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Voluntary home and car smoke-free rules in Japan: a cross-sectional study in 2015

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ABSTRACT

Objectives Recently, the Tokyo Metropolitan Assembly passed an ordinance prohibiting smoking in private homes and cars if children are present. However, no previous study has investigated existing, voluntary home and car smoke-free rules in Japan. Therefore, we examined prevalence and determinants of comprehensive home and car smoke-free rules.

Design A cross-sectional study.

Setting Internet survey data with adjustments using inverse probability weighting for 'being a respondent in an internet survey'.

Participants 5600 respondents aged 15–69 years in 2015 were analysed to estimate weighted percentages and prevalence ratios (PRs) with 95% CIs of having comprehensive home and car smoke-free rules.

Main outcome measures Respondents who answered 'smoking is never allowed' in their home and car were defined as having home and car smoke-free rules.

Results Overall, 47.0% (95% CI=45.8% to 48.3%) of respondents implemented comprehensive home and car smoke-free rules. People who agreed with 'smoking relieves stress' were less likely to have comprehensive smoke-free rules (PR=0.76, 0.71 to 0.82), especially among ever-users of electronic nicotine delivery systems (PR=0.49, 0.30 to 0.81). Higher education was significantly associated with higher PR for comprehensive smoke-free rules (PR=1.30, 1.19 to 1.41). Living with children was significantly associated with higher PR for smoke-free rules among current smokers than not living with children (PR=2.91, 1.99 to 4.27).

Conclusions In Japan, about 50% of respondents had voluntary smoke-free rules in the home and car. Information on current voluntary smoke-free rules will be useful as baseline information on home and car smoke-free status before enforcement of the 2018 Tokyo home and car smoke-free legislation.

Strengths and limitations of this study

- ► No previous study has investigated home and car smoke-free rules in Japan, although the Tokyo Metropolitan Assembly passed an ordinance to prohibit smoking in private homes and cars if children are present.
- ► Although an internet-based study has limitations in terms of generalisability, we were able to adjust the data to approximate a nationally representative estimate using inverse probability weighting.
- ► Our finding that attitudes towards smoking and electronic device use status are related to home and car smoke-free rules provides a novel viewpoint.
- ► One limitation of our study is that its cross-sectional nature limits our conclusions to associations (not causality) between variables and smoke-free rules.
- ► Another potential limitation is the use of data that were self-reported without validation testing.

INTRODUCTION

Secondhand smoke (SHS) is one of the most prevalent and preventable risk factors for many health outcomes in non-smoking adults and children.[1] Worldwide, approximately 35% of non-smokers are exposed to SHS and 603 000 deaths are attributable to SHS annually.[2] Smoke-free policies are therefore a key driver behind reducing risk of SHS exposure, particularly among non-smokers.[3] Previous studies have suggested that complete indoor smoking bans decrease the risk of SHS-related diseases such as acute coronary syndrome and childhood asthma.[4 5] At least 55 countries, comprising almost 1.5 billion people—20% of the world's population, have comprehensive smoke-free legislation.[3] However, this legislation does not determine smoke-free rules for private spaces such as the home and car, which are considered to be two of the greatest areas of exposure to SHS.[6 7]

Several countries, such as Australia, the UK, South Africa and some jurisdictions in Canada and the USA have enacted laws to ban smoking in cars carrying children.[8–10] This was possible because the space in a car can legally be considered as semi-public space (this same legal consideration enabled the prohibition of mobile phone use while driving) and previous studies had highlighted the considerable health benefits of smoke-free rules, especially for children.[11–15]

A recent review paper reported that the majority of studies showed significant increases in voluntary home smoking restrictions after the enactment of legislative bans

Table 1 Proportion and PRs of home and car smoke-free rules among total subjects

	N	n	% (95% CI)	PR* (95% CI)
Total	5600	2635	47.0 (45.8 to 48.3)	
Sex				
Male	2861	1318	46.1 (44.3 to 47.8)	1 (reference)
Female	2762	1327	48.1 (46.3 to 49.8)	**0.82 (0.76 to 0.89)**
Age group				
15–29	1338	581	43.5 (40.9 to 45.9)	1 (reference)
30–49	2145	1003	46.8 (44.8 to 48.8)	1.04 (0.92 to 1.17)
50–69	2141	1060	49.5 (47.5 to 51.6)	1.06 (0.93 to 1.22)
Marital status				
Married	3722	1854	49.8 (48.3 to 51.4)	1 (reference)
Never married	1590	654	41.2 (38.9 to 43.5)	**0.85 (0.75 to 0.96)**
Widowed or divorced	311	136	43.9 (38.7 to 49.1)	0.98 (0.83 to 1.16)
Education				
High school	3131	1316	42.0 (40.4 to 43.7)	1 (reference)
Technical or junior college	1135	568	50.1 (47.3 to 52.8)	**1.16 (1.06 to 1.28)**
University	1356	761	56.1 (53.6 to 58.6)	**1.30 (1.19 to 1.41)**
Home-ownership				
No	1331	604	45.4 (42.9 to 48.0)	1 (reference)
Yes	4292	2041	47.6 (46.1 to 49.0)	1.00 (0.92 to 1.09)
Self-rated health				
Good	5041	2381	47.2 (45.9 to 48.5)	1 (reference)
Bad	582	264	45.4 (41.6 to 49.3)	0.94 (0.83 to 1.06)
Children (<12 years)				
Without	4304	1979	46.0 (44.6 to 47.4)	1 (reference)
With	1319	666	50.5 (47.9 to 53.0)	**1.12 (1.02 to 1.24)**
Workplace smoke-free rules				
No	3181	1426	44.8 (43.2 to 46.5)	1 (reference)
Yes	2442	1220	49.9 (48.1 to 51.8)	1.03 (0.96 to 1.11)
'Difficult to smoke in a place where other people do not smoke'				
No	867	402	46.4 (43.2 to 49.5)	1 (reference)
Yes	4755	2243	47.2 (45.8 to 48.5)	1.10 (0.99 to 1.22)
'Smoking relieves stress'				
No	1910	1202	62.9 (60.9 to 65.0)	1 (reference)
Yes	3713	1443	38.9 (37.4 to 40.4)	**0.76 (0.71 to 0.82)**
'In general, what is sold to the public is safe'				
No	4430	2298	51.9 (50.5 to 53.3)	1 (reference)
Yes	1192	347	29.1 (26.7 to 31.6)	**0.77 (0.69 to 0.86)**
Smoking status				
Never	3085	1739	56.4 (54.7 to 58.0)	1 (reference)
Former	1232	719	58.4 (55.7 to 61.0)	0.99 (0.91 to 1.08)
Current	1306	187	14.3 (12.5 to 16.1)	**0.27 (0.24 to 0.32)**
E-cigarettes smoking status				
Never	5195	2550	49.1 (47.8 to 50.4)	1 (reference)
Ever	428	95	22.2 (18.5 to 25.9)	**0.72 (0.59 to 0.88)**

*Adjusted for all variables. Boldface indicates statistical significance of P <0.05.
N, total number; n, number of people who have home and car smoke-free rules; PR, prevalence ratio.

in public places[16] Although there is no comprehensive nationwide smoke-free legislation in Japan, even for public spaces, the Tokyo Metropolitan Assembly recently passed an ordinance prohibiting smoking, including electronic nicotine delivery systems, in private homes and cars if children are present.[17 18] While the ordinance will not carry penalties for violators, it will work as an incentive and could influence behaviour, even in private spaces such as the home; Tokyo is one of the largest and the most influential cities in the world. To the best of our knowledge, this is the first ordinance in the world to curtail smoking at home, and we, therefore, need to assess the impact of the ordinance in the future. However, to date, no study has investigated home and car smoke-free rules in Japan or the cities of Japan. Therefore, our objective in this study was to examine the prevalence and determinants of such rules. Although this study did not evaluate the Tokyo ordinance, the obtained estimates will be useful as baseline information before enforcement of the 2018 Tokyo home and car smoke-free legislation.

METHODS

Internet survey

The survey was conducted between 31 January and 17 February 2015 in Japan and data were collected on the first 9000 respondents (actually 9055); that is, 500 people aged 15–19 years and 800 people aged 20–29, 30–39, 40–49, 50–59 and 60–69 years for both sexes. Respondents were selected from a large survey panel recruited and managed by a major nationwide internet research agency, Rakuten Research, and invited to participate in our survey. At the time of our survey the overall survey panel comprised 2 278 733 people, of whom 53.9% were male, recruited from the entire Japanese population. Panel members represented all social categories, such as education, housing tenure and marital status, as defined by the Census in Japan. All participants gave informed consent. Details have been given in a previous report.[19]

Measures

Home and car smoke-free rules

Respondents were asked about smoking rules in their home, using the question: 'Please choose the option closest to your current smoking rules in your home'. The response options were 'never allowed', 'always allowed', 'allowed only in some places/times', 'do not have a home (eg, nursing home residents)' and 'no opinion'. We classified respondents who chose 'never allowed' as having home smoke-free rules. Respondents who did not have a home (n=369) or an opinion (n=765) were excluded from the analysis for home smoke-free rules.

Respondents were also asked about smoking rules in their cars, using the question: 'Please choose the option closest to your current smoking rules in your car'. The response options were 'never allowed', 'always allowed', 'allowed sometimes', 'do not have a car' and 'no opinion'. We classified respondents who chose 'never allowed' as having a car smoke-free rules. Respondents who did not have a car (n=1647) or an opinion (n=599) were excluded from the analysis for car smoke-free rules.

We classified respondents who chose 'never allowed' for both home and car rules as having comprehensive home and car smoke-free rules. Respondents who had neither a home nor a car (n=1684) or who did not have opinions for home or car rules (n=956) were excluded from the analysis for home and car smoke-free rules. Furthermore, we excluded respondents showing discrepancies and/or artificial/unnatural responses in the analyses. For example, if a respondent chose the same answer number throughout a set of questions, it was deemed to indicate a discrepancy. Further details of discrepancy identification are also shown in previous reports.[19 20] After excluding respondents with a discrepancy, we analysed 7106 subjects (weighted number=7165), for smoke-free home rules, 5994 subjects (weighted number=6652) for smoke-free car rules and 5600 subjects (weighted number=6240) for both rules.

Characteristics of respondents

Characteristics included: sex, age, marital status (married, never married, widowed and divorced), education (less than high-school and high school, technical or junior college, university [4 years] and graduate college), housing tenure (home-owner or not), self-rated health, living with children (under 12 years) (yes or no), workplace smoke-free rules (yes or no), home smoke-free rules (yes or no), car smoke-free rules (yes or no), smoking status and e-cigarette smoking status and attitudes towards smoking in terms of the following three issues (yes or no): (1) agree with 'it is difficult to smoke in a space where other people do not smoke', (2) agree with 'smoking relieves stress' and (3) agree with 'in general, what is sold to the public is safe'.

Smoking status

Respondents were asked about combustible cigarette smoking status, using the question: 'Please choose your current status for tailor-made and roll-your-own cigarettes separately'. The response options were 'never user', 'former non-regular user', 'former regular user' and 'current user'. Respondents who currently smoked combustible cigarettes (tailor-made and roll-your-own cigarettes) were considered 'current smokers'. Those who reported former use and did not currently smoke either type of cigarette were considered 'former smokers'. Those who had never smoked were considered 'never smokers'.

Electronic devices use status

Respondents were asked about their use of each of the following products: nicotine e-cigarettes, non-nicotine e-cigarettes, e-cigarettes with unknown nicotine content, Ploom and IQOS, using the question: 'Please choose your current status for each product', and the response options were 'never user', 'former non-regular user', 'former regular user' and 'current user'. The latter three

Table 2 Proportion and PRs of home and car smoke-free rules according to tobacco use status

	Never smoker				Former smoker				Current smoker				E-cigarette ever smoker			
	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)
Sex																
Male	1085	667	61.5 (58.7 to 64.2)	1 (reference)	752	480	63.9 (60.6 to 67.1)	1 (reference)	1013	165	16.3 (14.2 to 18.5)	1 (reference)	304	75	24.6 (20.0 to 29.2)	1 (reference)
Female	1988	1065	53.6 (51.5 to 55.7)	**0.84 (0.76 to 0.93)**	476	236	49.6 (45.4 to 53.9)	**0.83 (0.70 to 0.98)**	287	21	7.3 (4.5 to 10.1)	**0.47 (0.30 to 0.74)**	123	20	16.1 (10.0 to 22.3)	**0.58 (0.35 to 0.97)**
Age group																
15–29	932	478	51.2 (48.2 to 54.3)	1 (reference)	188	71	37.6 (31.1 to 44.2)	1 (reference)	212	31	14.4 (9.9 to 18.9)	1 (reference)	139	23	16.6 (10.8 to 22.5)	1 (reference)
30–49	1070	636	59.4 (56.6 to 62.2)	1.01 (0.87 to 1.16)	449	267	59.5 (55.2 to 63.8)	1.24 (0.95 to 1.61)	617	96	15.6 (12.9 to 18.3)	0.87 (0.56 to 1.35)	189	38	19.9 (14.5 to 25.3)	1.43 (0.78 to 2.62)
50–69	1071	619	57.8 (55.0 to 60.6)	1.03 (0.87 to 1.21)	590	378	64.1 (60.4 to 67.7)	1.13 (0.84 to 1.53)	471	59	12.6 (9.8 to 15.5)	1.26 (0.75 to 2.13)	99	34	34.3 (25.5 to 43.2)	**2.28 (1.14 to 4.55)**
Marital status																
Married	1858	1110	59.7 (57.6 to 61.8)	1 (reference)	961	597	62.1 (59.2 to 65.0)	1 (reference)	888	140	15.8 (13.5 to 18.1)	1 (reference)	246	56	22.9 (17.9 to 27.9)	1 (reference)
Never married	1050	530	50.5 (47.6 to 53.4)	**0.85 (0.74 to 0.99)**	201	83	41.4 (34.9 to 47.8)	**0.71 (0.55 to 0.93)**	332	38	11.4 (8.2 to 14.7)	1.10 (0.69 to 1.75)	145	27	18.7 (12.7 to 24.7)	1.03 (0.55 to 1.93)
Widowed or divorced	164	92	55.8 (48.6 to 63.0)	1.03 (0.84 to 1.26)	65	36	55.6 (44.1 to 67.1)	0.92 (0.67 to 1.27)	81	8	10.2 (4.0 to 16.5)	1.03 (0.52 to 2.04)	36	11	31.2 (16.9 to 45.5)	1.11 (0.57 to 2.19)
Education																
High school	1736	880	50.7 (48.5 to 52.9)	1 (reference)	675	354	52.5 (48.9 to 56.0)	1 (reference)	707	77	10.9 (8.7 to 13.0)	1 (reference)	261	60	23.1 (18.3 to 28.0)	1 (reference)
Technical or junior college	667	393	58.9 (55.4 to 62.5)	**1.16 (1.03 to 1.30)**	235	139	59.1 (53.2 to 65.1)	1.03 (0.87 to 1.23)	228	34	14.8 (10.5 to 19.2)	1.29 (0.87 to 1.92)	84	12	14.6 (7.5 to 21.8)	0.80 (0.43 to 1.49)
University	670	459	68.6 (65.2 to 71.9)	**1.30 (1.17 to 1.46)**	317	223	70.4 (65.6 to 75.1)	1.08 (0.93 to 1.25)	364	76	20.8 (16.9 to 24.8)	**1.70 (1.24 to 2.34)**	82	22	27.0 (17.8 to 36.1)	1.05 (0.65 to 1.71)
Home-ownership																
No	691	380	55.0 (51.5 to 58.5)	1 (reference)	272	164	60.4 (54.9 to 65.9)	1 (reference)	363	58	15.9 (12.3 to 19.5)	1 (reference)	141	30	21.4 (15.0 to 27.8)	1 (reference)
Yes	2382	1352	56.8 (54.9 to 58.6)	1.05 (0.94 to 1.18)	955	552	57.8 (54.8 to 60.7)	0.90 (0.76 to 1.07)	937	129	13.7 (11.7 to 15.8)	0.80 (0.59 to 1.09)	285	64	22.6 (18.0 to 27.2)	0.96 (0.62 to 1.47)
Self-rated health																
Good	2748	1557	56.7 (54.9 to 58.4)	1 (reference)	1083	638	58.9 (56.1 to 61.7)	1 (reference)	1190	177	14.9 (12.9 to 16.8)	1 (reference)	381	85	22.3 (18.3 to 26.2)	1 (reference)
Bad	325	175	54.0 (48.9 to 59.1)	0.99 (0.85 to 1.15)	144	78	54.2 (46.5 to 81.9)	1.04 (0.85 to 1.26)	111	10	8.7 (3.8 to 13.7)	0.66 (0.35 to 1.23)	46	10	21.5 (10.2 to 32.7)	0.74 (0.37 to 1.47)
Children (<12 years)																
Without	2414	1329	55.1 (53.2 to 56.9)	1 (reference)	911	543	59.7 (56.7 to 62.7)	1 (reference)	962	99	10.3 (8.5 to 12.1)	1 (reference)	290	66	22.9 (18.3 to 27.5)	1 (reference)
With	659	403	61.2 (57.6 to 64.7)	1.10 (0.97 to 1.24)	316	172	54.5 (49.3 to 59.7)	0.86 (0.68 to 1.08)	339	88	25.9 (21.4 to 30.3)	**2.91 (1.99 to 4.27)**	136	28	20.7 (14.2 to 27.1)	1.08 (0.65 to 1.79)
Workplace smoke-free rules																
No	1634	894	54.7 (52.4 to 57.0)	1 (reference)	730	409	56.1 (52.7 to 59.5)	1 (reference)	804	117	14.5 (12.2 to 16.8)	1 (reference)	251	53	21.0 (16.2 to 25.7)	1 (reference)
Yes	1439	838	58.3 (55.9 to 60.7)	1.04 (0.95 to 1.14)	497	307	61.6 (57.6 to 65.7)	1.05 (0.91 to 1.21)	496	70	14.0 (11.2 to 16.9)	0.83 (0.63 to 1.11)	176	42	23.9 (18.0 to 29.9)	1.07 (0.72 to 1.59)
'Difficult to smoke in a place where other people do not smoke'																
No	494	269	54.5 (50.3 to 58.6)	1 (reference)	184	110	59.7 (52.9 to 66.4)	1 (reference)	186	21	11.5 (7.1 to 15.8)	1 (reference)	51	14	26.9 (15.4 to 38.4)	1 (reference)
Yes	2579	1463	53.7 (54.9 to 58.5)	1.12 (0.99 to 1.27)	1043	606	58.1 (55.3 to 61.0)	0.99 (0.81 to 1.20)	1115	165	14.8 (12.8 to 16.8)	1.30 (0.83 to 2.02)	375	81	21.5 (17.6 to 25.5)	1.06 (0.58 to 1.95)
'Smoking relieves stress'																
No	1374	900	65.6 (63.2 to 67.9)	1 (reference)	373	255	68.3 (63.8 to 72.8)	1 (reference)	156	42	27.0 (20.4 to 33.6)	1 (reference)	62	22	36.3 (24.9 to 47.6)	1 (reference)
Yes	1699	832	48.9 (46.7 to 51.2)	**0.76 (0.70 to 0.84)**	854	461	54.0 (50.9 to 57.2)	**0.84 (0.72 to 0.97)**	1144	144	12.6 (10.8 to 14.4)	**0.64 (0.45 to 0.91)**	365	72	19.8 (15.9 to 23.7)	**0.49 (0.30 to 0.81)**
'In general, what is sold to the public is safe'																
No	2609	1538	59.0 (57.2 to 60.8)	1 (reference)	1004	613	61.1 (58.2 to 63.9)	1 (reference)	799	137	17.2 (14.7 to 19.7)	1 (reference)	272	67	24.6 (19.7 to 29.4)	1 (reference)
Yes	464	194	41.8 (37.5 to 46.0)	**0.76 (0.66 to 0.88)**	223	103	46.2 (40.0 to 52.4)	0.90 (0.73 to 1.10)	501	49	9.8 (7.4 to 12.3)	**0.59 (0.43 to 0.81)**	154	28	18.0 (12.2 to 23.7)	0.86 (0.55 to 1.35)
Smoking status																
Never													80	24	30.3 (20.7 to 39.8)	1 (reference)

Continued

Table 2 Continued

	Never smoker				Former smoker				Current smoker				E-cigarette ever smoker			
	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)
Former													105	29	27.5 (19.4 to 35.6)	1.14 (0.66 to 1.97)
Current													241	41	17.2 (12.7 to 21.7)	0.60 (0.36 to 1.01)
E-cigarettes smoking status																
Never	2993	1708	57.1 (55.4 to 58.8)	1 (reference)	1122	687	61.2 (58.5 to 63.9)	1 (reference)	1059	145	13.7 (11.7 to 15.7)	1 (reference)				
Ever	80	24	30.3 (20.7 to 39.8)	**0.57 (0.39 to 0.84)**	105	29	27.5 (19.4 to 35.6)	**0.53 (0.37 to 0.76)**	241	41	17.2 (12.7 to 21.7)	1.21 (0.86 to 1.71)				

*Adjusted for all variables. Boldface indicates statistical significance of P <0.05.
N, total number; n, number of people who have home and car smoke-free rules; PR, prevalence ratio.

responses were combined and defined as 'ever user' of electronic devices. Those who had never smoked any of the above five products were considered as 'never user' of electronic devices.

Statistical analyses

Internet surveys are not necessarily representative of the real world because they are not based on completely random sampling. However, previous studies have suggested that estimates adjusted using inverse probability weighting (IPW) obtained from a propensity score (calculated by logistic regression models using basic demographic and socioeconomic factors such as education and housing tenure) from an internet-based convenience sample provide similar estimates of parameters, or at least reduced the differences compared with probability sample based estimates.[19 21 22] We therefore present IPW-adjusted estimates rather than simple internet survey estimates as the main results of this study. To correct for the selectivity of internet-based samples, we used a nationally representative probability sample from the Japanese Comprehensive Survey of Living Conditions of People on Health and Welfare (CSLCPHW).[23] Data from two surveys (internet survey and CSLCPHW) were pooled (combined) and used for a logistic regression model with all the covariates mentioned above to estimate the probability of 'being a respondent in an internet survey', that is, propensity score. Detailed methods are available from our previous report.[19]

We present weighted percentages and prevalence ratios (PRs) for having home and car smoke-free rules (main outcome), home smoke-free rules and car smoke-free rules (online supplementary outcomes) among all respondents according to characteristics such as sex, age group and smoking status. Because the outcomes were not rare, we used log-binomial regression models to calculate the PRs for smoke-free rules, but the models did not converge. Therefore, we used log-Poisson models, which provide consistent but not fully efficient estimates of the PRs (ie, the CIs are slightly wider).[24 25] Percentages are shown with 95% CIs calculated by Wald and exact methods.

Probability values for statistical tests were two-tailed; p<0.05 was considered statistically significant. All analyses were performed using SAS V.9.3 (SAS Institute).

Patients and public involvement

Patients and public were not involved in the study.

RESULTS

Overall, 47.0% (95% CI=45.8% to 48.3%) of respondents implemented comprehensive home and car smoke-free rules (table 1). The prevalence of smoke-free rules by smoking status was highest among former smokers (58.4%), followed by never smokers (56.4%), then current smokers (14.3%). We found that 49.1% of e-cigarette ever users had smoke-free rules. Whereas, 55.1%

Table 3 Proportion and PRs of home and car smoke-free rules according to sex or living with/without children

	Male				Female				With children (<12 years)				Without children (<12 years)			
	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)
Sex																
Male									664	354	53.2 (49.6 to 56.8)	1 (reference)	2185	959	43.9 (41.9 to 45.9)	1 (reference)
Female									650	310	47.6 (44.0 to 51.3)	**0.86 (0.78 to 0.94)**	2101	1012	48.2 (46.2 to 50.2)	**0.73 (0.62 to 0.85)**
Age group																
15–29	647	277	42.9 (39.3 to 46.5)	1 (reference)	686	302	44.0 (40.5 to 47.5)	1 (reference)	287	125	43.4 (38.0 to 48.8)	1 (reference)	1045	454	43.5 (40.6 to 46.3)	1 (reference)
30–49	1091	510	46.8 (44.0 to 49.6)	1.07 (0.91 to 1.27)	1045	489	46.8 (43.9 to 49.7)	1.00 (0.85 to 1.17)	900	496	55.1 (52.1 to 58.2)	0.98 (0.85 to 1.13)	1236	503	40.7 (38.1 to 43.3)	1.09 (0.87 to 1.36)
50–69	1113	525	47.2 (44.4 to 50.0)	1.05 (0.86 to 1.28)	1019	531	52.1 (49.2 to 55.0)	0.89 (0.56 to 1.30)	126	42	33.2 (25.5 to 41.0)	1.10 (0.94 to 1.29)	2006	1014	50.6 (48.5 to 52.6)	0.71 (0.50 to 1.01)
Marital status																
Married	1914	943	49.3 (47.1 to 51.4)	1 (reference)	1793	904	50.4 (48.2 to 52.6)	1 (reference)	1171	610	52.1 (49.4 to 54.8)	1 (reference)	2535	1237	48.8 (46.9 to 50.6)	1 (reference)
Never married	846	335	39.6 (36.4 to 42.7)	**0.82 (0.69 to 0.97)**	737	317	43.0 (39.6 to 46.4)	0.87 (0.74 to 1.04)	105	39	37.2 (28.4 to 46.0)	0.91 (0.80 to 1.04)	1479	613	41.4 (39.1 to 43.8)	**0.69 (0.48 to 0.99)**
Widowed or divorced	89	35	39.1 (29.6 to 48.7)	0.97 (0.70 to 1.33)	220	101	45.8 (39.6 to 52.1)	0.99 (0.81 to 1.21)	38	14	36.7 (22.1 to 51.2)	1.03 (0.86 to 1.23)	272	122	44.9 (39.3 to 50.5)	0.83 (0.50 to 1.38)
Education																
High school	1538	647	42.1 (39.7 to 44.4)	1 (reference)	1581	664	42.0 (39.7 to 44.3)	1 (reference)	692	274	39.6 (36.1 to 43.0)	1 (reference)	2426	1037	42.7 (40.9 to 44.6)	1 (reference)
Technical or junior college	378	156	41.3 (36.6 to 46.0)	1.06 (0.89 to 1.25)	753	410	54.5 (51.1 to 57.8)	**1.21 (1.08 to 1.37)**	302	172	56.8 (51.6 to 62.1)	1.10 (0.99 to 1.24)	829	394	47.6 (44.4 to 50.8)	**1.30 (1.07 to 1.57)**
University	934	510	54.6 (51.6 to 57.6)	**1.24 (1.11 to 1.39)**	417	248	59.4 (55.0 to 63.9)	**1.35 (1.17 to 1.55)**	320	217	68.0 (63.2 to 72.9)	**1.24 (1.12 to 1.38)**	1031	540	52.4 (49.5 to 55.3)	**1.40 (1.16 to 1.68)**
Home-ownership																
No	686	318	46.4 (42.8 to 49.9)	1 (reference)	640	284	44.4 (40.7 to 48.0)	1 (reference)	370	173	46.8 (42.0 to 51.6)	1 (reference)	955	429	44.9 (41.9 to 47.9)	1 (reference)
Yes	2164	995	46.0 (44.0 to 48.0)	0.96 (0.85 to 1.08)	2111	1038	49.2 (47.2 to 51.2)	1.03 (0.90 to 1.17)	943	490	51.9 (48.9 to 54.9)	0.96 (0.86 to 1.07)	3331	1543	46.3 (44.7 to 47.9)	1.05 (0.89 to 1.24)
Self-rated health																
Good	2590	1205	46.5 (44.7 to 48.4)	1 (reference)	2431	1166	48.0 (46.1 to 49.9)	1 (reference)	1237	632	51.1 (48.4 to 53.7)	1 (reference)	3784	1740	46.0 (44.5 to 47.5)	1 (reference)
Bad	260	107	41.3 (35.6 to 47.0)	**0.81 (0.67 to 0.98)**	319	156	48.8 (43.6 to 54.0)	1.06 (0.90 to 1.24)	77	31	40.6 (30.2 to 50.9)	0.92 (0.81 to 1.05)	502	232	46.2 (42.0 to 50.3)	1.00 (0.70 to 1.42)
Children (<12 years)																
Without	2185	959	43.9 (41.9 to 45.9)	1 (reference)	2101	1012	48.2 (46.2 to 50.2)	1 (reference)								
With	664	354	53.2 (49.6 to 56.8)	**1.20 (1.04 to 1.38)**	650	310	47.6 (44.0 to 51.3)	1.05 (0.91 to 1.21)								
Workplace smoke-free rules																
No	1145	666	43.0 (40.6 to 45.3)	1 (reference)	1619	754	46.6 (44.3 to 48.9)	1 (reference)	728	354	48.6 (45.1 to 52.0)	1 (reference)	2440	1066	43.7 (41.8 to 45.6)	1 (reference)
Yes	1301	647	49.7 (47.2 to 52.3)	1.01 (0.91 to 1.12)	1131	568	50.2 (47.4 to 52.9)	1.05 (0.95 to 1.17)	586	309	52.8 (49.0 to 56.7)	1.04 (0.95 to 1.13)	1846	905	49.0 (46.9 to 51.2)	1.01 (0.87 to 1.17)
'Difficult to smoke in a place where other people do not smoke'																
No	485	222	45.8 (41.6 to 50.0)	1 (reference)	379	179	47.1 (42.3 to 51.8)	1 (reference)	188	99	52.9 (46.1 to 59.6)	1 (reference)	676	301	44.5 (41.0 to 48.1)	1 (reference)
Yes	2365	1091	46.1 (44.2 to 48.0)	1.12 (0.97 to 1.29)	2371	1143	48.2 (46.3 to 50.1)	1.08 (0.92 to 1.25)	1126	564	50.1 (47.3 to 52.8)	1.11 (0.98 to 1.25)	3610	1670	46.3 (44.7 to 47.8)	1.06 (0.87 to 1.31)
'Smoking relieves stress'																
No	851	568	66.7 (63.7 to 69.7)	1 (reference)	1051	629	59.9 (57.1 to 62.7)	1 (reference)	376	244	64.8 (60.2 to 69.4)	1 (reference)	1527	954	62.5 (60.2 to 64.8)	1 (reference)
Yes	1998	745	37.3 (35.3 to 39.3)	**0.73 (0.65 to 0.81)**	1699	693	40.8 (38.6 to 43.0)	**0.79 (0.71 to 0.88)**	938	419	44.7 (41.7 to 47.7)	**0.77 (0.71 to 0.85)**	2760	1018	36.9 (35.2 to 38.6)	**0.79 (0.67 to 0.92)**
'In general, what is sold to the public is safe'																
No	2109	1095	51.9 (49.9 to 53.9)	1 (reference)	2304	1194	51.8 (49.9 to 53.8)	1 (reference)	1013	541	53.4 (50.5 to 56.3)	1 (reference)	3399	1748	51.4 (49.8 to 53.0)	1 (reference)
Yes	741	218	29.4 (26.3 to 32.5)	**0.81 (0.70 to 0.94)**	447	128	28.7 (24.7 to 32.6)	**0.71 (0.60 to 0.85)**	301	122	40.6 (35.3 to 45.9)	**0.69 (0.60 to 0.79)**	887	224	25.2 (22.5 to 27.9)	0.99 (0.81 to 1.20)
Smoking status																
Never	1085	667	61.5 (58.7 to 64.2)	1 (reference)	1988	1065	53.6 (51.5 to 55.7)	1 (reference)	659	403	61.2 (57.6 to 64.7)	1 (reference)	2414	1329	55.1 (53.2 to 56.9)	1 (reference)

Continued

Table 3 Continued

	Male				Female				With children (<12 years)				Without children (<12 years)			
	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)	N	n	% (95% CI)	PR* (95% CI)
Former	752	480	63.9 (60.6 to 67.1)	1.01 (0.90 to 1.14)	476	236	49.6 (45.4 to 53.9)	1.01 (0.88 to 1.16)	316	172	54.5 (49.3 to 59.7)	1.05 (0.94 to 1.16)	911	543	59.7 (56.7 to 62.7)	0.88 (0.74 to 1.05)
Current	1013	165	16.3 (14.2 to 18.5)	**0.30 (0.25 to 0.35)**	287	21	7.3 (4.5 to 10.1)	**0.17 (0.12 to 0.26)**	339	88	25.9 (21.4 to 30.3)	**0.21 (0.17 to 0.26)**	962	99	10.3 (8.5 to 12.1)	**0.41 (0.33 to 0.52)**
E-cigarettes smoking status																
Never	2546	1238	48.6 (46.8 to 50.5)	1 (reference)	2628	1302	49.6 (47.7 to 51.4)	1 (reference)	1178	635	53.9 (51.2 to 56.6)	1 (reference)	3996	1905	47.7 (46.2 to 49.1)	1 (reference)
Ever	304	75	24.6 (20.0 to 29.2)	0.96 (0.85 to 1.08)	123	20	16.1 (10.0 to 22.3)	1.03 (0.90 to 1.17)	136	28	10.7 (14.2 to 27.1)	0.96 (0.86 to 1.07)	290	66	22.9 (18.3 to 27.5)	1.05 (0.89 to 1.24)

*Adjusted for all variables. Boldface indicates statistical significance of P <0.05.
N, total number; n, number of people who have home and car smoke-free rules; PR, prevalence ratio.

(95% CI=53.9% to 56.2%) of respondents had home smoke-free rules, and 62.4% (95% CI=61.2% to 63.5%) of respondents had car smoke-free rules (online supplementary table S1).

Table 1 shows PRs of home and car smoke-free rules among total subjects. Respondents who were 'female', 'never married', agreed with 'smoking relieves stress', agreed with 'in general, what is sold to the public is safe', 'current smokers' and 'electronic device ever user' had significantly lower PRs of comprehensive home and car smoke-free rules than the reference category. Respondents who had 'higher education' and were living with children had significantly higher PRs of comprehensive home and car smoke-free rules than the reference category. Online supplementary table S1 also shows PRs of home or car smoke-free rules among total subjects.

Results stratified by tobacco use status (never, former and current smoker, and e-cigarette ever user) are shown in table 2 and by sex or living with children (male, female and living with or without children) in table 3. Among all tobacco users, people who agreed with 'smoking relieves stress' had significantly lower PRs for comprehensive home and car smoke-free rules. Higher education attainments were significantly associated with higher PRs for smoke-free rules except for former smokers and electronic device ever-users. Differences across tobacco user status were observed in some characteristics. Living with children was significantly associated with a higher PR for smoke-free rules than not living with children, among current smokers. Ever-users of electronic devices had significantly lower PRs than non-users, for home and car smoke-free rules among never and former smokers. Online supplementary tables S2 and S3 for home smoke-free rules also show results stratified by tobacco use status and sex or living with children, respectively. Online supplementary tables S4 and S5 for car smoke-free rules show results stratified by tobacco use status and sex or living with children, respectively.

DISCUSSION

To the best of our knowledge, this is the first study to examine the prevalence and predictors of voluntary home and car smoke-free rules in Japan. Even among non-smokers, coverage of voluntary smoke-free rules (56.4%) is far from complete and much lower than that in the USA (85%).[26] The estimated proportion of households with home and car smoke free rules in Japan (55.1% or 62.4%) was lower than that observed in a previous study in the USA (83.7% or 78.1%),[12] but higher than that in Spain (45.6% or 61.6%).[27] The estimated proportion of current smokers who implemented smoke-free rules in their homes in Japan (23.5%) was lower than in Australia (34.1%), Canada (27.3%) and the USA (26.4%), but higher than in the UK (15.3%).[28] In households with smokers, children in particular suffer from SHS inhalation in homes and cars.[29] In the present study, living with children is significantly associated with

comprehensive home and car smoke-free rules among current smokers. This may suggest that smokers are aware of the harm tobacco caused by tobacco and restrict smoking to protect their children.[30] Previous studies have reported that smokers who know about the harmful effects of SHS were more likely to have smoke-free home or car rules.[13 28 31] Public health campaigns are therefore necessary to heighten the public perception of the harmfulness of exposure to SHS in private spaces and, as a result, increase voluntary adoption of smoke-free home and car rules.[32]

Recently, novel electronic nicotine delivery systems such as heat-not-burn tobacco and e-cigarettes have been introduced to the Japanese market.[20] Use of these products is considered in the present study under the heading 'electronic devices use status'. Our findings suggest that use of electronic devices use might impede the introduction of smoke-free rules at home and in the car (this is the first report to suggest these associations). A previous study that examined the determinants of home and car smoke-free rules among e-cigarette and combustible cigarette users reported the home smoke-free rate among e-cigarette users (82.5%). However, this study did not report the association between e-cigarette use and implementation of smoke-free rules for the home and the car.[12]

The finding that women are less likely to have smoke-free rules concurs with the previous study.[12] Although pregnant women are not covered by the Tokyo home and car smoke-free legislation, protecting them is desirable.

Several attitudes towards smoking were also associated with home and car smoke-free rules. Previous studies have revealed that smokers who did not believe cigarette smoke was dangerous and could cause lung cancer in non-smokers were more likely to smoke at home and in the car with non-smokers.[13 28 31] Further, many people believe 'smoking relieves stress'. This is, however, a false belief,[33] created by the tobacco industry who funded psychological researchers such as Hans Selye.[34] If nicotine-dependent people are deprived of the drug, they are stressed until the moment they smoke a cigarette and satisfy the craving, hence the feeling of relief. We have to educate the public about stress and smoking public. This may lead to better understanding about tobacco products, as well as the implementation of smoke-free rules in homes.

There are several limitations to this study. First, due to the cross-sectional nature of the study, conclusions can only be made about associations (not causality) between variables and smoke-free rules. Second, data were self-reported without validation testing. In some cases, smoke-free rules in homes and cars might be ambiguous, especially if there are no smokers in the family. Our analysis does not include variables on whether smokers are living together, although this variable has often been used in previous studies. Third, the measures for smoking status were not ideal. We did not collect information on whether respondents had smoked more than 100 cigarettes in their lifetime as a cut-off for regular smoker.

CONCLUSION

About 50% of the Japanese population had home and car smoke-free rules, although these private spaces have not been included in the smoke-free legislation. This information will be useful as a baseline on home and car smoke-free status before the enforcement of the 2018 Tokyo home and car smoke-free legislation.

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