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Original Research

Active cigarette smoking, secondhand smoke exposure at work and home, and self-rated health

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SUMMARY

Objectives: Although active smoking has been reported to be associated with poor self-rated health (SRH), its association with secondhand smoke (SHS) is not well understood.
Study design: A cross-sectional study was conducted to examine the association of active smoking and SHS exposure with SRH.
Methods: A total of 2558 workers (1899 men and 689 women), aged 16–83 (mean 45) years, in 296 small and medium-sized enterprises were surveyed by means of a self-administered questionnaire. Smoking status and exposure levels to SHS (no, occasional or regular) among lifetime non-smokers were assessed separately at work and at home. SRH was assessed with the question: How would you describe your health during the past 1-year period (very poor, poor, good, very good)? SRH was dichotomized into suboptimal (poor, very poor) and optimal (good, very good). Odds ratios (ORs) with 95% confidence intervals (CIs) for reporting suboptimal vs optimal SRH according to smoking status and smoke exposure were calculated.
Results: Current heavy smokers (20+ cigarettes/day) had a significantly increased suboptimal SRH than lifetime non-smokers after adjusting for sociodemographic, lifestyle, physical and occupational factors (OR 1.34, 95% CI 1.06–1.69). Similarly, lifetime non-smokers occasionally exposed to SHS at work alone had worse SRH than their unexposed counterparts (OR 1.50, 95% CI 1.02–2.11). In contrast, lifetime non-smokers exposed at home alone had no significant increase in suboptimal SRH.
Conclusions: The present study indicates an increase in suboptimal SRH among current heavy smokers, and suggests that SHS exposure at work is a possible risk factor for non-smokers. Whether or not the association is causal, control of smoking at work may protect workers from developing future health conditions.

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Introduction

Self-rated health (SRH) or self-perceived health has become an increasingly common measure used in population surveys. It is often based on a simple question where people are asked to rate their current overall health, typically on a four- or five-point scale ranging from 'very good (excellent)' to 'very poor'. Despite its simplicity, responses to this question have proven to be a robust predictor of functional disability,[1] mortality,[2–6] morbidity[7] and healthcare use,[7,8] independent of psychosocial, behavioural, environmental or health-related risk factors. SRH has also been indicated to be a stronger predictor of mortality than physician-observed medical records or self-reported medical conditions among the elderly population.[9]

Most studies investigating determinants of suboptimal SRH have found active smoking to be a major or moderate risk factor,[10–17] although there are some studies which could not detect a clear association between smoking and suboptimal SRH.[18,19] In studies that classified smoking status as current smoker, former smoker and lifetime non-smoker, SRH of former smokers was often worse than that of lifetime non-smokers but better than or equal to that of current smokers.[10,13] In several studies, former smokers perceived their health to be worse than that of current smokers, which may be explained by the fact that those who became sick stopped smoking.[16,20]

To date, only a limited number of studies have focused on the relationship between smoking and SRH. In a population survey in

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Taiwan, Ho et al. found that healthy male current and former smokers aged 60–74 years were twice as likely to report suboptimal SRH than lifetime non-smokers, while such an increase was not apparent in men aged 25–39 or 40–59 years.[20] In contrast, healthy women aged 25–39 years were 2.5 times more likely to report suboptimal SRH than lifetime non-smokers, while this was not true for women aged 40–59 or 60–74 years. A study focused on male former smokers demonstrated that SRH improves with time since cessation, but those who smoked for a longer duration or who smoked intensively before they quit smoking had worse SRH than those who smoked for a shorter duration or who did not smoke intensively.[21] A series of studies in adolescents consistently found that daily smoking is a strong risk factor for suboptimal SRH.[22–24]

Despite the negative consequences of active smoking on SRH, a critical issue remains unresolved, namely the effects of exposure to secondhand smoke (SHS) on SRH. Given that SHS exposure is a well-known risk factor for various health hazards,[25] non-smokers who are exposed to SHS may express reduced SRH more often than non-smokers who are not exposed to SHS. To date, only a couple of studies have specifically examined the effects of SHS exposure on SRH.[26] One study reported that adults in the USA who had never smoked and who reported any SHS exposure had a significantly increased risk of suboptimal health compared with those without exposure [adjusted odds ratio (OR) 1.47, 95% confidence interval (CI) 1.34–1.62]. This risk exceeded that of current (adjusted OR 1.31, 95% CI 1.10–1.56) and former (adjusted OR 1.22, 95% CI 1.07–1.39) smokers. Using a sample of 1472 Chinese American adults living in New York City, Shelley et al. reported that non-smokers who lived under a total household smoking ban alone, total workplace ban alone or both household and total workplace ban were, respectively, 1.90, 1.13 and 2.61 times more likely to report better SRH compared with those who reported no smoking ban at work and home.[27] A cross-sectional study from Switzerland reported that high SHS exposure at home predicted a greater reduction of health-related quality of life as measured by the 36-Item Short Form Health Survey (SF-36) in a sample of 2500 lifetime non-smokers.[28] Although the latter two studies indicated that SHS exposure at home is a strong factor that has a negative impact on perceived health, people who are employed in workplaces with no or weaker smoking policies may also report poor health. Thus, a better understanding of the link between SHS exposure by exposure setting, i.e. at work or at home, may have implications for the development of strategies for improving the health of the working population.

Therefore, this study was designed to examine the associations of active smoking and SHS exposure with SRH among Japanese full-time workers. Exposures to SHS at work and at home were measured, and a broad range of potential confounding factors were controlled for in the statistical analyses.

Methods

The study design was cross-sectional and data were collected using a self-rated questionnaire between August and December 2002. Subjects were full-time workers in small and medium-sized enterprises with one to 158 workers in Yashio city, Saitama, and Ohta ward, Tokyo. Yashio city has the highest percentage of manufacturing plants in Saitama prefecture. The Ohta ward, which is a so-called 'industrial area,' is unique for its number of small and medium-sized enterprises. In total, 329 enterprises from Yashio city and 61 enterprises from Ohta ward were selected at random depending on the distribution of types of business in each city. The occupational health nurse (TI) or occupational health doctor (MH) contacted each enterprise by telephone to request participation in a questionnaire survey. Among these enterprises, 248 in Yashio city and 52 in Ohta ward agreed to participate in the survey. Questionnaires were distributed during visits to each factory and were given to 2591 workers in Yashio city and 1102 workers in Ohta ward ($n = 3693$). Finally, responses were obtained from 2884 workers (2022 men and 862 women) from 296 enterprises, representing a response rate of 78.1%. Among these, 296 workers were excluded because of missing data for gender, smoking status, SHS exposure, number of cigarettes smoked per day and SRH. The characteristics of survey respondents by smoking status are shown in Table 1. The questionnaire elicited information on demographics, lifestyle, height, body weight, smoking-related disease(s) treated, job type, industry sector, work schedule, company size and SRH.

Measures

Smoking status

Smoking status was assessed by the following two questions: (1) Are you a current or former smoker, or a lifetime non-smoker? (2) If you are a current smoker, how many cigarettes do you smoke each day and how many years have you been smoking? Current smokers were divided into three groups by number of cigarettes smoked per day (1–9, 10–19, 20+).

SHS exposure among lifetime non-smokers was assessed by the following question: Are you currently exposed to cigarette smoke from other people? Exposures at work and at home were considered separately, and responses were categorized as no exposure, occasional exposure and regular exposure.[29,30]

Self-rated health

SRH was assessed with a question: How would you describe your health during the past 1-year period? Response options were 'very good', 'good', 'poor' and 'very poor'. SRH was dichotomized into suboptimal (poor or very poor) and optimal (good or very good). Similar use of SRH is common in studies of this type.[7,13,20]

Other potential confounding variables

Other variables were age, marital status, educational level, lifestyle, job type, industrial sector, work schedule, company size, depressive symptoms and disease(s) treated, as listed in Table 1.

Lifestyle factors included alcohol consumption (number of alcoholic drinks consumed per day, with one drink estimated as approximately 9 g of pure ethanol), caffeine intake (number of cups of tea or coffee per day) and body mass index (BMI; calculated as weight in kilogrammes divided by the square of height in metres).

Depressive symptoms were measured using a Japanese version of the Center for Epidemiologic Studies Depression (CES-D) scale.[31] The 20-item depressive symptom scale measures the level of depressive symptoms experienced in the past week. The CES-D scale cut-off score is 16, which differentiates those exhibiting high levels of depressive symptoms (score ≥ 16) from those with lower levels of such symptoms (score < 16).[32] The internal consistency of the CES-D scale for the study sample was 0.84.

Company size was assessed by the number of people working at the office or factory, and divided into quintiles for statistical analyses.

Participants were asked if they had been treated for any of the following diseases: hypertension, hyperlipidaemia, diabetes mellitus, major depression, menopausal disorder or other diseases. If the subjects reported 'other diseases', they were asked to specify the condition. Subjects reported various diseases including cardiovascular disease, cancer, gout, liver disease, renal disease, peptic ulcer, cerebrovascular disease, hyperuricaemia, allergy, panic

Table 1
Characteristics of survey respondents by smoking status ($n = 2588$).[a]

Characteristics	Lifetime non-smoker	Former smoker	Current smoker	*P value*[c]
Number of respondents (%)[b]	968 (37.4)	277 (10.7)	1343 (51.9)	
Self-rated health				0.013
Suboptimal (very poor/poor)	301 (31.1)	90 (32.5)	495 (36.9)	
Optimal (very good/good)	667 (68.9)	187 (67.5)	848 (63.1)	
Demographic factors				
Gender				<0.001
Men	472 (48.8)	234 (84.5)	1193 (88.8)	
Women	496 (51.2)	43 (15.5)	150 (11.2)	
Age group (years)				<0.001
16–24	77 (8.0)	7 (2.5)	76 (5.7)	
25–29	104 (10.7)	18 (6.5)	141 (10.5)	
30–34	103 (10.6)	22 (7.9)	174 (13.0)	
35–39	76 (7.9)	24 (8.7)	181 (13.5)	
40–44	76 (7.9)	19 (6.9)	131 (9.8)	
45–49	64 (6.6)	31 (11.2)	117 (8.7)	
50–54	138 (14.3)	38 (13.7)	175 (13.0)	
55–59	155 (16.0)	49 (17.7)	185 (13.8)	
60–64	106 (11.0)	37 (13.4)	101 (7.5)	
65+	50 (5.2)	29 (10.5)	44 (3.3)	
Missing	19 (2.0)	3 (1.1)	18 (1.3)	
Marital status				0.014
Married	598 (61.8)	202 (72.9)	873 (65.0)	
Single	263 (27.2)	49 (17.7)	337 (25.1)	
Separated/divorced/widowed	67 (6.9)	20 (7.2)	77 (5.7)	
Missing	40 (4.1)	6 (2.2)	56 (4.2)	
Highest education				0.217
Junior high school	203 (21.0)	61 (22.0)	264 (19.7)	
High school	431 (44.5)	109 (39.4)	642 (47.8)	
Vocational/college/university	289 (29.9)	95 (34.3)	386 (28.7)	
Missing	45 (4.6)	12 (4.3)	51 (3.8)	
Lifestyle and physical factors:				
Alcohol consumption (g ethanol/day)				<0.001
Non-drinker (0.0)	429 (44.3)	76 (27.4)	322 (24.0)	
0.01–4.9	201 (20.8)	32 (11.6)	167 (12.4)	
5.0–14.9	171 (17.7)	58 (20.9)	286 (21.3)	
15.0–24.9	82 (8.5)	53 (19.1)	263 (19.6)	
25.0+	67 (6.9)	56 (20.2)	287 (21.4)	
Missing	18 (1.9)	2 (0.7)	18 (1.3)	
Caffeine intake (cups of coffee or tea/day)				<0.001
Almost none	113 (11.7)	30 (10.8)	73 (5.4)	
1–2	459 (47.4)	144 (52.0)	582 (43.3)	
3+	386 (39.9)	100 (36.1)	672 (50.0)	
Missing	10 (1.0)	3 (1.1)	16 (1.2)	
Body mass index (in quintiles)				<0.001
1st quintile (lowest)	187 (19.3)	39 (14.1)	296 (22.0)	
2nd quintile	183 (18.9)	44 (15.9)	273 (20.3)	
3rd quintile	176 (18.2)	49 (17.7)	269 (20.0)	
4th quintile	192 (19.8)	71 (25.6)	250 (18.6)	
5th quintile (highest)	188 (19.4)	70 (25.3)	234 (17.4)	
Missing	42 (4.3)	4 (1.4)	21 (1.6)	
Disease(s) treated				
Hypertension				<0.001
Present	127 (13.1)	64 (23.1)	125 (9.3)	
Absent	841 (86.9)	213 (76.9)	1218 (90.7)	
Diabetes mellitus				0.020
Present	28 (2.9)	18 (6.5)	50 (3.7)	
Absent	940 (97.1)	25(93.5)	1293 (96.3)	
Major depression				0.552
Present	8 (0.8)	1 (0.4)	7 (0.5)	
Absent	960 (99.2)	276 (99.6)	1336 (99.5)	
Cardiovascular disease				0.023
Present	5 (0.5)	4 (1.4)	3 (0.2)	
Absent	963 (99.5)	273 (98.6)	1340 (99.8)	
Cancer				0.968
Present	3 (0.3)	1 (0.4)	5 (0.4)	
Absent	965 (99.7)	276 (99.6)	1338 (99.6)	
Cerebrovascular disease				0.039
Present	1 (0.1)	2 (0.7)	1 (0.1)	
Absent	967 (99.9)	275 (99.3)	1342 (99.9)	
Depressive symptoms				<0.001
CES-D score ≥ 16	295 (30.5)	72 (26.0)	487 (36.3)	
CES-D score < 16	515 (53.2)	170 (61.4)	691 (51.5)	
Missing	158 (16.3)	35 (12.6)	165 (12.3)	

Table 1 (*continued*)

Characteristics	Lifetime non-smoker	Former smoker	Current smoker	*P value*[c]
Occupational factors:				
Job type				<0.001
Managerial/clerical	307 (31.7)	72 (26.0)	292 (21.7)	
Sales/service	44 (4.5)	29 (10.5)	116 (8.6)	
Technical	31 (3.2)	18 (6.5)	48 (3.6)	
Production/Manufacturing	389 (40.2)	100 (36.1)	606 (45.1)	
Other	197 (20.4)	58	281 (20.9)	
Industry sector				<0.001
Ceramic/clay/stone	11 (1.1)	5 (1.8)	21 (1.6)	
Textile	13 (1.3)	5 (1.8)	30 (2.2)	
Papermaking	51 (5.3)	12 (4.3)	76 (5.7)	
Printing	17 (1.8)	7 (2.5)	31 (2.3)	
Chemical	144 (14.9)	29 (10.5)	177 (13.2)	
Leather	19 (2.0)	4 (1.4)	24 (1.8)	
Metalworking	404 (41.7)	119 (43.0)	553 (41.2)	
Food	74 (7.6)	12 (4.3)	58 (4.3)	
Machinery	124 (12.8)	61 (22.0)	214 (15.9)	
Transportation	46 (4.8)	8 (2.9)	100 (7.4)	
Other	65 (6.7)	15 (5.4)	59 (4.4)	
Work schedule				0.784
Non-shift daytime	879 (90.8)	257 (92.8)	1217 (90.6)	
Shift/night	43 (4.4)	9 (3.2)	68 (5.1)	
Missing	46 (4.8)	11 (4.0)	58 (4.3)	
Size of company by number of workers (in quintiles)				0.059
1–8	172 (17.8)	56 (20.2)	239 (17.8)	
9–18	191 (19.7)	69 (24.9)	277 (20.6)	
19–31	191 (19.7)	56 (20.2)	283 (21.1)	
32–61	192 (19.8)	54 (19.5)	297 (22.1)	
62+	222 (22.9)	42 (15.2)	247 (18.4)	

SD, standard deviation.
[a] Data may not total 100% due to rounding.
[b] Percent within smoking status.
[c] P value derived from Chi-squared test.

disorder, hyperthyroidism, prostatomegaly, rheumatism, musculoskeletal disorders and gynaecological diseases. Among these disorders, six major smoking-related diseases (hypertension, diabetes mellitus, major depression, cardiovascular disease, cancer and cerebrovascular disease) were selected as covariates.[28]

Statistical analyses

The prevalence of SRH and other factors by smoking status were tested using Chi-squared test. The risk of suboptimal SRH by smoking status and SHS exposure was estimated by univariate and multivariate logistic regression, with ORs and 95% CIs as measures of association. In the multivariate logistic regression analyses, sociodemographic and lifestyle factors that showed relationships with smoking status were initially included at $P < 0.10$ level (Model 1). In a similar way for Model 2, all variables in Table 1 were controlled for, except educational levels and work schedule which did not meet the $P < 0.10$ entry criteria.

Linear trends were tested by treating the ordinal exposure variable as continuous in the linear regression model. The significance level for all statistical analyses was $P < 0.05$ (two-tailed test). Data were analysed using Statistical Package for the Social Sciences Version 15.0 (SPSS, Inc., Chicago, IL, USA).

Results

Descriptive statistics of participants by smoking status

Descriptive statistics of participants stratified by smoking status are shown in Table 1. Approximately 52% of participants were current smokers, 11% were former smokers and 37% were lifetime non-smokers. The percentage of participants with suboptimal SRH was higher in current smokers than in lifetime non-smokers. Smoking was more prevalent in men than in women. The percentage of current smoking was higher among married people, those who drank more alcohol and caffeinated beverages, and those in the lower BMI category. Current smokers had higher percentages of depressive symptoms than lifetime non-smokers. In general, former smokers had a higher prevalence of hypertension, diabetes mellitus, major depression, cardiovascular disease and cerebrovascular disease than lifetime non-smokers and current smokers. Among occupational factors, participants employed in sales/service work and in the transportation industry tended to smoke more.

Matrix of lifetime non-smokers exposed to SHS at work and at home

In order to clarify subgroup analyses, a cross-classification table of the nine subgroups formed by the three-category variables of exposure source (home/work) and level of exposure (none, occasional, regular) was built, as shown in Table 2. Those who are only exposed to SHS at work are shown in the first row and those who are only exposed to SHS at home are shown in the first column of this table. Analyses for the association of SHS exposure and SRH were restricted to exposure at work alone and at home alone.

Association between smoking status and SRH

Both univariate and multivariate logistic regression analyses found that current heavy smokers (20+ cigarettes/day) had significantly increased odds of suboptimal SRH compared with lifetime non-smokers, while current smokers who smoked one to

Table 2
Matrix of lifetime non-smokers exposed to secondhand smoke at work and at home ($n = 968$).

Exposure at home	Exposure at work		
	None	Occasional	Regular
	n (%)[a]	*n* (%)[a]	*n* (%)[a]
None	357 (36.9)	288 (29.8)	112 (11.6)
Occasional	81 (8.4)	50 (5.2)	7 (0.7)
Regular	32 (3.3)	3 (0.3)	38 (3.9)

[a] Percentages are estimated as total lifetime non-smokers as the denominator.

nine cigarettes/day or 10–19 cigarettes/day, and former smokers did not show significant increases in suboptimal SRH compared with lifetime non-smokers (Table 3). However, there was a dose-dependent relationship between smoking status and suboptimal SRH.

Association of lifetime non-smokers exposed to SHS with SRH by different exposure source

Lifetime non-smokers exposed to SHS at work alone and at home alone are shown in Table 4. Lifetime non-smokers occasionally exposed to SHS at work had significantly increased odds of suboptimal SRH compared with lifetime non-smokers unexposed to SHS. No significant association was found between non-smokers regularly exposed to SHS at work and SRH. Similarly, non-smokers regularly or occasionally exposed to SHS at home did not show any significant relationship with SRH in this sample. A dose–response gradient was apparent between the level of SHS exposure at work and suboptimal SRH among lifetime non-smokers.

Discussion

The primary objective of this study was to clarify the relationship between SRH and active smoking and different levels of SHS exposure at work and home among lifetime non-smokers. The results revealed that current heavy smokers had a 33–39% increase in suboptimal SRH compared with lifetime non-smokers. Lifetime non-smokers occasionally exposed to SHS at work had a 43–51% increase in suboptimal SRH compared with lifetime non-smokers unexposed to SHS. SHS exposure at home was not associated with SRH. Although no statistically significant association was found between regular SHS exposure at work and SRH, the results suggest a possible increase in suboptimal SRH by workplace SHS exposure.

Very little work has been directed towards the relationship between SHS exposure and SRH. In studies of active smoking and SRH, the non-smoking reference group could include subjects potentially exposed to SHS. Thus, it is possible that previous studies underestimated a positive relationship between active smoking and suboptimal SRH, and at the same time overlooked the effects of SHS exposure on SRH as shown in this study. The results of the current study are consistent with previous reports that found higher odds of suboptimal SRH in non-smokers exposed to SHS compared with those without such exposure.[26–28]

A positive association was found between occasional SHS exposure at work and suboptimal SRH, but no significant association was found between regular SHS exposure at work and suboptimal SRH. This result is inconsistent with previous findings reporting a dose-dependent relationship between SHS exposure and respiratory or sensory irritation symptoms,[33,34] and disorders such as cardiovascular disease[35] and lung cancer.[36] The following speculations can be considered for this unexpected inconsistency. First, compared with regularly exposed workers, occasionally exposed or non-exposed workers may be more aware of their health conditions and may try to avoid SHS exposure because rates of existing diseases for regular, occasional or no exposure were 21.9%, 23.5% and 27.5%, respectively (data not shown). Second, the relatively small sample size of lifetime non-smokers regularly exposed to SHS may have limited the power to detect differences.

Although the exact reasons for the present findings remain unclear, three arguments can be put forward to explain the relationship between SHS exposure and elevated suboptimal SRH. First, it is possible that SHS exposure is associated with minor respiratory symptoms, such as having a frequent cough, wheeze, phlegm, runny nose, shortness of breath or cold,[33,34,37] which may result in a poor perception of health. For example, it has been reported that a constellation of respiratory symptoms such as throat problems, cough, phlegm and wheezing were positively associated with the number of smokers at home and at work among lifetime non-smoking police officers in Hong Kong.[34] Poor respiratory health may be related to suppression of immune function through SHS exposure.[38] Second, SHS exposure may also be associated with symptoms such as annoyance, irritation, depressed mood or disturbed sleep,[39–41] which may not be diagnosed clinically but may be perceivable enough to cause the participants to rate their health as less than good. Thus, the majority of cases who rated their health as less than good by active smoking or SHS exposure at work in this study population may be attributable to minor symptoms related to SRH. Third, workers who are exposed to SHS may simply think that their health is poor because of the knowledge of risks associated with smoking.

No significant association was found between SHS exposure at home and SRH as reported in two previous studies.[27,28] Several explanations are possible for this finding. Although participants' perceptions of the levels of SHS exposure may not differ between the work and home settings, the exposure situation/environment may differ. For example, the duration of exposure may be longer at work than at home because participants worked for an average of 8.9 (SD 1.8) h/day. In addition, 52% of co-workers of non-

Table 3
Odds ratios for reporting suboptimal vs optimal self-rated health in former and current smokers compared with lifetime non-smokers.

	Lifetime non-smoker	Former smoker		Current smoker						
				Number of cigarettes smoked per day among current smokers						
				1-9		10-19		20+		
Suboptimal self-rated health	**OR (95% CI)**	**OR (95% CI)**	*P*	**OR (95% CI)**	*P*	**OR (95% CI)**	*P*	**OR (95% CI)**	*P*	P_{trend}
Number of respondents	$n = 968$	$n = 277$		$n = 80$		n = 349		$n = 914$		
Unadjusted OR	1.00 (Reference)	1.07 (0.80-1.42)	0.659	1.48 (0.93-2.36)	0.102	1.18 (0.91-1.52)	0.102	1.33 (1.10-1.60)	0.004	0.007
Adjusted OR[a]	1.00 (Reference)	1.14 (0.84-1.53)	0.409	1.47 (0.91-2.37)	0.112	1.21 (0.92-1.59)	0.180	1.39 (1.12-1.73)	0.003	0.001
Fully adjusted OR[b]	1.00 (Reference)	1.19 (0.87-1.64)	0.281	1.46 (0.88-2.41)	0.143	1.23 (0.92-1.65)	0.159	1.34 (1.06-1.69)	0.015	<0.001

OR, odds ratio; CI, confidence interval.
[a] Adjusted for gender, age group, marital status, caffeine intake, alcohol consumption and body mass index (Model 1).
[b] Adjusted for gender, age group, marital status, caffeine intake, alcohol consumption, body mass index, depressive symptoms, job type, industry sector, company size, hypertension, diabetes mellitus, major depresion, cardiovascular disease, cancer and cerebrovascular disease (Model 2).

Table 4
Odds ratios for reporting suboptimal vs optimal self-rated health by exposure to secondhand smoke at work and at home among lifetime non-smokers.

	Exposure to secondhand smoke					
	No exposure[a]	Occasional		Regular		
Suboptimal self-rated health	**OR (95% CI)**	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***	P_{trend}
Exposure to secondhand smoke at work alone	$n = 357$	$n = 288$		$n = 112$		
Unadjusted OR	1.00 (Reference)	1.43 (1.03-2.00)	0.035	1.32 (0.84-2.08)	0.231	0.050
Adjusted OR[b]	1.00 (Reference)	1.51 (1.07-2.15)	0.023	1.37 (0.85-2.22)	0.194	0.032
Fully adjusted OR[c]	1.00 (Reference)	1.50 (1.02-2.21)	0.040	1.32 (0.77-2.27)	0.308	0.019
Exposure to secondhand smoke at home alone	$n = 357$	$n = 81$		$n = 32$		
Unadjusted OR	1.00 (Reference)	0.90 (0.52-1.56)	0.705	1.01 (0.45-2.25)	0.989	0.573
Adjusted OR[b]	1.00 (Reference)	1.02 (0.55-1.87)	0.960	1.41 (0.58-3.40)	0.447	0.299
Fully adjusted OR[c]	1.00 (Reference)	1.12 (0.57-2.18)	0.758	1.20 (0.46-3.11)	0.709	0.273

OR, odds ratio; CI, confidence interval.
[a] Neither exposed at work nor at home.
[b] Adjusted for gender, age group, marital status, caffeine intake, alcohol consumption and body mass index (Model 1).
[c] Adjusted for gender, age group, marital status, caffeine intake, alcohol consumption, body mass index, depressive symptoms, job type, industry sector, company size, hypertension, diabetes mellitus, major depresion, cardiovascular disease, cancer and cerebrovascular disease (Model 2).

smokers are current smokers (Table 1), and non-smokers are exposed to SHS from multiple smokers at work leading to constant exposure. It may also be difficult for non-smokers to ask their smoking colleagues to stop smoking if there is no (or a weak) smoking policy at the workplace.[42,43] Moreover, smoking and SHS exposure tends to be more prevalent in smaller enterprises than in larger enterprises.[42–45] In contrast, SHS exposure at home may only be expected from smoking family members, and it may therefore be easier for non-smoking members to ask them to refrain from smoking or to smoke outside their house. These assumptions could be supported by the fact that non-smoking participants reported 3.5 times more SHS exposure at work than at home (41.4% vs 11.7%, Table 2).

In Japan, the prevalence of smoking is reducing gradually but it is still at a high level compared with Western countries. The most recently conducted survey by the Ministry of Health, Labour and Welfare, Japan suggested a prevalence for men and women of 39.3% and 11.3%, respectively, in 2005.[46] Accordingly, as many as 72.8% of non-smokers were exposed to SHS at work (77.5% of men and 68.8% of women); 33.1% (37.1% of men and 29.8% of women) were exposed almost every day and 39.7% (40.4% of men and 39.2% of women) were exposed occasionally.[47] The survey also indicated that 49.1% (50.7% of men and 47.8% of women) of non-smokers feel uncomfortable or get sick when exposed to SHS. These estimates indicate that three-quarters of non-smokers are exposed to SHS on a daily basis, and approximately half of non-smokers are experiencing some physical symptoms, which support the study findings.

Strengths and limitations

A strength of this study is that, to the authors' knowledge, this may be one of the first studies to consider the effect of SHS exposure on SRH in a developed country with a high smoking prevalence. SHS exposure at work and home were differentiated to make sources of exposure clear. In addition, a number of potential confounders were considered, including work-related factors, in the analyses.

It is acknowledged that this study has a number of limitations. First, the subjects were asked about the frequency of SHS exposure at work and at home, but were not asked about other sources of exposure such as exposure during leisure time. Second, SHS exposure was assessed by self-report rather than objective measures such as blood or urine cotinine levels. Self-reported exposure may lead to misclassification of true exposure because a recent study reported that a substantial number of people who denied SHS exposure at work/home had detectable levels of cotinine in their blood, indicating SHS exposure.[48] Third, response bias may have occurred if non-respondents differed from respondents with respect to smoking status and SRH. Fourth, the data in this study came from a survey of workers from small and medium-sized enterprises, which was not representative of the entire Japanese workforce, making generalizability less definitive. Finally, although this study adjusted for a variety of confounders, it is possible that unmeasured/unknown confounders (e.g. diet, physical exercise, social factors) may explain the present finding.

Conclusion

Notwithstanding these limitations, this investigation indicated an increase in suboptimal SRH among current heavy smokers and suggested that occasional SHS exposure at work among non-smokers is a possible risk factor for suboptimal SRH. Further research is needed to confirm if control of smoking and an elimination of SHS exposure at work will improve SRH and protect workers from developing future health conditions. Researchers can verify this assumption by investigating workplace(s) where a total smoking ban has already been introduced.

Ethical approval

The Medical Ethical Committee of the University of Tokyo.

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Competing interests

None declared.

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