Article

A National Cross-Sectional Survey to Assess Tobacco and Nicotine Product Usage Patterns and Behaviour Since the Introduction of Tobacco Heating Products in Japan: Wave 1

Joshua Jones[1]*, Jason Adamson[1], Claudia Kanitscheider[2], Krishna Prasad[1], Oscar M Camacho[1], Ekaterina Beliaeva[2], Hans Bauer[2], Yoga Keralapura Bhagavan[1], James Murphy[1]

[1] British American Tobacco, R&D, Regents Park Road, Southampton, Hampshire, SO15 8TL, UK
[2] Kantar Germany, Landsberger Straße 284, 80687 Munich, DE, Germany
* Correspondence: Joshua_David_Jones@bat.com (J.J.)

Abstract: Providing data on usage patterns is key to assessing the reduced-risk potential of novel tobacco and nicotine products at a population level. We performed a nationwide cross-sectional survey of the general population in Japan to assess usage patterns after the introduction of tobacco heating products (THPs). Eligible participants were Japanese residents, aged 20 years or older who consented to complete the survey. Individuals living in institutions were excluded. A three-stage probability sampling method was applied that was geographically stratified by street blocks proportionate to population density. Respondents self-reported patterns of product use and reasons for THP use. Complete responses were available from 5,306 individuals, of whom 933.5 (17.6%) were current users, 984.2 (18.5%) were former users and 3388.4 (63.9%) were never users of tobacco products. Cigarettes were used by 14.6% of current tobacco product users and THPs by 5.3%. Cigarettes and THPs were used exclusively by 64.5% and 12.2%, respectively, and both were used by 12.7%. The most common reasons reported for THP use were perceived reduction in harm to self and others compared to cigarettes. While the prevalence of cigarette use in Japan is decreasing, THPs seem to be increasingly used as long-term alternatives to cigarette smoking.

Keywords: Tobacco and nicotine products; tobacco heating products; cigarettes; switching; consumer behaviour; usage patterns.

1. Introduction

During the past few decades, the global smoking landscape has changed substantially. Regulations restricting smoking have been introduced in many countries, with efforts made to reduce tobacco consumption and prevent initiation of use. Meanwhile, alternative tobacco and nicotine products have recently entered the market that aim to reduce overall exposure to harmful toxicants and reduce the risk associated with cigarette smoking [Cancer Research UK, 2020; Royal College of Physicians, 2016].

To evaluate the modified risk potential of new products, various studies are recommended to compare the effects with cigarettes [Institute of Medicine, 2012]. Post-market surveillance is also required to assess consumer behaviour and usage patterns and confirm the reduced risk potential. To demonstrate benefits at the population level, a holistic approach is needed that considers current, former and never users.

Tobacco heating products (THPs) heat tobacco sticks enough to release aerosol containing nicotine, glycerol and some volatile tobacco flavour compounds without combustion. Therefore, the formation of many of the toxicants generated in cigarette smoke is prevented or substantially reduced [Eaton et al. 2018; Forster et al. 2018; Gale et al. 2019; Mallock et al, 2018; Schaller et al. 2016; Simonavuicius et al. 2019; Smith et al 2016]. Japan, the first country where THPs were successfully

introduced in 2014, has shown high levels of acceptance for this product category [Adamson et al. 2020; Hair et al. 2018]. THPs accounted for 23% of the Japanese tobacco market in 2018 [Greenhalgh 2020]. Japan is, therefore, a preferred location for investigating the impact of THP introduction at a population level.

A pilot cross-sectional survey was conducted in 2018 across three areas of Japan (Tokyo, Osaka and Sendai) to assess tobacco and nicotine product usage after the introduction of THPs [Adamson et al. 2020]. Following successful completion of the pilot, a nationwide three-wave survey was initiated [Adamson et al. 2019]. Here we report the results of wave one.

2. Experimental Section

2.1. Study design and population

The wave one survey was performed between February 23rd and April 7th, 2019. The eligible study population comprised current residents of Japan living in a private household, aged 20 years (legal smoking age) or older, who could speak and read Japanese and were willing to participate after study information was provided. We excluded people in institutionalised populations (e.g. prisons, military bases, mental facilities and homes for the aged).

This study was conducted in accordance with the latest version of the Declaration of Helsinki, Good Epidemiological Practice, the JMRA Marketing Research Guideline and the Personal Information Protection Guideline (which also complies with the ICC/ESOMAR codes of conduct), as well as any relevant local laws and regulations. Approval was obtained from the independent ethics committee at Kitamachi Clinic, Tokyo, Japan.

2.2. Sampling design and procedures

We applied geographically stratified three-stage probability sampling to select potential participants. Japan is classified into nine regions containing 47 prefectures that are further separated into municipalities. Urbanisation is stratified by four degrees – major cities, large cities, medium cities and small towns – based on population data recorded by the residential registration programme. The primary sampling units (PSUs) in this survey were street blocks selected by stratified random sampling. We randomly selected 500 PSUs that were proportionate in size to population density. Within each PSU, households were numbered in ascending order, using the Zenrin residential map database (Zenrin Co Ltd, Kitakyushu, Fukuoka, Japan). A starting number was chosen randomly, from which 50 households separated by regular numeric intervals were selected. If there were not enough households in the selected PSU, households from the next street block listed on the residential map database in a neighbouring PSU of the same municipality were added.

Interviewers were provided with lists of the selected houses and visited them in order until ten interviews had been completed. If an interviewer could not complete ten interviews within the 50 listed households, he or she visited the next household based on the regular numeric interval until ten interviews were completed. Within each household, one respondent was selected by next birthday method [Salmon & Nichols 1983]. To control for inclusion of participants in multiple waves, different PSUs were used in the pilot study and each wave of the survey.

Based on previous experience and results from the pilot study [Adamson et al. 2020], we expected the age groups 20–24 years and 25–29 years to be under-represented in the samples. We therefore oversampled for these age groups by adding a quota to each assigned PSU. Once the target sample of ten interviews was reached, the interviewer selected further households using the same method as for the main sample until the quota was met. Questionnaires from oversampling were specifically marked to differentiate them from the main sample to allow application of different weighting factors based on selection probability before they were merged into the final sample.

2.3. Study instrument

Participants completed a self-administered paper questionnaire that was provided with instructions for completion. In each survey wave, the study questionnaires were adapted from that used in the pilot study [Adamson et al. 2020] to cover adequately topics that emerged or evolved during the study run time and were deemed to be essential to assess tobacco use behaviour (Table 1).

Table 1: A Summary of relevant changes to questionnaire from Pilot Wave to Wave 1, concerning tobacco usage behaviour

No.	Change Description
1	The questions regarding smoking/using 1–2 years ago and the amount of use up until 12 months ago were removed and the graphic visualization of the time periods were removed. Based on that, the order of questions was changed, and some questions were rephrased to be more specific
2	Preferred flavour for THP was specified as 'Menthol flavour', 'Non-menthol flavour', and 'No flavour'
3	The addition of product name HEETS together with HeatSticks and NEOs together with NeoStiks, as they are sold in parallel
4	The sections on 'Pipe and Kiseru' and 'Cigars and Cigarillos' were deleted and summarized in the section on 'Other Tobacco Products'
5	The section 'Other tobacco heating products' was added to account for THPs that entered the market after the questionnaire was finalised

2.4. Survey distribution and data collection

Interviewers visited target households and posted a card explaining the purpose of the study, a request to participate and contact information. They returned on a different day to make first personal contact. Once the selected respondent in the household had been identified and consented to hear about the study, the interviewer explained the purpose of the study, provided a participant information letter and answered questions if necessary. If the respondent agreed to participate in the study, the interviewer provided the questionnaire and requested completion. By completing the questionnaire, the participant implicitly gave consent to participate.

The interviewer checked the returned data for completeness and correctness and asked the participant to clarify any unclear information and/or complete missing parts of the questionnaire. Completed questionnaires were returned in person or securely posted to the fieldwork provider for data entry. For completion of the questionnaire, each participant received a cash voucher for JPY1,000.

2.5. Measures

Full details on the measures used within this study were published as part of the protocol in 2019 [Adamson et al. 2019]. All measures outlined had been used successfully in the 2018 pilot survey and were deemed appropriate for the first nationwide wave [Adamson et al. 2020].

Intention to quit the use of cigarettes and THPs amongst current users was measured using the contemplation ladder [Biener & Abrams 1991], where 0 indicates no thought of quitting and 10 indicates taking action to quit. Reasons for THP use were assessed using tools available in published literature [Pepper et al. 2014]. The Heaviness of Smoking Index was used to estimate self-reported dependency on nicotine [Rutten et al. 2015]. Changes in tobacco use between the categories never users, current users and former users were compared with self-reported statuses 12 months before the survey.

2.6. Statistical methods and analyses

All analyses were descriptive in nature and were performed using appropriate epidemiological methods. The statistical evaluation was performed by using the software package SAS release 9.4 or higher (SAS Institute Inc., Cary, NC, USA). Raw data were converted by the Clinical Data Interchange Standards Consortium Study Data Tabulation Model and processed into analysis datasets according to CDISC Analysis Data Model specifications, using Implementation Guide final version 1.1 and document final version 2.1 (CDISC, Austin, Texas, USA).

Weightings were applied to adjust for probabilities of selection of a respondent and non-response, with adjustments made according to known characteristics of the population [Adamson et al. 2019].

3. Results

3.1. Population characteristics

From the 40,167 households visited, 5,308 (13%) interviews were completed, and 34,859 (87%) interviews failed. The number of interviews completed includes two booster samples, both of 154 participants, in the 20–24-year and 25–29-year age groups. Two participants with insufficient information to classify current tobacco usage were excluded from the final analysis. Thus, the final analysis included 5,306 respondents, whom 933.5 (17.6%) were current users, 984.2 (18.5%) were former users and 3388.4 (63.9%) were never users of tobacco products. Characteristics of participants are shown in (Tables 2 and 3). The results are presented after weighting and, therefore, numbers of participants are given to one decimal place.

Table 2: Study population characteristics by tobacco use status

Parameter	Total (N=5306.1)	Never user (n=3388.4)	Current user (n=933.5)	Former user (n=984.2)
Gender				
Male	2561.8 (48.3%)	1090.7 (32.2%)	704.9 (75.5%)	766.2 (77.9%)
Female	2744.3 (51.7%)	2297.8 (67.8%)	228.6 (24.5%)	217.9 (22.1%)
Age (years)				
Mean (SE)	53.5 (0.32)	53.4 (0.41)	48.2 (0.58)	58.8 (0.58)
Median	52.9	52.9	46.3	59.4
Min	20	20	20	20
Max	96	96	91	95
Highest level of education				
Junior high school	517.9 (9.8%)	312.4 (9.2%)	103.3 (11.1%)	102.2 (10.4%)
High school	2175.3 (41.0%)	1291.2 (38.1%)	467.1 (50.0%)	417.1 (42.4%)
Professional training college	642.3 (12.1%)	421.4 (12.4%)	106.1 (11.4%)	114.8 (11.7%)
Junior college	441.2 (8.3%)	361.8 (10.7%)	32.9 (3.5%)	46.5 (4.7%)
College, university or graduate course	1379.7 (26.0%)	894.2 (26.4%)	200.9 (21.5%)	284.7 (28.9%)
Prefer not to answer	146.3 (2.8%)	104.0 (3.1%)	23.3 (2.5%)	19.0 (1.9%)
Missing	3.4 (0.1%)	3.4 (0.1%)	0.0 (0.0%)	0.0 (0.0%)

Employment status

Person working in agriculture, forestry, or fisheries	69.1 (1.3%)	42.9 (1.3%)	9.4 (1.0%)	16.8 (1.7%)
Self-employed, family business, or professional	496.1 (9.3%)	249.3 (7.4%)	105.9 (11.3%)	140.9 (14.3%)
Regular employee	1725.8 (32.5%)	920.7 (27.2%)	461.3 (49.4%)	343.8 (34.9%)
Non-regular employee (part-timer)	871.2 (16.4%)	621.8 (18.3%)	141.7 (15.2%)	107.8 (11.0%)
Unemployed	329.5 (6.2%)	192.9 (5.7%)	49.1 (5.3%)	87.5 (8.9%)
Student	127.8 (2.4%)	112.7 (3.3%)	12.3 (1.3%)	2.8 (0.3%)
Full-time homemaker	809.5 (15.3%)	700.6 (20.7%)	46.9 (5.0%)	62.0 (6.3%)
Pensioner	745.0 (14.0%)	463.3 (13.7%)	73.4 (7.9%)	208.4 (21.2%)
Prefer not to answer	131.6 (2.5%)	83.8 (2.5%)	33.6 (3.6%)	14.1 (1.4%)
Missing	0.5 (0.0%)	0.5 (0.0%)	0.0 (0.0%)	0.0 (0.0%)

Marital status

Never married	894.5 (16.9%)	651.2 (19.2%)	179.6 (19.2%)	63.7 (6.5%)
Married	3749.5 (70.7%)	2294.8 (67.7%)	633.4 (67.9%)	821.3 (83.4%)
Cohabiting	15.7 (0.3%)	5.5 (0.2%)	8.6 (0.9%)	1.6 (0.2%)
Widowed	369.5 (7.0%)	287.6 (8.5%)	25.5 (2.7%)	56.5 (5.7%)
Divorced	189.9 (3.6%)	86.8 (2.6%)	70.0 (7.5%)	33.0 (3.4%)
Prefer not to answer	87.0 (1.6%)	62.6 (1.8%)	16.4 (1.8%)	8.1 (0.8%)
Missing	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)

Annual household income (JPY)

<3 million	1006.8 (19.0%)	666.8 (19.7%)	157.3 (16.9%)	182.6 (18.6%)
3 million to <5 million	1234.1 (23.3%)	715.4 (21.1%)	272.4 (29.2%)	246.2 (25.0%)
5 million to <10 million	1235.1 (23.3%)	725.3 (21.4%)	247.7 (26.5%)	262.1 (26.6%)
≥10 million yen	302.5 (5.7%)	191.7 (5.7%)	51.9 (5.6%)	59.0 (6.0%)
No income	49.5 (0.9%)	34.7 (1.0%)	7.7 (0.8%)	7.1 (0.7%)
Unknown	575.7 (10.8%)	451.4 (13.3%)	66.6 (7.1%)	57.7 (5.9%)
Preferred not to answer	899.8 (17.0%)	600.9 (17.7%)	129.8 (13.9%)	169.1 (17.2%)
Missing	2.6 (0.0%)	2.3 (0.1%)	0.0 (0.0%)	0.4 (0.0%)

Data are n (%) unless otherwise stated. Values are shown after weighting to account for oversampling in the 20–24-year and 25–29-year age groups and, therefore, are given to one decimal place.

Table 3: Study population age characteristics by gender

Age (years)	Total (N=5306.1)	Male (n=2561.8)	Female (n=2744.3)
20–24	306.9 (5.8%)	157.0 (6.1%)	149.9 (5.5%)
25–29	314.8 (5.9%)	161.2 (6.3%)	153.6 (5.6%)
30–39	759.0 (14.3%)	387.9 (15.1%)	371.1 (13.5%)
40–49	960.4 (18.1%)	489.3 (19.1%)	471.1 (17.2%)
50–59	799.9 (15.1%)	402.5 (15.7%)	397.5 (14.5%)
60–69	886.3 (16.7%)	433.7 (16.9%)	452.6 (16.5%)
70–79	879.3 (16.6%)	372.5 (14.5%)	506.8 (18.5%)
≥80	399.6 (7.5%)	157.9 (6.2%)	241.7 (8.8%)

Values are shown after weighting to account for oversampling in the 20–24-year and 25–29-year age groups and, therefore, are given to one decimal place.

3.2. Overall tobacco and nicotine product usage

Of the individuals interviewed, nearly two-thirds had never used tobacco (Table 2). The rates of never use were about twice as high in women as in men (83.7% vs. 42.6%). Never use overall was highest among respondents aged 20–24 years (83.5%). Roughly equal proportions of the remaining third of participants were current and former users. The prevalence of tobacco use was substantially higher among men than women (Table 2).

Cigarettes (manufactured and roll your own) were the most common currently used tobacco and nicotine product (n=775.5, 14.6%) amongst the survey population, followed by THPs (n=283.4, 5.3%) then e-cigarettes (n=83.8, 1.6%) and other tobacco products (n=24.8, 0.5%). Of 933.5 current tobacco users, 602.0 (64.5%) smoked cigarettes exclusively and 113.7 (12.2%) used THPs exclusively. Exclusive use of cigarettes was proportionately higher among women than men (69.1% [158.0] vs. 63.0% [444.0]), as was that of THPs (16.9% [38.5] vs. 10.7% [75.2]). Exclusive THP use was highest in the age groups 25–29 years (17 [21.6%]) and 30–39 years (37 [20.5%]) age groups, however interestingly the prevalence was much lower amongst 20-24-year olds (6.5%, n=2.7). By contrast, solus cigarette use was most common amongst the older age groups, ranging between 69.7% and 87.5% in the four age groups between 50 and 80+ years.

Current dual use of cigarettes and THPs was reported by 118.5 (12.7%) respondents. Dual use was observed more frequently in men than women (98.3 [13.9%] vs. 20.2 [8.8%]) and was most common in the 20–24-year age group than in the other age groups (14.0 [33.2%] vs. 13.4–36.2 [12.0–16.6%] for age groups between 25 and 59 years, 1.9–9.0 [2.2–6.9%] in the age groups between 60–79-years and 0 in the ≥80 age group). When exclusive and dual users were combined, the prevalence of cigarette use was 77.2% (n=720.5) and of THP use was 24.9% (m=232.2). THP poly use with e-cigarettes or other tobacco product was reported by 85.0 (9.1%) current tobacco users.

3.3. Manufactured and 'roll your own' cigarette usage

Current cigarette use in the overall survey population was reported by 775.5 (14.6%) respondents and was markedly higher among men than among women (591.8 [23.1%] vs. 183.7 [6.7%]). 1,102.6 (20.8%) respondents reported former use of cigarettes. Most (711.5 [93.3%]) current cigarette smokers reported daily use whereas only 49.8 (6.5%) respondents reported smoking cigarettes occasionally (average use on 10.2 (0.82 SE) of the past 30 days).

Daily users smoked an average of 15.6 (0.33 SE) cigarettes per day, with number slightly lower for women than men (13.6 [0.53 SE] vs. 16.2 [0.39 SE]). Occasional smokers consumed a mean of 6.1 (0.82 SE) cigarettes on days they smoked.

Among current cigarette smokers, most preferred no added flavour (472.9 [62.0%]), 223.7 (29.3%) preferred menthol and 63.8 (8.4%) preferred other flavours. The most common cigarette tar level was 1–3mg (287.6 [37.7%]), followed by 4–6mg (183.8 [24.1%]), 7–9mg (130.7 [17.1%]) and 10 mg or higher (137.5 [18.0%]). More women than men preferred lower tar levels (1–6 mg; 132.1 [72.3%] vs. 339.2 [58.6%]).

Nicotine dependency scores were available for 711.5 current daily smokers and were mainly medium (360.3 [50.6%]) followed by low (311.1 [43.7%]) then high (38.7 [5.4%]). More men were classified as having a high nicotine dependence level (35.9 [6.6%]) than women (2.7 [1.6%]). Time to first cigarette after waking was 5 min in 198.7 (26.1%) current cigarette smokers and 6–30 min in 329.2 (43.2%).

Over one-fifth of current cigarette smokers (168.5 [22.1%]) had no thought of quitting while over one-quarter (209.9 [27.5%]) reported they would consider quitting someday. Only 74.0 (9.7%) were taking action to quit. Previous quit attempts were reported by 472.3 (61.9%) current smokers, among whom 339.3 (71.8%) had tried more than 12 months previously. When asked about their most recent quitting attempt, most (155.0 [32.8%]) had stopped for 8–29 days, compared with less than 1 day (61.3 [13.0%]), 1–7 days (61.3 [13.0%]) or 1 year or longer (63.0 [13.3%]).

3.4. THP usage

Current THP use in the overall survey population was reported by 283.4 (5.3%) and former use was reported by 53.3 (1.0%). Of brands available in Japan, 590.2 (76.1%) current smokers had heard of iQOS, 449.7 (58.0%) of glo, 401.7 (51.8%) of Ploom TECH and 129.0 (16.6%) of other THPs. Current or former use of iQOS was the most frequent (253.1 [75.2%]), followed by glo (94.1 [27.9%]) and Ploom TECH (85.3 [25.3%]). Daily use followed a similar pattern (iQOS 158.2 [86.6%] followed by glo 42.8 [67.2%] and Ploom TECH 33.6 [53.9%]).

Among all current tobacco product users, 113.7 (12.2%) used THPs exclusively and a further 118.5 (12.7%) reported dual use with cigarettes. Average daily THP consumption was 14.3 (0.7 SE) tobacco sticks for iQOS, 14.5 (1.1 SE) tobacco sticks for glo and 3.6 (0.2 SE) capsules for Ploom TECH. Occasional use in the previous 30 days was reported by 23.1 (12.7%) for iQOS, 20.9 (32.8%) for glo and 28.7 (46.1%) for Ploom TECH, on a mean number of 8.4 (±1.2), 10.3 (±1.1) and 7.9 (±1.2) days, respectively.

Among the 283.4 current THP users, 27.1 (9.6%) respondents reported THP poly-use. Most used two THPs (iQOS and Ploom TECH, 10.1 [3.6%], followed by glo and iQOS, 7.1 [2.5%]). Use of all three THPs was reported by 5.5 (1.9%) respondents.

Menthol was most popular flavour of THP consumable (209.4 [62.2%]), followed by no added flavour (71.6 [21.3%]) and non-menthol flavours (55.7 [16.5%]). Proportionately more women than men preferred menthol (75.6% [n=57.6] vs. 58.3% [n=151.9] of responses).

Among current and former users, the most common reason for using a THP was that "they might be less harmful to me than conventional cigarettes", followed by "they might be less harmful to people around me than conventional cigarettes" and "they produce no ash" (Table 4). The use of THPs as a way to cut back on smoking conventional cigarettes, reduce cravings for cigarettes or quit smoking were cited by small proportions of respondents, (16.7%, 10.3% and 9.9%, respectively; Table 4).

Table 4: Self-reported reasons for use of tobacco heating products amongst current and former users

Reasons	Total (n=336.7)	Male (n=260.6)	Female (n=76.1)
They might be less harmful to me than conventional cigarettes	205.3 (61.0%)	157.7 (60.5%)	47.6 (62.5%)
They might be less harmful to people around me than conventional cigarettes	193.2 (57.4%)	147.0 (56.4%)	46.1 (60.6%)
They produce no ash	176.2 (52.3%)	132.9 (51.0%)	43.2 (56.8%)
THPs don't smell bad	134.2 (39.8%)	105.4 (40.4%)	28.8 (37.8%)
THPs contain no tar	102.6 (30.5%)	80.2 (30.8%)	22.4 (29.4%)
I was curious about THPs	95.7 (28.4%)	80.3 (30.8%)	15.4 (20.2%)
THPs don't bother people who don't use tobacco	84.8 (25.2%)	64.2 (24.6%)	20.6 (27.0%)
I can use them in places where smoking conventional cigarettes isn't allowed	70.4 (20.9%)	58.7 (22.5%)	11.8 (15.4%)
Using a THP feels like smoking a conventional cigarette	57.8 (17.2%)	46.3 (17.8%)	11.5 (15.1%)
THPs can help me cut back on smoking conventional cigarettes	56.3 (16.7%)	48.3 (18.5%)	7.9 (10.4%)
It helps me to cope with stress and to relax	54.0 (16.0%)	35.8 (13.7%)	18.2 (24.0%)
I have a friend or family member who uses THPs	51.6 (15.3%)	30.2 (11.6%)	21.4 (28.1%)
They help me deal with cravings to smoke	34.8 (10.3%)	23.6 (9.1%)	11.2 (14.7%)
THPs can help me quit smoking	33.3 (9.9%)	25.2 (9.7%)	8.1 (10.6%)
THPs are new and innovative products	31.5 (9.4%)	27.7 (10.6%)	3.8 (5.0%)
Out of habit	13.7 (4.1%)	10.7 (4.1%)	3.0 (4.0%)
They deliver a real tobacco taste	11.9 (3.5%)	10.8 (4.2%)	1.1 (1.4%)
Other reason	4.0 (1.2%)	4.0 (1.5%)	0.0 (0.0%)

Values are shown after weighting to account for oversampling in the 20–24-year and 25–29-year age groups and, therefore, are given to one decimal place.

3.5. Changes in tobacco product use

Product use 12 months before the survey was reported by 940.6 respondents (Table 5). Among the 688.1 respondents who reported being exclusive cigarette smokers 12 months previously, 48.4 (7.0%) had initiated the use of a THP at the time of the survey. Of these, 33.8 (4.9%) had changed to dual use and 14.6 (2.1%) had switched completely to THPs. The initiation rates were similar for men and women (35.7 [7.0%] and 12.7 [7.2%], respectively). Among the 97.2 earlier dual users, 6.9 (7.1%) had switched completely to solus THP at the time of the survey.

Table 5: Self-reported changes in tobacco usage behaviour from 12 months before the survey

Tobacco product usage 12 months prior to survey	Tobacco product usage at time of survey				
	Total	Current solus cigarette use	Current solus THP use	Current dual user	Former tobacco products user
Total	940.6 (100.0% / 100.0%)	582.3 (100.0% / 61.9%)	103.5 (100.0% / 11.0%)	115.1 (100.0% / 12.2%)	48.4 (100.0% / 5.1%)
Solus cigarette user 12 months ago	688.1 (73.2% / 100.0%)	569.3 (97.8% / 82.7%)	14.6 (14.1% / 2.1%)	33.8 (29.4% / 4.9%)	36.4 (75.2% / 5.3%)
Solus THP user 12 months ago	91.2 (9.7% / 100.0%)	0.0 (0.0% / 0.0%)	82.0 (79.2% / 89.9%)	0.8 (0.7% / 0.8%)	2.7 (5.5% / 2.9%)
Dual cigarette and THP user 12 months ago	97.2 (10.3% / 100.0%)	10.7 (1.8% / 11.0%)	6.9 (6.7% / 7.1%)	76.0 (66.0% / 78.2%)	3.5 (7.2% / 3.6%)

Values are shown after weighting to account for oversampling in the 20–24-year and 25–29-year age groups and, therefore, are given to one decimal place. Percentages are presented as the % of the column followed by the % of the row. **Some users transitioned to/from behaviours not included within the table.**

Exclusive THP use with no history of smoking 12 months previously was reported by 10.2 respondents, of whom none had switched to exclusive cigarette use and 0.8 had switched to dual cigarette and THP use. No former smokers who switched completely to using THPs had re-initiated cigarette smoking within the previous 12 months. For former tobacco product use overall, 2.9% had reinitiated the use of tobacco in the previous 12 months, with the proportion being higher among women than men (5.7% vs. 2.1%).

Among 939.0 former cigarette smokers with no history of THP use, nine (1.0%) had initiated using THPs in the previous 12 months, and among 3420.7 never tobacco product users, 6.2 (0.2%) reported starting to use THPs.

Quitting of all tobacco products in the previous 12 months was reported by 48.4 (5.1%) of 940.6 respondents (Table 5), with a total of 61.4 (6.5%) having given up cigarettes and 16.9 (1.8%) having quit the use of THPs. Most (39.1 [80.7%]) users who quit all tobacco products had been using only one product (solus cigarette or THP use) 12 months earlier. The quit rates for all tobacco products among women and men were similar (11. 5 [5.2%] vs. 29.7 [4.1%]). No clear trends in tobacco cessation were observed by age.

When looking at exclusive users 12 months before the survey only 36.4 (5.3%) of 688.1 cigarette smokers and 2.7 (2.9%) of 91.2 THP users quit using tobacco products altogether (Table 5).

4. Discussion

Although cigarette smoking in Japan has declined consistently since its peak in the 1970s [Forey et al. 2016], smoking prevalence remains high [Adamson et al. 2020; Japan Tobacco Incorporation 2018]. In 2018, prevalence was estimated to be 17.9%, equating around 18.8 million smokers nationwide [Japan Tobacco Incorporation 2018]. In this national survey, we found that cigarettes were by far the most frequent tobacco product used in the general population, but that THP prevalence was notable at 5.3%. Very small proportions of people used e-cigarettes, which are currently illegal in Japan, or other tobacco products. Thus, Japan can effectively be classed as a two-category tobacco product market. We found minimal uptake of THPs use among respondents with no history of tobacco product use.

The main reasons for THP use in Japan were perceived reduction in harm, both to self and others, compared to conventional cigarettes. Similar observations have been reported in previous studies, which have proposed a link to Japanese cultural values, including cleanliness and respect for others [Adamson et al. 2020; Hair et al 2018]. Interestingly, in contrast to our pilot study 1 year earlier [Adamson et al. 2020], reduction in harm to self was reported more frequently than reduction in harm to others. Remarkably low priorities were given to using THPs as a way to cut back on cigarettes or quit smoking. We noted that the intention to quit was close to the overall and the combined proportions of respondents who had quit the use of cigarettes and all tobacco products in the 12 months prior to the survey.

In general, tobacco product usage did not change dramatically in the 12 months before the wave one survey. The proportion of respondents starting exclusive or dual THP use was lower than in our pilot study [Adamson et al. 2020] but, since the proportion of users quitting THPs was lower than the proportion initiating THP use, the overall prevalence remained at around 5%. Roughly 90% of exclusive THP users 12 months before the survey continued to be so; only one participant switched to dual use and none switching to exclusively smoking. More than three-quarters of dual users continued dual use and switching to exclusive use of cigarettes or THPs was seen in around 7% each. The stability of THP use in the general population over time suggests that THPs are being used as a longer-term full or partial substitution for cigarettes by consumers.

The study has various strengths. A comprehensive approach was applied to estimate product-specific use and to collect data on tobacco and nicotine product consumption nationwide. The large sample size of this study allowed for robust prevalence estimations and subgroup analyses to be conducted, and the selection of participants by a stratified three-stage sampling method allowed for national generalisability of results. When compared with Japanese data from 2018, the overall and gender-stratified prevalence rates were similar and appeared to follow year-on-year trends [Japan Tobacco Incorporation 2018; Japanese Ministry of Health 2018]. Such data will be critical in aiding understanding of population use behaviours over time and is being used to support population modelling of long-term health impacts based on estimated transition rates between product use statuses. The self-administered data collection method was carefully selected to minimize any bias that could arise from social desirability for answers.

Some limitations are also associated with this study. Questionnaires were self-administered and the results might have been subject to recall and/or reporting bias. However, this is a limitation inherent to all survey methods and there was no benefit to participants from answering the questions inaccurately or untruthfully. Previous surveys have shown that self-administered questionnaires adequately capture tobacco use in populations [Molina et al. 2010] and that smokers estimate average daily cigarette consumption fairly accurately [Blank et al. 2016]. The collection of cross-sectional data allowed only assessment of changes of usage behaviour. To assess use trajectories over time, longitudinal studies would be needed.

5. Conclusions

As the prevalence of conventional cigarette use continues to decrease in Japan, that of THP use is seemingly increasing among tobacco product users but remains stable in the general population. The use of other tobacco containing products in Japan appears to be negligible. Thus, most Japanese

tobacco consumers use cigarettes or THPs exclusively or together. However, there is very little uptake of THPs among never tobacco users or of exclusive smoking among THP users, suggesting the gateway effect of THPs is negligible. Overall, the results of this survey suggest that THPs are being accepted as a long-term alternative to cigarette smoking in Japan. This first wave of the study supported the methodology and study instrument, which will continue to be used in the next wave.

References

Adamson J, Kanitscheider C, Prasad K, Camacho OM, Beyerlein E, Bhagavan YK, Proctor C, Murphy J. Protocol for a Japanese nationwide repeated cross-sectional study to assess tobacco and nicotine product use behaviour after market introduction of tobacco heating products (THPs) [version 1; peer review: 1 approved]. F1000 Res 2019;8:739. https://doi.org/10.12688/f1000research.18920.1.

Adamson J, Kanitscheider C, Prasad K, Camacho OM, Bhagavan YK, Proctor C, Murphy J. Results from a 2018 cross-sectional survey in Tokyo, Osaka and Sendai to assess tobacco and nicotine product usage after the introduction of heated tobacco products (HTPs) in Japan. Harm Reduct J 2020;17:32. https://doi.org/10.1186/s12954-020-00374-3.

Biener L, Abrams DB. The contemplation ladder: validation of a measure of readiness to consider smoking cessation. Health Psychol 1991;10:360-365.

Blank MD, Breland AB, Enlow PT, Duncan C, Metzger A, Cobb CO. Measurement of smoking behavior: Comparison of self-reports, returned cigarette butts, and toxicant levels. Exp Clin Psychopharmacol 2016;24:348-355. doi: 10.1037/pha0000083. Epub 2016 Jun 27.

Borland R, Yong H-H, O'Connor RJ, Hyland A, Thompson ME. The reliability and predictive validity of the Heaviness of Smoking Index and its two components: findings from the International Tobacco Control Four Countrystudy. Nicotine Tob Res 2010;12(suppl 1):S45-S50. https://doi.org/10.1093/ntr/ntq038.

Cancer Research UK. Our policy on e-cigarettes. 2020. https://www.cancerresearchuk.org/about-us/we-develop-policy/our-policy-on-preventingcancer/our-policy-on-tobacco-control-and-cancer/our-policy-on-e-cigarettes (accessed 8 Sept 2020).

Eaton D, Jakaj B, Forster M, Nicol J, Mavropoulou E, Scott K, Liu C, McAdam K, Murphy J, Proctor CJ. Assessment of tobacco heating product THP1.0. Part 2: product design, operation and thermophysical characterisation. Regul Toxicol Pharmacol 2018;93:4-13. doi: 10.1016/j.yrtph.2017.09.009.

Forey B, Hamling J, Hamling J, Lee P. International smoking statistics. a collection of worldwide historical data. Sutton: PN Lee Statistics and Computing Ltd, 2016.

Forster M, Fiebelkorn S, Yurteri C, Mariner D, Liu C, Wright C, McAdam K, Murphy J, Proctor C. Assessment of Novel Tobacco Heating Product Thp1.0. Part 3: Comprehensive Chemical Characterisation of Harmful and Potentially Harmful Aerosol Emissions. Regul Toxicol Pharmacol 2018;93:14-33. doi: 10.1016/j.yrtph.2017.10.006.

Gale N, McEwan M, Eldridge A, Fearon IM, Sherwood N, Bowen E, McDermott S, Holmes E, Hedge A, Hossack S, Wakenshaw L, Glew J, Camacho OM, Errington G, McAughey J, Murphy J, Liu C, Proctor CJ. Changes in biomarkers of exposure on switching from a conventional cigarette to tobacco heating products: a randomized, controlled study in healthy Japanese subjects. Nicotine Tob Res 2019;21:1220-1227. doi: 10.1093/ntr/nty104.

Greenhalgh, EM. 18C. Heated tobacco ('heat-not-burn') products. In Scollo, MM and Winstanley, MH (eds). Tobacco in Australia: Facts and issues. Melbourne: Cancer Council Victoria, 2019.

Hair EC, Bennett M, Sheen E, Cantrell J, Briggs J, Fenn Z, Willett JG, Vallone D. Examining perceptions about IQOS heated tobacco product: consumer studies in Japan and Switzerland. Tob Control 2018;27(suppl 1):s70-s73. doi: 10.1136/tobaccocontrol-2018-054322.

Institute of Medicine (IOM). Scientific Standards for Studies on Modified Risk Tobacco Products. Washington, DC: The National Academies Press, 2012.

Japan Tobacco Incorporation. JT's annual survey finds 17.9% of Japanese adults are smokers. 30 July 2018. https://www.jt.com/media/news/2018/pdf/20180730_02.pdf (accessed 17 Nov 2020).

Japanese Ministry of Health, Labour and Welfare. National Health and Nutrition Survey 2016. https://www.nibiohn.go.jp/eiken/kenkounippon21/en/eiyouchousa/kekka_todoufuken_h28.html (accessed 08 Sept 2020).

Mallock N, Böss L, Rurk R, Danziger M, Welsch T, Hahn H, Trieu H-L, Hahn J, Henkler-Stephani F, Hutzler C, Luch A. Levels of selected analytes in the emissions of "heat not burn" tobacco products that are relevent to assess human health risks. Arch Toxiciol 2018;92:2145-2149. doi: 10.1007/s00204-018-2215-y.

Molina AJ, Fernández D, Delgado M, Martín V. Sensitivity and specificity of a self-administered questionnaire of tobacco use; including the Fagerström test. Int J Nurs Stud 2010;47:181-189. doi: 10.1016/j.ijnurstu.2009.05.022.

Pepper JK, Ribisl KM, Emery SL, Brewer NT. Reasons for starting and stopping electronic cigarette use. Int J Environ Res Public Health 2014; 11:10345-10361. doi: 10.3390/ijerph111010345.

Royal College of Physicians. Nicotine without smoke: tobacco harm reduction. RCP policy: public health and health inequality. London: Royal College of Physicians, 2016.

Rutten LJ, Blake KD, Agunwamba AA, Grana RA, Wilson PM, Ebbert JO, Okamoto J, Leischow SJ. Use of e-cigarettes among current smokers: association among reasons for use, quit intentions, and current tobacco use. Nicotine Tob Res 2015;2015:1228-1234. Doi: 10.1093/ntr/ntv003.

Salmon CT, Nichols JS. The next-birthday method of respondent selection. Public Opin Q 1983;47:270-276. https://doi.org/10.1086/268785.

Schaller JP, Keller D, Poget L, Pratte P, Kaelin E, McHugh D, Cudazzo G, Smart D, Tricker AR, Gautier L, Yerly M, Pires RR, Le Bouhellec S, Ghosh D, Hofer I, Garcia E, Vanscheeuwijck P, Maeder S. Evaluation of the Tobacco Heating System 2.2. Part 2: chemical composition, genotoxicity, cytotoxicity, and physical properties of the aerosol. Regul Toxicol Pharmacol 2016;81(suppl 2):S27-S47. doi: 10.1016/j.yrtph.2016.10.001.

Simonavuicius E, McNeill A, Shahab L, Brose L.S. Heat-not-burn tobacco products: a systematic literature review. Tob Control 2019;28:582-594. doi: 10.1136/tobaccocontrol-2018-054419.

Smith MR, Clark B, Luedicke F, Schaller JP, Vanscheeuwijck P, Hoeng J, Peitsch MC. Evaluation of the tobacco heating system 2.2. Part 1: description of the system and the scientific assessment program. RegulToxicol Pharmacol 2016;81(suppl 2):S17-S26. doi: 10.1016/j.yrtph.2016.07.006.