10/131 –7.60	0.93 (0.38 to 2.27)	0.876	0.84 (0.34 to 2.10)	0.715
	40–49	37/168 –22.00	1.03 (0.60 to 1.79)	0.909	1.03 (0.59 to 1.82)	0.916	18/168 –10.70	1.35 (0.62 to 2.97)	0.452	1.22 (0.54 to 2.73)	0.636
	50–59	45/185 –24.30	1.17 (0.69 to 2.00)	0.552	1.25 (0.73 to 2.15)	0.414	19/185 –10.30	1.29 (0.59 to 2.81)	0.521	1.32 (0.60 to 2.90)	0.494
	60 and above	29/135 –21.50	Reference		Reference		11/135 –8.10	Reference		Reference	
Final education	Lower than college degree	69/296 –23.30	1.31 (0.91 to 1.89)	0.144	1.34 (0.91 to 1.96)	0.137	37/296 –12.50	1.31 (0.91 to 1.89)	0.023	1.69 (1.00 to 2.85)	0.049
	College degree or higher	79/420 –18.80	Reference		Reference		31/420 –7.40	Reference		Reference	
Combustible tobacco use in the last year	Non smoker	24/143 –16.80	0.73 (0.45 to 1.18)	0.201	0.71 (0.43 to 1.17)	0.18	12/143 –8.40	0.85 (0.44 to 1.62)	0.615	0.75 (0.38 to 1.47)	0.402
	Ever smoker	124/573 –21.60	Reference		Reference		56/573 –9.80	Reference		Reference	
Do you think HTP use is also forbidden in places where tobacco smoking is forbidden?	No	47/199 –23.60	1.27 (0.86 to 1.89)	0.228	1.22 (0.81 to 1.82)	0.338	23/199 –11.60	1.37 (0.81 to 2.33)	0.245	1.29 (0.75 to 2.22)	0.354
	Yes	101/517 –19.50	Reference		Reference		45/517 –8.70	Reference		Reference	
Do you think passive smoking of HTP is harmful?	No	80/331 –24.20	1.49 (1.03 to 2.14)	0.033	1.42 (0.98 to 2.07)	0.064	34/331 –10.30	1.49 (1.03 to 2.14)	0.033	1.16 (0.69 to 1.93)	0.576
	Yes	68/385 –17.70	Reference		Reference		34/385 –8.80	Reference		Reference	
Total		148/716 –20.70					68/716 –9.50				

CI, confidence interval; HTPs, heated tobacco products; OR, odds ratio.

**Table 2** Experience of use of HTPs in the restaurants where smoking was not permitted in the last year

		Ever use					Frequent use				
		n/N (%)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value	n/N (%)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Sex	Male	94/841 –11.2	0.76 (0.50 to 1.16)	0.207	0.75 (0.47 to 1.19)	0.219	38/841 –4.5	0.76 (0.41 to 1.43)	0.402	0.76 (0.37 to 1.55)	0.449
	Female	34/240 –14.2	Reference		Reference		14/240 –5.8	Reference		Reference	
Age	16–29	22/134 –16.4	1.45 (0.78 to 2.69)	0.243	1.21 (0.62 to 2.35)	0.579	12/134 –9.0	1.61 (0.70 to 3.71)	0.259	1.28 (0.52 to 3.17)	0.592
	30–39	17/172 –9.9	0.81 (0.42 to 1.55)	0.520	0.71 (0.37 to 1.39)	0.324	6/172 –3.5	0.59 (0.22 to 1.62)	0.307	0.50 (0.18 to 1.39)	0.182
	40–49	33/259 –12.7	1.07 (0.62 to 1.87)	0.799	1.01 (0.57 to 1.77)	0.982	15/259 –5.8	1.01 (0.46 to 2.21)	0.982	0.93 (0.42 to 2.08)	0.862
	50–59	31/307 10.1	0.83 (0.47 to 1.45)	0.504	0.79 (0.45 to 1.39)	0.412	7/307 –2.3	0.38 (0.15 to 0.99)	0.048	0.35 (0.14 to 0.93)	0.035
	60 and above	25/209 –12.0	Reference		Reference		12/209 –5.7	Reference		Reference	
Final education	Lower than college degree	53/511 –10.4	0.76 (0.53 to 1.11)	0.158	0.72 (0.49 to 1.06)	0.096	17/511 –3.3	<b>0.53 (0.29 to 0.95)</b>	<b>0.033</b>	<b>0.48 (0.26 to 0.89)</b>	<b>0.020</b>
	College degree or higher	75/570 –13.2	Reference		Reference		35/570 –6.1	Reference		Reference	
Combustible tobacco use in the last year	Non smoker	24/224 –10.7	0.87 (0.54 to 1.39)	0.558	0.85 (0.53 to 1.38)	0.518	11/224 –4.9	1.03 (0.52 to 2.03)	0.937	1.05 (0.52 to 2.13)	0.893
	Ever smoker	104/857 –12.1	Reference		Reference		41/857 –4.8	Reference		Reference	
Do you think HTP use is also forbidden in places where tobacco smoking is forbidden?	No	46/277 –16.6	<b>1.75 (1.19 to 2.59)</b>	<b>0.005</b>	<b>1.80 (1.21 to 2.67)</b>	<b>0.004</b>	22/277 –7.9	<b>2.23 (1.26 to 3.93)</b>	<b>0.006</b>	<b>2.35 (1.31 to 4.19)</b>	<b>0.004</b>
	Yes	82/804 –10.2	Reference		Reference		30/804 –3.7	Reference		Reference	
Do you think passive smoking of HTP is harmful?	No	54/506 –10.7	0.81 (0.56 to 1.17)	0.265	0.76 (0.52 to 1.11)	0.154	21/506 –4.2	0.76 (0.43 to 1.34)	0.343	0.68 (0.38 to 1.23)	0.204
	Yes	74/575 –12.9	Reference		Reference		31/575 –5.4	Reference		Reference	
Total		128/1081 –11.8					52/1081 –4.8				

CI, confidence interval; HTP, heated tobacco product; OR, odds ratio

**Table 3** Experience of use of HTPs in the workplaces where smoking was not permitted in the last year

		Ever use					Frequent use				
		n/N (%)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value	n/N (%)	Crude OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Sex	Male	91/766 –11.90	1.09 (0.63 to 1.87)	0.76	0.99 (0.6 to 1.63)	0.977	59/766 –7.70	0.84 (0.45 to 1.55)	0.575	0.82 (0.47 to 1.44)	0.491
	Female	22/184 –12.00	Reference		Reference		17/184 –9.20	Reference		Reference	
Age	–29	15/89 –16.90	1.5 (0.67 to 3.36)	0.321	1.47 (0.69 to 3.15)	0.322	8/89 –9.00	0.94 (0.34 to 2.55)	0.896	1.09 (0.42 to 2.82)	0.865
	30–39	18/179 –10.10	0.81 (0.39 to 1.68)	0.571	0.81 (0.4 to 1.66)	0.565	10/179 –5.60	0.6 (0.24 to 1.47)	0.26	0.65 (0.27 to 1.58)	0.343
	40–49	36/258 –14.00	1.17 (0.62 to 2.22)	0.625	1.18 (0.63 to 2.21)	0.615	24/258 –9.30	1.05 (0.49 to 2.23)	0.903	1.13 (0.53 to 2.38)	0.752
	50–59	28/292 –9.60	0.79 (0.41 to 1.52)	0.481	0.77 (0.4 to 1.48)	0.43	23/292 –7.90	0.94 (0.44 to 1.99)	0.864	0.94 (0.44 to 1.99)	0.873
	60 and above	16/132 –12.10	Reference		Reference		11/132 –8.30	Reference		Reference	
Final education	Lower than college degree	47/433 –10.90	0.82 (0.54 to 1.24)	0.339	0.83 (0.56 to 1.24)	0.365	36/433 –8.30	1.02 (0.63 to 1.66)	0.931	1.08 (0.68 to 1.73)	0.744
	College degree or higher	66/517 –12.80	Reference		Reference		40/517 –7.70	Reference		Reference	
Combustible tobacco use in the last year	Non smoker	24/187 –12.80	1.11 (0.68 to 1.81)	0.683	1.12 (0.69 to 1.81)	0.658	18/187 –9.60	1.28 (0.73 to 2.25)	0.387	1.29 (0.74 to 2.25)	0.362
	Ever smoker	89/763 –11.70	Reference		Reference		58/763 –7.60	Reference		Reference	
Do you think HTP use is also forbidden in places where tobacco smoking is forbidden?	No	41/249 –16.50	1.68 (1.10 to 2.56)	0.016	1.72 (1.14 to 2.61)	0.01	27/249 –10.80	1.64 (0.99 to 2.71)	0.054	1.62 (0.99 to 2.65)	0.056
	Yes	72/701 –10.30	Reference		Reference		49/701 –7.00	Reference		Reference	
Do you think passive smoking of HTP is harmful?	No	54/428 –12.60	1.09 (0.73 to 1.63)	0.68	1.13 (0.76 to 1.68)	0.534	34/428 –7.90	0.91 (0.56 to 1.48)	0.706	0.99 (0.62 to 1.58)	0.954
	Yes	59/522 –11.30	Reference		Reference		42/522 –8.00	Reference		Reference	
Total		113/950 –11.90					76/950 –8.00				

CI, confidence interval; HTPs, heated tobacco products; OR, odds ratio.

significant factor was found in the analysis for frequent use of HTP.

## DISCUSSION

Using data from the 2019 JASTIS, the present study investigated the actual prevalence of HTP use in locations where tobacco smoking was not allowed, including home, restaurants and workplaces among Japanese HTP users. This is the first study to examine the current situation regarding HTP use in smoke-free environments. Our findings may provide important information from which we can infer the impact of the widespread use of HTPs on existing smoke-free policies and which is expected to serve as a basis for future research and planning of appropriate countermeasures against HTP use in community settings. Our results demonstrated that a considerable proportion of HTP users actually used HTPs in smoke-free locations: that is, the proportion of HTP users who had used HTPs in smoke-free locations in the last year was 20.7% at home, 11.8% in restaurants and 11.9% in workplaces. In this study, 'smoke-free locations' denoted locations where use of combustible tobacco was not allowed but where HTP use was not explicitly mentioned. Therefore, they may have used HTPs in such locations to intentionally violate the rules or inadvertently because they did not understand that the current smoke-free rules also covered HTPs. Although we did not aim to determine the exact reasons for HTP use in this survey, our results would suggest that existing tobacco-control efforts have already been confused by the spread of HTPs.

## Comparison with previous studies

The results of this study showed a lower proportion of HTP use in smoke-free locations than previous similar studies. Recently, Sutanto *et al* studied the experience of HTP use in indoor public spaces in Japan.<sup>18</sup> According to their report, the proportions of any type of HTP users that had an experience of HTP use in the last 6 months were approximately 50% in restaurant or café and 40% in workplace. This was the first study that collectively examined population estimates of HTP use within indoor public spaces, but they did not consider the existence of smoke-free rules in each location. Therefore, it is quite natural that their reported proportions of HTP use were higher than those of our study. Another study from Japan reported that approximately 30% of e-cigarette users have ever used and 20% have frequently used e-cigarettes in smoke-free areas of restaurants and workplaces in 2015.<sup>19</sup> Another previous study conducted in the USA also reported that 59.5% of e-cigarette users had vaped where cigarette smoking was not allowed in 2014.<sup>20</sup> We assume that the discrepancy in the results is mainly due to the differences in legal treatment between HTPs and e-cigarettes. In Japan, the sale of e-cigarettes containing nicotine has been banned since 2010 by the Pharmaceutical Affairs Act, but e-cigarettes that do not contain nicotine are not legally regulated. Therefore, the use of e-cigarettes containing nicotine in Japan is limited to privately imported products, whereas e-cigarettes that do not contain nicotine are widely sold in Japanese marketplaces, even into minors. In 2014–2015, shortly after new tobacco products were launched, e-cigarettes were marketed to consumers as a way to circumvent smoke-free rules by enabling users to 'smoke anywhere'.<sup>21</sup> Therefore, many e-cigarette users would intentionally have used e-cigarettes as a loophole to avoid tobacco control measures. On the other hand, HTPs are legally regarded as tobacco products and are regulated by the Tobacco Industries Act, and their sale to minors is prohibited. Hence,

unlike e-cigarettes, many people might have considered HTPs to be similar products to combustible tobacco and felt hesitant to use HTPs in smoke-free locations.

## Implications for policymaking

The statistically significant factors associated with HTP use found in our results varied by location. Approximately one-fourth of HTP users thought HTP use was not forbidden in places where tobacco smoking is forbidden, and these respondents were generally more likely to use HTPs in such locations. Since there was no national legislation prohibiting HTP use in public locations in Japan at the time of the survey, most places have adopted their own smoke-free rules. For example, according to a recent paper from the JASTIS study, approximately two-thirds of workplaces where combustible tobacco smoking was not allowed also did not allow HTP use indoors in 2018.<sup>13</sup> Therefore, our results may suggest that the voluntary smoke-free rules in each place are not fully recognised by citizens. To properly inform smoke-free regulation and improve the compliance rate, policymakers should establish explicit rules regarding HTP use in smoke-free environments.

## Current legislation in Japan and future research

In the future, continued monitoring of HTP use is needed to assess the impact of the law and accumulate evidence for the development of more appropriate control measures. As we noted above, Japan did not have smoke-free legislation with penal provisions, and tobacco control measures in Japan were considered the weakest in the developed world.<sup>12</sup> Under such circumstances, the Health Promotion Law was revised to include smoke-free regulation with penalties in 2018. As the first step of the implementation of this law, use of both combustible tobacco and HTPs has been prohibited indoors in schools, hospitals and government offices since July 2019. In general offices, factories and restaurants (exceptions are made for restaurants smaller than 100 m<sup>2</sup>), smoking has been allowed in two types of designated tobacco rooms since April 2020: (1) tobacco rooms for any tobacco product—smoking is the only activity permitted in the room and (2) tobacco rooms, especially for HTP use—eating/drinking and other activities besides HTP use are permitted in the room. Thus, the enforcement of this law will change people's behaviour in smoke-free areas in the future.

## Limitations

There are several inherent limitations in this study. First, since our study area was limited to Japan, the results may not easily apply to other countries. Considering that the marketing strategies and regulation of HTPs and other environmental circumstances may vary by country, patterns of HTP use and the total effect on public health could differ. Second, the questionnaire survey was carried out with a convenience sample of those who had voluntarily registered themselves as internet research panellists. Therefore, our study subjects may not be representative of all HTP users in Japan. Third, the validity of the questionnaire items was not fully confirmed. Although we conducted a response consistency check and excluded the invalid responses from analyses, our data quality may not be high. Fourth, we have no way of knowing the actual smoke-free rules of each location. We relied on respondents' self-reports to obtain such information. Therefore, there is a possibility of misclassification because some respondents may have been unwilling to answer for breaking the rules, although not legally

punishable. Thus, these limitations may cause overestimation or underestimation of the outcomes of interest, and our results should be carefully interpreted regarding limited generalisability, reliability and validity.

## CONCLUSION

The present study demonstrated that a considerable number of people used HTPs in smoke-free locations in Japan: that is, 11.8%–20.7% of HTP users had ever used and 4.8%–9.5% had frequently used HTPs in the home, restaurants or workplaces in the last year. Policymakers should establish explicit regulations regarding the use of HTPs in smoke-free environments. Moreover, continued monitoring of HTP use is required to accumulate evidence for the development of appropriate control measures.

## What this paper adds

### What is already known on this subject

- Recently, heated tobacco products (HTPs) have been increasing their market share in Japan and are frequently being used as an alternative to combustible cigarettes.

### What important gaps in knowledge exist on this topic

- The use of HTPs in smoke-free environments may undermine measures already in place to prevent harm from secondhand smoke exposure.
- However, the current situation regarding the use of HTPs in smoke-free areas has not been sufficiently investigated.

### What this paper adds

- The proportion of HTP users who had ever used HTPs in locations where tobacco smoking was not allowed in the last year was 20.7% (148/716) at home, 11.8% (128/1081) in restaurants and 11.9% (113/950) in workplaces.
- The proportion of those who had frequently used HTPs in those locations was 9.5% (68/716) at home, 4.8% (52/1081) in restaurants and 8.0% (76/950) in workplaces.

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