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Tolerance for and potential indicators of second-hand smoke exposure among nonsmokers: A comparison of self-reported and cotinine verified second-hand smoke exposure based on nationally representative data



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A R T I C L E I N F O

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ABSTRACT

Objective: We assessed the extent to which self-reported exposure to SHS underestimates the actual exposure to SHS and what factors are associated with a tolerance for SHS exposure in the Korean setting where the smoke-free policy is incomplete.

Methods: Information on socio-demographic characteristics, alcohol drinking and smoking was collected for 7948 nonsmokers aged \geq 19 years from the fourth Korea National Health and Nutrition Examination Survey, 2008–2009. Self-reported and cotinine verified SHS exposures were compared. Potential factors associated with cotinine verified but not self-reported SHS exposures were assessed using a logistic regression model.

Results: Self-reported SHS exposure significantly underestimated the actual SHS exposure as determined by cotinine verification (kappa coefficient: 0.1066). At younger age, frequent alcohol drinking in females and a longer smoking duration in males were positively associated with cotinine verified exposure but not with the self-reported SHS exposure; they were also positively associated with cotinine verified exposure irrespective of self-reported SHS exposure.

Conclusions: Our findings show a tolerance for smoking in Korea. The current partial ban on smoking does not fully protect people from exposure to SHS. Smoking should be banned in all public places. In addition, efforts to de-normalize smoking in the Korean culture need to be strengthened.

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Introduction

Second-hand smoke (SHS) is considered one of the world's most critical environmental health hazards. SHS is classified as a group 1 carcinogen because it contains thousands of harmful chemicals that have clear associations with severe health outcomes, such as respiratory diseases, cardiovascular diseases and cancer (Callinan et al., 2010; The U.S. Department of Health and Human Services, 2006; WHO and IARC, 2004). Many countries have made efforts to minimize the harmful effects of SHS exposure by developing educational campaigns to increase public awareness and by adopting smoke-free policies. However, in 2004, approximately 40% of the world's children and one-third of the nonsmoking adults were reported to still be exposed to SHS. These proportions are the highest in the Western Pacific Region, where the exposure rate among men, women and children is greater than 50% (Eriksen et al., 2012).

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In the Republic of Korea, which has one of the highest prevalence of smoking in Asia (46.7% of males and 7.1% of females in 2009), self-reported SHS exposure has been increasing among nonsmokers, including among females and children (42.1% in males and 31.6% in females in 2007; 45.9% in males and 33.8% in females in 2010) (KCDC and MW, 2011; Lee and Ha, 2011).

Since the enactment of the National Health Promotion Act in Korea in 1995, smoke-free policies have led to the designation of non-smoking areas in several settings, such as large buildings, theaters, stores, hospitals, schools, concert halls, gyms and public transportation. Some restaurants, game rooms, and some outdoor areas were also included in the stationary smoke-free areas when the law was revised in 2010 and 2012. However, restaurants smaller than 150 m², entertainment venues, and other enclosed areas where SHS exposure is quite frequent and high, are exempted from this law. Therefore, because of the incomplete smoke-free policy and the related SHS exposure in Korea, there is a need to identify and apply accurate assessments of SHS exposure in order to correctly determine the level of exposure and to develop appropriate prevention strategies.

Self-reported questionnaire information has been commonly used to assess SHS exposure mainly in a qualitative manner; however, the



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use of biomarkers (i.e., cotinine) to measure SHS exposure has been gaining momentum as the awareness of the health risks of SHS exposure increases (Benowitz, 1996; Simoni et al., 2006). Even if the outcomes of two different measures of SHS exposure (i.e., self-reported and cotinine-verified) have corresponded significantly in most previous studies (Baheiraei et al., 2012; Simoni et al., 2006; Thompson et al., 1990; Yano, 2005), other studies have reported poor agreement or have suggested that data based on self-report need to be verified by a biomarker analysis to increase the accuracy of SHS exposure estimates (Johnson-Kozlow et al., 2010; O'Connor et al., 1995; Paek et al., 2009; Sasaki et al., 2011; Wong et al., 2013). It has been shown to be difficult to distinguish exposed from non-exposed non-smokers by selfreporting alone. There is no gold-standard questionnaire that can be used to verify SHS exposure. In some populations accustomed to living in environments less exposed to SHS exposure, exposure to SHS is easily recognized, and the accuracy of self-report might be improved. However, the use of self-reported SHS exposure alone may lead to the underestimation of SHS exposure in some populations because the awareness and perception of SHS might be affected by different levels of social tolerance for smoking. A high prevalence of smoking and a high tolerance to SHS exposure could make people less likely to recognize the exposure, which could lead to inaccurate self-assessments of SHS exposure in some populations. This tolerance and the resulting inaccurate assessments of SHS exposure could cause more harm to nonsmokers and could be a barrier to strengthening smoke-free policies. For this reason, in countries where there is a high prevalence of smoking, such as Russia, China, Japan, Korea and other Asian countries (OECD, 2013), it is necessary to estimate the national level of SHS exposure using both self-report and biomarkers, such as cotinine concentration, in order to compare outcomes, to obtain accurate data on SHS exposure and to contribute scientific evidence to support smoke-free policies. Cotinine, a major nicotine metabolite, is considered an accurate quantitative measure of recent exposure to tobacco smoke (Jarvis et al., 1987; Wong et al., 2013). It can be measured in various biological samples, including urine, and has a half-life of 16-20 h (Wong et al., 2013). In this context, the aims of this study are 1) to compare selfreported SHS exposure with corresponding urinary cotinine concentrations among non-smokers; and 2) to investigate factors associated with cotinine verified but not self-reported SHS exposure as well as cotinine verified exposure irrespective of self-reported SHS exposure. This study uses a nationally representative sample from the Korean population.

Methods

Data and study variables

Information for 20,277 males and females was initially collected from the data of the fourth Korea National Health and Nutrition Examination Survey (KNHANES IV), carried out in 2008 and 2009. KNHANES IV used a stratified multistage probability sampling method based on geographical area and housing type (the implicit stratification variable was the ratio of the population by age) to obtain a representative sample of the Korean population. After excluding individuals aged under 19 years (n = 5206), self-reported current smokers (n = 3171), and those with incomplete information on the status of self-reported smoking experience (n = 803) and urinary cotinine concentration (n = 3149), 7948 adult nonsmokers (never and former smokers) were included in the present analysis. The study was approved by the Institutional Review Board of the National Cancer Center of Korea (IRB number: NCCNCS-13-735).

Information on socio-demographic characteristics such as sex, age (years: 19–29, 30–39, 40–49, 50–59, and \geq 60), marital status (married, single), education (duration in years: \leq 6, 7–9, 10–12, and \geq 12), monthly household income (10,000 KRW/month: <200, 200–399, and \geq 400) and employment (employed, unemployed) were included.

Information on alcohol drinking (non-drinker, drinker: 1 time per month, 2–4 times per month, and >2 times per week), self-reported SHS exposure (non-exposed, exposed: 0 h per day, <1 h per day, and \geq 1 h per day), smoking duration (never smoker, <10, 10–19, 20–29, and \geq 30 years), urinary cotinine concentration (<5 ng/ml, \geq 5 ng/ml), and self-reported smoking status (never: smoked <100 cigarettes during their lifetime, former: smoked \geq 100 cigarettes during their lifetime and currently smoke) was also derived from the data of KNHANES IV.

Respondents who answered "<1 h or ≥ 1 h" to the question, "How many hours per day are you exposed to SHS at work or at home?" were categorized as the self-reported SHS exposure group; those who answered "0 h" to the same question were not. Urine samples which were collected in mid-pee, were kept in the refrigerator at 2–8 °C for 2 days at most and were analyzed by tandem mass spectrometry with the Tandem mass API 4000 (Applied Biosystems, Carlsbad, California, USA) and by gas chromatography and mass spectrometry with the Perkin Elmer Clarus 600T (PerkinElmer, Turku, Finland) (KCDC and MW, 2011). The respondents with a urinary cotinine concentration of 5 ng/ml or more were classified as the cotinine verified SHS exposure group (Moyer et al., 2002). The limit of detection (LOD) and the limit of quantitation (LOQ) for urinary cotinine were 0.01 ng/ml and 0.03 ng/ml, respectively.

Statistical analysis

The kappa coefficient was used to evaluate the agreement between self-reported and cotinine verified SHS exposure in nonsmokers who had both questionnaire data and urinary cotinine concentration available. The adjusted odds ratios (ORs) and 95% confidence intervals (CIs) of cotinine verified SHS exposure were calculated for potential factors associated with SHS exposure in the multiple logistic regression analyses. The data were analyzed using Survey Procedures in SAS (SAS Institute, Inc., Cary, North Carolina, USA), version 9.2.

Results

Of the 7948 subjects, 61.2% (n = 5320) were female and 38.8% (n = 2628) were male. The mean age of all of the subjects was 45.9 years (standard error of the mean (SE): \pm 0.34 years; range: 19–93). The geometric mean (GM) urinary cotinine concentration was 2.42 ng/ml (GSE: \pm 1.08) and was higher in males (3.48, GSE: \pm 1.10 ng/ml) than in females (1.92, GSE: \pm 1.09 ng/ml). Of the total study sample, 53.7% had a cotinine verified SHS exposure (using a threshold of 5 ng/ml), but only 36.1% had a self-reported SHS exposure. The self-reported SHS exposure rate was relatively low among both males and females. The correspondence between the self-reported and cotinine verified SHS exposures was low (kappa value: 0.1066, 95% CI [0.1062, 0.1070]) (Table 1).

As shown in our multiple logistic regression model, which was adjusted for all variables as appropriate, younger age among both genders, alcohol drinking among females, and having a former smoking experience among males were all positively associated with a cotinine verified SHS exposure at a statistically significant level. A significant linear trend by age group among both genders, the frequency of drinking alcohol among females (p = 0.0071), and a period of former smoking among males (p = 0.0004) was also observed with the highest odds in subjects aged 19–29 years among both genders (OR for females: 1.99, 95% CI [1.37, 2.89]; OR for males: 1.82, 95% CI [1.15, 2.89]), as well as drinking alcohol more than two times per week among females (OR = 1.64, 95% CI [1.15, 2.33]), and having smoked for 30 years or more among males (OR = 2.02, 95% CI [1.37, 2.99]) (Table 2).

The number of subjects who reported exposure to SHS was higher in the cotinine verified SHS exposure group among both females and males compared with the cotinine verified non-SHS exposure group. A

Table 1

Kappa coefficients of self-reported and cotinine verified second-hand smoke (SHS) exposure among non-smokers.

			Cotinine ve exposure	erified SHS	Crude kappa coefficient ^a (95% CI)	Adjusted kappa coefficient ^b (95% Cl)	
			No	Yes			
Overall	Self-reported SHS exposure	No	2799	2534	0.1066 (0.1062-0.1070)	0.0658 (0.0654-0.0662)	
		Yes	1051	1558			
Male	Self-reported SHS exposure	No	759	839	0.0814 (0.0807-0.0821)	0.0406 (0.0400-0.0412)	
		Yes	398	632			
female	Self-reported SHS exposure	No	2040	1695	0.1107 (0.1102-0.1112)	0.0811 (0.0806-0.0816)	
		Yes	653	926			

The self-reported SHS exposure and cotinine verified SHS exposure were 36.1% and 53.7%, respectively.

Kappa coefficients are calculated by Cohen's methods.

^a Kappa coefficient without adjustment.

^b Kappa coefficient adjusted for gender, age, marital status, education and monthly household income as appropriate.

significant linear trend by the duration of SHS exposure at workplaces and at homes was also observed (Table 2).

Compared with group 1 (non-SHS exposure), a younger age for both genders, alcohol drinking for females, and having a self-reported former smoking experience for males were positively associated with group 2 (cotinine verified SHS exposure alone). Female subjects who drank alcohol more than two times per week (OR for group 2: 1.74, 95% CI [1.25–2.44]; OR for group 3: 3.45, 95% CI [2.48–4.79]) and male subjects who had smoked for 30 years or more (OR = 1.84, 95% CI [1.30–2.60]) had the highest odds (Tables 3 and 4).

The average urinary cotinine concentration increased with an increasing frequency of alcohol drinking among females and was the highest in those who drank more than two times per week (GM: 31.84, GSE: \pm 1.11 ng/ml). Males who had smoked for 10–20 years (GM: 31.05 ng/ml, GSE: \pm 1.11 ng/ml) and females who had smoked for less than 10 years (GM: 42.81 ng/ml, GSE: \pm 1.25 ng/ml) had the highest values compared with the other groups (Fig. 1).

Discussion

The present study indicates that there is a considerable discrepancy between self-reported and cotinine verified SHS exposure among nonsmokers in Korea. The results also suggest that being younger than 50 years old and having former smoking and drinking habits are significantly associated with an increased SHS exposure.

These results give us meaningful information on how SHS exposure should be measured, understood and applied in the form of smoke-free policies in many Asian countries where the prevalence of smoking is still high.

Although the discrepancy between self-reported and biomarkermeasured SHS exposure has been reported in previous studies, studies using nationally representative data in Asia are scarce, and those that do exist consider only a small number of subjects in specific groups, such as workers, pregnant women, or children (Arheart et al., 2008; Jhun et al., 2010; Johnson-Kozlow et al., 2010; Lee et al., 2009; Lu et al., 2011; Paek et al., 2009; Sasaki et al., 2011). The nationally representative data in the present study showed that there were a substantial number of subjects reporting no exposure who indeed had detectable urinary cotinine concentrations (\geq 5 ng/ml). Self-reported SHS exposure (36.1%) was lower than cotinine verified SHS exposure (53.7%) (Table 1). The discrepancy was profound in female subjects aged 60 years old or over (data not shown). As is well described in national statistics, Korea has one of the highest prevalence of smoking, with a huge gender difference (60.9% of males and 5.2% of females in 2001; 47.3% of males and 6.8% of females in 2011) (KCDC and MW, 2011). National educational campaigns to minimize SHS exposure have been implemented in the last 2 decades, and a ban was placed on smoking in some public places in accordance with the National Health Promotion Act of Korea (MGL, 2013). However, an environment that is tolerant toward smoking has remained in the country and can be observed in most public places that are not designated as smoke-free. Indeed, most people view smoking in public places as a natural thing and thus do not take into account any related SHS exposure. In particular, subjects aged 60 years or older had lived in a society where smoking was prevalent with more than 70% of males being smokers and the majority of females being nonsmokers. Thus, women gradually accepted male smoking as natural; former smokers were also accustomed to being in a smoking environment due to their past smoking behaviors (KASH, 2008). This past experience may result in a failure for some non-smokers to recognize SHS. This explanation is supported by the Behavioral Ecological Model (Hovell et al., 2009, pp. 415–449), which says that awareness of SHS exposure is influenced by personal, environmental, and cultural contingencies, as well as by previous study results which suggest that traditional Korean values condone smoking (Hofstetter et al., 2004; Hughes et al., 2008).

Being younger than 50 years old in both females and males, alcohol drinking in females, and former smoking in males were all significant factors associated with cotinine verified SHS exposure after adjusting for all variables, including self-reported SHS exposure (Table 2). Furthermore, the association increased with an increasing frequency of alcohol drinking in females and smoking duration in males with significant trends. The average urinary cotinine concentration was also higher among younger subjects, subjects who drank more frequently, and who had smoked longer (Fig. 1). Even if small number of former smokers among females did not cause the significant association of former smoking with cotinine verified SHS exposure, the odds increased among females. The association of drinking alcohol with cotinine verified SHS exposure in males was borderline significant, which might be explained by frequent SHS exposure from other sources rather than from drinking. These results were similar in a comparison of the cotinine verified group but not in the self-reported SHS exposure group with the non-SHS exposure group, which means that unperceived SHS exposure was also more frequent among females who drank alcohol more frequently, among males who had a longer past smoking duration, and among both genders who are younger (Tables 3 and 4). This suggests that people could not recognize the SHS exposure because they have a tolerance for SHS exposure in smoking prevalent conditions. A higher SHS exposure in former smokers was reported in a subset analysis of the European Prospective Investigation into Cancer and Nutrition (EPIC) cohort using serum cotinine concentrations as well as in some cross-sectional studies using self-reported data (Baltar et al., 2011; Lee and Ha, 2011; Skorge et al., 2007; Twose et al., 2007). An association between SHS exposure and alcohol drinking, with or without statistical significance, has also been suggested in some studies in the general population (Lee and Ha, 2011; Skorge et al., 2007). A relatively high SHS exposure among younger individuals, and/or females, was also reported in the USA, Canada, and some European countries (Gu et al., 2004; Lee and Ha, 2011; Mannino et al., 1997; Skorge et al., 2007). As previously

Table 2

Prevalence of and factors associated with cotinine verified second-hand smoke (SHS) exposure.

$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		Total	Female Cotinine verified SHS exposure		Total	Male	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$						Cotinine verified SHS exposure	
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60 + 154 680 (401) 1.00 88 427 (49.6) 1.00 $90 - 49$ 1016 538 (52.9) 1.33 (10.2 - 16.7) 49.6 297 (61.7) 1.55 (1.15 - 2.07) $90 - 39$ 642 383 (59.7) 1.36 (10.3 - 18.1) 427 206 (63.2) 1.75 (1.22 - 2.51) $19 - 29$ 642 383 (59.7) 1.99 (1.37 - 2.89) 3.8 214 (63.7) 1.82 (1.15 - 2.89) Marital status ⁴ $$	Age groups ^a						
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ange 340 300 (0.74 (0.35-1.01) 409 2.9 (0.30) (0.30) Education*	Single	4736	2511 (49.5)	1.00	2211	1206 (37.3)	1.00
$\begin{array}{c} \text{Lucation} \\ \leq 9 \ \text{cars} \\ \leq 9 \ \text{cars} \\ 10 - 12 \ \text{years} \\ 11 - 12 \ \text{years} \\ 11 - 12 \ \text{years} \\ 11 + 12 \ \text{years} \\ 12 \ \text{years} \ 12 \ \text{years} \\ 12 \ \text{years} \\ 12 \ \text{years} \ 12 \ \text{years} \ 12 \ \text{years} \ 12 \ \text{years} \ 12 \ 12 \ 12 \ 12 \ 12 \ 12 \ 12 \ 1$	Education	540	508 (50.7)	0.74 (0.55-1.01)	409	257 (05.0)	1.05 (0.06-1.01)
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Monthly household income (10,000 KRW/month) ⁴ Lotential construction of the second seco	12 + years	1144	015 (54.5)	P: 0 3754	828	478 (58.8)	0.84 (0.63–1.13) P· 0.2670
-200 ⁻¹ 2287 1057 (47.3) 1.00 1021 522 (52.2) 1.00 200-400 1194 617 (53.1) 1.00 (0.84-1.20) 890 513 (58.7) 1.02 (0.79-1.32) 400 + 1194 617 (53.1) 1.03 (0.81-1.32) 659 402 (62.4) 1.26 (0.95-1.66) Employed 2512 1294 (53.3) 1.03 (0.89-1.19) 1889 1081 (59.7) 0.91 (0.70-1.19) Drinking alcohol ^a	Monthly household income (10,000 KRW/month) ^a			1100701			11012070
200-400 1723 897 (52.4) 1.00 (0.81-1.20) 890 513 (58.7) 1.02 (0.79-1.32) 400 + 1194 617 (53.1) 1.03 (0.81-1.32) 659 402 (62.4) 1.26 (0.95-1.6) Employment ¹	<200	2287	1057 (47.3)	1.00	1021	522 (55.2)	1.00
400 + 1194 617 (53.1) 1.03 (0.81-1.32) 659 402 (62.4) 1.26 (0.95-1.66) Employment* . <td< td=""><td>200-400</td><td>1723</td><td>897 (52.4)</td><td>1.00 (0.84-1.20)</td><td>890</td><td>513 (58.7)</td><td>1.02 (0.79-1.32)</td></td<>	200-400	1723	897 (52.4)	1.00 (0.84-1.20)	890	513 (58.7)	1.02 (0.79-1.32)
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	400+	1194	617 (53.1)	1.03 (0.81-1.32)	659	402 (62.4)	1.26 (0.95-1.66)
Employment ^a Unemployed 2800 1326 (48.0) 1.00 730 384 (55.9) 1.00 Employed 2512 1294 (53.3) 1.03 (0.89-1.19) 1889 1081 (59.7) 0.91 (0.70-1.19) Drinking alcohol ^a				P: 0.8104			P: 0.0998
Unemployed 2800 1326 (48.0) 1.00 730 384 (55.9) 1.00 Employed 2512 1294 (53.3) 1.03 (0.89-1.19) 188 1081 (59.7) 0.91 (0.70-1.19) Drinking alcohol ⁸	Employment ^a						
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Drinking alcohol ^a 3734 1527 (46.4) 1.00 873 446 (53.9) 1.00 Drinker 1942 1096 (56.6) 1.29 (1.12-1.48) 1753 1024 (60.9) 1.16 (0.93-1.43) Frequency of drinking alcohol ^b	Employed	2512	1294 (53.3)	1.03 (0.89–1.19)	1889	1081 (59.7)	0.91 (0.70-1.19)
Non-drinker 3374 1527 (46.4) 1.00 873 446 (53.9) 1.00 Drinker 1942 1096 (56.6) 1.29 (1.12-1.48) 1753 1024 (60.9) 1.16 (0.93-1.43) Frequency of drinking alcohol ^b	Drinking alcohol ^a						
Drinker 1942 1096 (56.6) 1.29 (1.12–1.48) 1753 1024 (60.9) 1.16 (0.93–1.43) Frequency of drinking alcohol ^b 3374 1527 (46.4) 1.00 873 446 (53.9) 1.00 1 time per month 649 349 (54.7) 1.19 (0.89–1.58) 231 129 (57.2) 1.19 (0.78–1.82) 2-4 times per month 641 448 (53.8) 1.12 (0.88–1.42) 671 401 (61.6) 1.22 (0.89–1.67) Over 2 times per week 412 259 (65.2) 1.64 (1.15–2.33) 851 494 (61.4) 1.16 (0.88–1.54) P: 0.0071 ver smoker 5097 2498 (50.2) 1.00 1040 550 (55.9) 1.00 Status of self-reported smoking experience ^b 223 126 (56.6) 1.25 (0.89–1.75) 1588 921 (60.9) 1.39 (1.15–1.69) Smoking period of self-reported smoking experience ^b 24 12 (55.5) 1.65 (0.79–3.47) 137 170 (60.6) 1.71 (0.85–1.61) 10–20 years 24 13 (48.4) – 479 286 (53.6) 1.51 (1.12–2.02) 20–30 years<	Non-drinker	3374	1527 (46.4)	1.00	873	446 (53.9)	1.00
Frequency of drinking alcohol [®] 3374 1527 (46.4) 1.00 873 446 (53.9) 1.09 Non-drinker 339 954.7) 1.19 (0.89-1.58) 231 129 (57.2) 1.19 (0.78-1.82) 2-4 times per month 881 488 (53.8) 1.12 (0.88-1.42) 671 401 (61.6) 1.22 (0.89-1.67) Over 2 times per week 412 259 (65.2) 1.64 (1.15-2.33) 851 494 (61.4) 1.16 (0.88-1.54) Never smoker 223 126 (56.6) 1.25 (0.89-1.75) 1588 921 (60.9) 1.39 (1.15-1.69) Smoking period of self-reported smoking experience ^a 223 126 (56.6) 1.25 (0.89-1.75) 1588 921 (60.9) 1.39 (1.15-1.69) Never smoker 5097 2498 (50.2) 1.00 1040 550 (55.9) 1.00 Nore smoker 5097 2498 (50.2) 1.00 1040 550 (55.9) 1.00 Never smoker 126 71 (56.5) 1.65 (0.79-3.47) 317 179 (60.6) 1.51 (1.12-2.02) 20-30 years 24 15 (57.3) 0.70 (0.14-3.58) 353 166 (58.0) 1.31 (0.94+1.83)	Drinker	1942	1096 (56.6)	1.29 (1.12–1.48)	1753	1024 (60.9)	1.16 (0.93–1.43)
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Frequency of drinking alcohol ^b						
1 time per month 649 349 (54.7) 1.19 (0.89-1.58) 231 129 (57.2) 1.19 (0.78-1.82) 2-4 times per month 881 488 (58.8) 1.12 (0.88-1.42) 671 401 (61.6) 1.22 (0.89-1.67) Over 2 times per week 412 259 (56.2) 1.64 (1.15-2.33) 851 494 (61.4) 1.16 (0.88-1.54) Never smoker 5097 2498 (50.2) 1.00 1040 550 (55.9) 1.00 Former smoker 223 126 (56.6) 1.25 (0.89-1.75) 1588 921 (60.9) 1.39 (1.15-1.69) Smoking period of self-reported smoking experience ^b 71 (56.5) 1.65 (0.79-3.47) 317 179 (60.6) 1.17 (0.85-1.61) 10-20 years 126 71 (55.5) 1.65 (0.79-3.47) 317 179 (60.6) 1.51 (1.12-2.02) 20-30 years 24 15 (57.3) 0.70 (0.14-3.58) 353 196 (58.0) 1.31 (0.94-1.83) 30 + years 24 13 (48.4) - 479 281 (60.4) 2.02 (1.37-2.99) Ferported second-hand smoking exposure ⁴ 1579 926 (59.2) 1.55 (1.34-1.81) 1030 632 (63.6) 1.35 (1.09-1.69) <	Non-drinker	3374	1527 (46.4)	1.00	873	446 (53.9)	1.00
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	1 time per month	649	349 (54.7)	1.19 (0.89–1.58)	231	129 (57.2)	1.19 (0.78–1.82)
Over 2 times per week 412 259 (65.2) 1.64 (1.15–2.33) 851 494 (61.4) 1.16 (0.88–1.54) P: 0.0071 P: 0.0071 P: 0.0071 P: 0.2249 Status of self-reported smoking experience* Jono 1040 550 (55.9) 1.00 Former smoker 2023 126 (56.6) 1.25 (0.89–1.75) 1588 921 (60.9) 1.39 (1.15–1.69) Smoking period of self-reported smoking experience* 223 126 (56.6) 1.65 (0.79–3.47) 317 179 (60.6) 1.17 (0.85–1.61) Never smoker 5097 2498 (50.2) 1.00 1040 550 (55.9) 1.00 <10 years	2–4 times per month	881	488 (53.8)	1.12 (0.88–1.42)	671	401 (61.6)	1.22 (0.89–1.67)
P: 0.0071 P: 0.2249 Status of self-reported smoking experience*P: 0.0071 P: 0.0071 Status of self-reported smoking experience*Image: Status of self-reported smoking experience*Image: Status of self-reported smoking experience*P: 0.0071 1.00Former smoker2231.26 (56.6)1.25 ($0.89-1.75$)1588921 (60.9)1.39 ($1.15-1.69$)Smoking period of self-reported smoking experience*Image: Status of self-reported smoking experience*P: 0.006 Image: Status of self-reported smoking experience*P: 0.006 Status of self-reported	Over 2 times per week	412	259 (65.2)	1.64 (1.15–2.33)	851	494 (61.4)	1.16 (0.88–1.54)
Status of self-reported smoking experience" 5097 2498 (50.2) 1.00 1040 550 (55.9) 1.00 Former smoker 223 126 (56.6) 1.25 (0.89-1.75) 1588 921 (60.9) 1.39 (1.15-1.69) Smoking period of self-reported smoking experience ^b 700 1040 550 (55.9) 1.00 Never smoker 5097 2498 (50.2) 1.00 1040 550 (55.9) 1.00 <10 years				P: 0.0071			P: 0.2249
Never smoker 5097 2498 50.2 1.00 1040 550 (55.9) 1.00 Former smoker 223 223 (56.6) 1.25 (0.89-1.75) 1588 921 (60.9) 1.39 (1.15-1.69) Smoking period of self-reported smoking experience ^b - -	Status of self-reported smoking experience	5007	2400 (50.2)	1.00	10.40		1.00
Former smoker 223 126 (56.6) 1.26 (0.89–1.75) 1588 921 (60.9) 1.39 (1.15–1.69) Smoking period of self-reported smoking experience ^b	Never smoker	5097	2498 (50.2)	1.00	1040	550 (55.9)	1.00
Notes Solution of self-reported shoking experience Never smoker 5097 2498 (50.2) 1.00 1040 550 (55.9) 1.00 <10 years	Former smoker Smoking paried of colf reported smoking experience	223	126 (56.6)	1.25 (0.89–1.75)	1588	921 (60.9)	1.39 (1.15–1.69)
Never Sinoler 3097 2498 (30.2) 1.00 1040 300 (35.9) 1.00 <10 years	Never smoler	5007	2409 (50.2)	1.00	1040	EEO (EE 0)	1.00
10-20 years 49 27 (59.6) 5.23 (1.34-20.51) 439 265 (63.6) 1.51 (1.12-2.02) 20-30 years 24 15 (57.3) 0.70 (0.14-3.58) 353 196 (58.0) 1.31 (0.94-1.83) 30 + years 24 13 (48.4) - 479 281 (60.4) 2.02 (1.37-2.99) P: 0.0565 Self-reported second-hand smoking exposure ^a Non-exposed 3735 1695 (46.4) 1.00 1598 839 (55.1) 1.00 Exposed 3735 1695 (46.4) 1.00 1598 839 (55.1) 1.00 Exposed 1579 926 (59.2) 1.55 (1.34-1.81) 1030 63.2 (63.6) 1.59 (1.09-1.69) Exposed 1579 926 (59.2) 1.55 (1.34-1.81) 1030 63.2 (63.6) 1.51 (1.0-1.69) Exposed 1593 774 (49.3) 1.00 938 501 (55.4) 1.00 Exposed: less than 1 h 249 157 (63.7) 1.35 (0.97-1.89) 193 123 (65.4) 1.40 (0.97-2.02) P: 0.0162 P: 0.0214 P: 0.0214 P: 0.0214 P: 0.		126	2498 (30.2)	1.00	217	170 (60.6)	1.00
10-20 years 49 27 (39.6) 52.23 (1.34-20.31) 439 263 (63.6) 1.31 (1.12-2.02) 20-30 years 24 15 (57.3) 0.70 (0.14-3.58) 353 196 (58.0) 1.31 (0.94-1.83) 30 + years 24 13 (48.4) - 479 281 (60.4) 2.02 (1.37-2.99) Self-reported second-hand smoking exposure ^a P: 0.0565 P: 0.0004 Self-seported second-hand smoking at workplace ^b 1579 926 (59.2) 1.55 (1.34-1.81) 1030 632 (63.6) 1.35 (1.09-1.69) Exposed 1579 926 (59.2) 1.55 (1.34-1.81) 1030 632 (63.6) 1.35 (1.09-1.69) Exposed 1593 774 (49.3) 1.00 938 501 (55.4) 1.00 Exposed: less than 1 h 659 359 (58.0) 1.27 (1.01-1.59) 753 455 (62.9) 1.34 (1.04-1.73) Exposed: more than 1 h 249 157 (63.7) 1.35 (0.97-1.89) 193 123 (65.4) 1.40 (0.97-2.02) P: 0.0162 P: 0.0214 P: 0.0214 P: 0.0214 P: 0.0214 P: 0.0214 Exposed: less than 1 h 717 421 (57.7) 1.39 (1.06-1.81) <td></td> <td>120</td> <td>71 (50.5) 27 (50.6)</td> <td>1.00(0.79-3.47)</td> <td>420</td> <td>179 (00.0)</td> <td>1.17(0.00-1.01) 1.51(1.10,2.02)</td>		120	71 (50.5) 27 (50.6)	1.00(0.79-3.47)	420	179 (00.0)	1.17(0.00-1.01) 1.51(1.10,2.02)
20-30 years 24 13 (37.3) 0.70 (14-3.36) 333 190 (38.0) 1.10 (34-1.83) 30 + years 24 13 (48.4) - 479 281 (60.4) 2.02 (1.37-2.99) Self-reported second-hand smoking exposure ^a P: 0.0565 P: 0.0565 P: 0.0004 Self-reported second-hand smoking at workplace ^b 1579 926 (59.2) 1.55 (1.34-1.81) 1030 632 (63.6) 1.35 (1.09-1.69) Exposed 1579 926 (59.2) 1.55 (1.34-1.81) 1030 632 (63.6) 1.35 (1.09-1.69) Exposed 1593 774 (49.3) 1.00 938 501 (55.4) 1.00 Exposed: less than 1 h 659 359 (58.0) 1.27 (1.01-1.59) 753 455 (62.9) 1.34 (1.04-1.73) Exposed: more than 1 h 249 157 (63.7) 1.35 (0.97-1.89) 193 123 (65.4) 1.40 (0.97-2.02) P: 0.0162 P: 0.0214 P: 0.0214 P: 0.0214 P: 0.0214 P: 0.0214 Exposed: less than 1 h 717 421 (57.7) 1.39 (1.06-1.81) 112 76 (69.6) 2.53 (1.24-5.18) Non-exposed 4384 2045 (48.2) <t< td=""><td>10-20 years</td><td>49</td><td>27 (59.0)</td><td>5.25(1.54-20.51) 0.70(0.14, 2.58)</td><td>459</td><td>203 (03.0)</td><td>1.31(1.12-2.02) 1.21(0.04, 1.92)</td></t<>	10-20 years	49	27 (59.0)	5.25(1.54-20.51) 0.70(0.14, 2.58)	459	203 (03.0)	1.31(1.12-2.02) 1.21(0.04, 1.92)
30+ years 24 13 (48.4) - 47.9 281 (00.4) 2.00 (1.37-2.39) Self-reported second-hand smoking exposure ^a P: 0.0565 P: 0.0565 P: 0.0004 Self-reported second-hand smoking exposure ^a 1.00 1598 839 (55.1) 1.00 Exposed 1579 926 (59.2) 1.55 (1.34-1.81) 1030 632 (63.6) 1.35 (1.09-1.69) Exposure to second-hand smoking at workplace ^b - -	20-50 years	24	12 (27.5)	0.70 (0.14-5.58)	470	190 (36.0) 281 (60.4)	1.51(0.94-1.65)
Self-reported second-hand smoking exposure ^a 1.00001 Non-exposed 3735 1695 (46.4) 1.00 1598 839 (55.1) 1.00 Exposed 1579 926 (59.2) 1.55 (1.34–1.81) 1030 632 (63.6) 1.35 (1.09–1.69) Exposure to second-hand smoking at workplace ^b	S0 + years	24	13 (40.4)	– P: 0.0565	475	281 (00.4)	P. 0 0004
Non-exposed 3735 1695 (46.4) 1.00 1598 839 (55.1) 1.00 Exposed 1579 926 (59.2) 1.55 (1.34–1.81) 1030 632 (63.6) 1.35 (1.09–1.69) Exposure to second-hand smoking at workplace ^b Non-exposed 1593 774 (49.3) 1.00 938 501 (55.4) 1.00 Exposed: less than 1 h 659 359 (58.0) 1.27 (1.01–1.59) 753 455 (62.9) 1.34 (1.04–1.73) Exposed: more than 1 h 249 157 (63.7) 1.35 (0.97–1.89) 193 123 (65.4) 1.40 (0.97–2.02) P: 0.0162 P: 0.0214 P: 0.0214 P: 0.0214 P: 0.0214 P: 0.0214 Exposed: less than 1 h 717 421 (57.7) 1.39 (1.06–1.81) 112 76 (69.6) 2.53 (1.24–5.18) Non-exposed: more than 1 h 207 152 (68.1) 2.54 (1.41–4.57) 14 10 (77.3) 3.88 (0.49=30.77)	Self-reported second-hand smoking exposure ^a			1.0.0505			1.0.0001
Exposed 1579 926 (59.2) 1.55 (1.34–1.81) 1030 632 (63.6) 1.35 (1.09–1.69) Exposure to second-hand smoking at workplace ^b	Non-exposed	3735	1695 (46.4)	1.00	1598	839 (55.1)	1.00
Exposure to second-hand smoking at workplace ^b 1593 774 (49.3) 1.00 938 501 (55.4) 1.00 Non-exposed 1593 774 (49.3) 1.00 938 501 (55.4) 1.00 Exposed: less than 1 h 659 359 (58.0) 1.27 (1.01–1.59) 753 455 (62.9) 1.34 (1.04–1.73) Exposed: more than 1 h 249 157 (63.7) 1.35 (0.97–1.89) 193 123 (65.4) 1.40 (0.97–2.02) P: 0.0162 P: 0.0162 P: 0.0214 Exposed: less than 1 h 717 421 (57.7) 1.39 (1.06–1.81) 112 76 (69.6) 2.53 (1.24–5.18) Exposed: more than 1 h 207 152 (68.1) 2.54 (1.41–4.57) 14 10 (77.3) 3.88 (0.49–30.77)	Exposed	1579	926 (59.2)	1.55 (1.34-1.81)	1030	632 (63.6)	1.35 (1.09-1.69)
Non-exposed 1593 774 (49.3) 1.00 938 501 (55.4) 1.00 Exposed: less than 1 h 659 359 (58.0) 1.27 (1.01–1.59) 753 455 (62.9) 1.34 (1.04–1.73) Exposed: more than 1 h 249 157 (63.7) 1.35 (0.97–1.89) 193 123 (65.4) 1.40 (0.97–2.02) P: 0.0162 P: 0.0162 P: 0.0214 Exposed: less than 1 h 717 421 (57.7) 1.39 (1.06–1.81) 112 76 (69.6) 2.53 (1.24–5.18) Exposed: more than 1 h 207 152 (68.1) 2.54 (1.41–4.57) 14 10 (77.3) 3.88 (0.49–30.77)	Exposure to second-hand smoking at workplace ^b					())	(,
Exposed: less than 1 h 659 359 (58.0) 1.27 (1.01-1.59) 753 455 (62.9) 1.34 (1.04-1.73) Exposed: more than 1 h 249 157 (63.7) 1.35 (0.97-1.89) 193 123 (65.4) 1.40 (0.97-2.02) P: 0.0162 P: 0.0162 P: 0.0214 Exposed: less than 1 h 717 421 (57.7) 1.39 (1.06-1.81) 112 76 (69.6) 2.53 (1.24-5.18) Exposed: more than 1 h 207 152 (68.1) 2.54 (1.41-4.57) 14 10 (77.3) 3.88 (0.49-30.77)	Non-exposed	1593	774 (49.3)	1.00	938	501 (55.4)	1.00
Exposed: more than 1 h 249 157 (63.7) 1.35 (0.97-1.89) 193 123 (65.4) 1.40 (0.97-2.02) Exposure to second-hand smoking at home ^b P: 0.0162 P: 0.0214 Exposed 4384 2045 (48.2) 1.00 2500 1383 (57.9) 1.00 Exposed: less than 1 h 717 421 (57.7) 1.39 (1.06-1.81) 112 76 (69.6) 2.53 (1.24-5.18) Exposed: more than 1 h 207 152 (68.1) 2.54 (1.41-4.57) 14 10 (77.3) 3.88 (0.49-30.77)	Exposed: less than 1 h	659	359 (58.0)	1.27 (1.01-1.59)	753	455 (62.9)	1.34 (1.04-1.73)
P: 0.0162 P: 0.0214 Exposure to second-hand smoking at home ^b P: 0.0214 Non-exposed 4384 2045 (48.2) 1.00 2500 1383 (57.9) 1.00 Exposed: less than 1 h 717 421 (57.7) 1.39 (1.06-1.81) 112 76 (69.6) 2.53 (1.24-5.18) Exposed: more than 1 h 207 152 (68.1) 2.54 (1.41-4.57) 14 10 (77.3) 3.88 (0.49-30.77)	Exposed: more than 1 h	249	157 (63.7)	1.35 (0.97–1.89)	193	123 (65.4)	1.40 (0.97-2.02)
Exposure to second-hand smoking at home ^b Image: Second-hand smoking at home ^b <	-		. /	P: 0.0162		- /	P: 0.0214
Non-exposed 4384 2045 (48.2) 1.00 2500 1383 (57.9) 1.00 Exposed: less than 1 h 717 421 (57.7) 1.39 (1.06-1.81) 112 76 (69.6) 2.53 (1.24-5.18) Exposed: more than 1 h 207 152 (68.1) 2.54 (1.41-4.57) 14 10 (77.3) 3.88 (0.49-30.77)	Exposure to second-hand smoking at home ^b						
Exposed: less than 1 h717421 (57.7)1.39 (1.06–1.81)11276 (69.6)2.53 (1.24–5.18)Exposed: more than 1 h207152 (68.1)2.54 (1.41–4.57)1410 (77.3)3.88 (0.49–30.77)	Non-exposed	4384	2045 (48.2)	1.00	2500	1383 (57.9)	1.00
Exposed: more than 1 h 207 152 (68.1) 2.54 (1.41–4.57) 14 10 (77.3) 3.88 (0.49–30.77)	Exposed: less than 1 h	717	421 (57.7)	1.39 (1.06-1.81)	112	76 (69.6)	2.53 (1.24-5.18)
\mathbf{I} (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	Exposed: more than 1 h	207	152 (68.1)	2.54 (1.41-4.57)	14	10 (77.3)	3.88 (0.49-30.77)
P: 0.0002 P: 0.0184				P: 0.0002			P: 0.0184

Cotinine verified SHS exposure is based on a 5 ng/ml threshold of urinary cotinine concentration.

OR: odds ratio; CI: confidence interval; P: P for trend.

The reference is the non-exposed group, which was verified with urinary cotinine measures.

^a Multiple logistic regression models adjusting for age, marital status, education, monthly household income, employment, self-reported second-hand smoking exposure, drinking alcohol and status of self-reported smoking experience.

^b Multiple logistic regression models adjusting for age, marital status, education, monthly household income, exposure to second-hand smoking at work place, exposure to second-hand smoking at home, frequency of drinking alcohol, and smoking period of self-reported smoking experience.

mentioned, former smokers are usually very tolerant of others who smoke, and drinking and smoking often coincide at social gatherings. In particular, in traditional Korean culture, smoking and drinking have been considered a means for facilitating social relationships and gatherings (Kim et al., 2005). Therefore, former smokers might be more likely to socialize with friends or neighbors who are current smokers and may also easily condone their smoking. Moreover, younger people and females are brought up to respect the behaviors, including smoking, of the older generations and people in higher social positions. It has been reported that, if possible, and to avoid direct confrontation, Korean people tend to express their reluctance toward SHS exposure indirectly only, with facial cues or with modest body language (Hughes et al., 2011). The socio-cultural contexts related to smoking behavior in Korea do not allow people to bring attention to SHS exposure or to avoid those practicing this behavior, which could also be linked to a higher SHS exposure among nonsmokers. Therefore, it is necessary to account for these social components when looking at SHS exposure.

However, the present study suggested a relatively high level of SHS exposure among Koreans, which may be a result of incomplete smoke-free legislation and a continued high prevalence of smoking in males. Among our nonsmoking study subjects, 40.7% reported SHS exposure, which is lower than in China (49.2%) (Gu et al., 2004) and Spain (69.5% for males and 62.9% for females) (Twose et al., 2007), while it is higher than the SHS exposure in Finland (14%) (Jousilahti and Helakorpi, 2002), Norway (14.4% at home, 12.8% at work) (Skorge et al., 2007), and Canada (22%) (Wong et al., 2013). Regardless of the measuring method, self-reported SHS exposure at work and at home was higher in females (57.1% at work, 17.8% at home) than in males (41.2% at work, 4.8% at home) in our study and was much higher at work than at home in both genders (data not shown). In the past, those with smokers in their families did not enforce home smoking bans due to traditional Korean culture, which has considered smoking to be a symbol of male identity (Kim et al., 2005). Recently, with the contribution of the national campaign on the harm of SHS exposure, and motivated housewives' efforts to ban smoking at home in order to protect their children from SHS exposure, the probability of being exposed to SHS at home has decreased (Hughes et al., 2008). However, SHS exposure outside the home has not really been affected; the prevalence of SHS exposure at work is still high. This suggests that the comprehensive implementation of smoke-free legislation, as well as political and social enforcement, is necessary to sustain smoke-free environments and to make them part of the mainstream culture.

Even though self-reported SHS exposure did not significantly correspond with the cotinine verified SHS exposure in the present study, the number of subjects who reported exposure to SHS was higher in the cotinine verified SHS exposure group compared with the cotinine verified non-SHS exposure group. Additionally, cotinine verified SHS exposure at home and at work significantly increased with increasing self-reported SHS exposure time in both females and males. These results are in agreement with some previous studies (Baheiraei et al., 2012; Baltar et al., 2011; Simoni et al., 2006; Thompson et al., 1990; Yano, 2005). For future studies, other measures, such as hair nicotine and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol (NNAL), should also be considered to examine long term exposure or to improve the accuracy of the current study.

Table 3

Frequency distribution of non-SHS exposure, cotinine verified SHS exposure alone, both self-reported, and cotinine verified SHS exposure group and factors associated with cotinine verified but not with self-reported SHS exposure (females).

	Total	Group 1	Group 2		Group 3	
	n = 5314	n = 2040 (36.5%)	n = 1695 (31.6%)	OR (95% CI)	n = 926 (18.9%)	OR (95% CI)
Age groups ^a						
60+	1651	806 (29.5)	528 (21.4)	1.00	152 (11.1)	1.00
50–59	979	371 (18.6)	269 (16.5)	1.05 (0.84-1.33)	189 (18.7)	2.83 (2.07-3.87)
40-49	1016	326 (18.8)	303 (19.9)	1.15 (0.87-1.52)	235 (26.4)	4.08 (2.83-5.88)
30–39	1026	355 (19.6)	362 (22.4)	1.17 (0.85-1.61)	200 (20.7)	3.48 (2.36-5.12)
19–29	642	182 (13.5)	233 (19.8)	1.70 (1.12-2.57)	150 (23.1)	4.54 (2.71-7.60)
				P: 0.0131		P: <0.0001
Marital status ^a						
Married	4753	1872 (88.4)	1519 (85.2)	1.00	790 (79.9)	1.00
Single	545	159 (11.6)	172 (14.8)	0.79 (0.56-1.11)	135 (20.1)	1.29 (0.88-1.88)
Education ^a						
≤9 years	2466	1078 (43.8)	715 (33.5)	1.00	364 (32.3)	1.00
10–12 years	1702	553 (31.9)	541 (36.1)	1.16 (0.90-1.49)	385 (45.3)	0.96 (0.72-1.27)
12+ years	1144	408 (24.3)	438 (30.4)	1.25 (0.93-1.67)	177 (22.3)	0.60 (0.42-0.84)
				P: 0.2100		P: 0.0003
Monthly household income (10,000 KRW/month) ^a						
<200	2282	952 (41.8)	678 (34.7)	1.00	377 (38.4)	1.00
200-400	1722	609 (34.0)	584 (38.2)	1.14 (0.92–1.41)	312 (35.0)	0.77 (0.61-0.97)
400 +	1194	429 (24.2)	400 (27.2)	1.12 (0.84–1.48)	217 (26.6)	0.86 (0.64–1.17)
				P: 0.4513		P: 0.8370
Drinking alcohol ^a						
Non-drinker	3369	1461 (67.7)	1074 (60.3)	1.00	451 (45.6)	1.00
Drinker	1941	577 (32.3)	620 (39.7)	1.26 (1.06–1.50)	475 (54.4)	2.01 (1.67–2.42)
Frequency of drinking alcohol ^b						
Non-drinker	3369	1461 (67.7)	1074 (60.3)	1.00	451 (45.6)	1.00
1 time per month	649	220 (11.8)	209 (13.4)	1.18 (0.92–1.51)	140 (15.7)	1.66 (1.26–2.20)
2–4 times per month	881	261 (15.4)	282 (17.5)	1.15 (0.92–1.45)	206 (23.2)	1.78 (1.38–2.31)
Over 2 times per week	411	96 (5.10)	129 (8.8)	1.74 (1.25–2.44)	129 (15.5)	3.45 (2.48–4.79)
				P: 0.0025		P: <0.0001
Status of self-reported smoking experience	5004	1000 (05 5)	1010 (010)	1.00	000 (05 0)	1.00
Never smoker	5091	1960 (95.5)	1612 (94.6)	1.00	883 (95.3)	1.00
Former smoker	223	80 (4.5)	83 (5.4)	1.13 (0.77-1.65)	43 (4.7)	0.92 (0.58–1.47)
Smoking period of self-reported smoking experience	5001	1000 (05 5)	1012 (04 0)	1.00	002 (05 2)	1.00
	120	1960 (95.5)	1012 (94.0)		883 (95.3)	1.00
< IU years	126	40 (2.9)	40 (3.2) 16 (1.2)	0.90(0.59-1.57)	23 (3.0) 11 (1.1)	0.78(0.40-1.50)
10-20 years	49	10(0.8)	10(1.3)	1.55(0.04-2.85)	11(1.1)	0.93(0.37-2.48)
20-50 years	24	/ (0.2)	12(0.4)	2.04(1.00-7.02)	5(0.2)	2.00(0.30-7.97)
JU T years	24	11(0.5)	3(0.4)	0.70 + 0.27 - 2.02	+(0.)	1.10 (0.00-0./2)

Cotinine verified SHS exposure is based on a 5 ng/ml threshold of urinary cotinine concentration.

OR: odds ratio; CI: confidence interval; P: P for trend.

Group 1 (Reference group): non-SHS exposure; group 2: cotinine verified SHS exposure alone; group 3: both self-reported and cotinine verified SHS exposure. The group of self-reported SHS exposure alone was omitted in the table even though it was included in the multinomial logistic regression analysis.

^a Multinomial logistic regression models adjusting for age, marital status, education, monthly household income, drinking alcohol, and status of self-reported smoking experience. ^b Multinomial logistic regression models adjusting for age, marital status, education, monthly household income, frequency of drinking alcohol, and smoking period of self-reported smoking experience.

Table 4

Frequency distribution of non-SHS exposure, cotinine verified SHS exposure alone, both self-reported, and cotinine verified SHS exposure group and factors associated with cotinine verified but not with self-reported SHS exposure (males).

	Total	Group 1	Group 2		Group 3		
	n = 2628	n = 759 (25.8%)	n = 839 (31.6%)	OR (95% CI)	n = 632 (27.16%)	OR (95% CI)	
Age groups ^a							
60+	888	361 (30.7)	352 (25.4)	1.00	75 (6.8)	1.00	
50–59	489	139 (20.1)	137 (16.5)	1.06 (0.78-1.45)	127 (18.1)	3.70 (2.43-5.64)	
40-49	486	103 (18.5)	127 (19.2)	1.34 (0.96-1.88)	170 (27.8)	5.92 (3.77-9.31)	
30-39	427	82 (14.1)	102 (15.5)	1.72 (1.11–2.67)	167 (27.7)	9.55 (5.63–16.2)	
19–29	338	74 (16.7)	121 (23.5)	2.89 (1.67-5.01)	93 (19.6)	8.03 (3.89–16.57)	
				P: 0.0007		P: <0.0001	
Marital status ^a							
Married	2211	656 (78.7)	696 (74.1)	1.00	512 (76.1)	1.00	
Single	409	101 (21.3)	139 (25.9)	0.69 (0.43-1.12)	118 (23.9)	0.59 (0.34-1.04)	
Education ^a		. ,	. ,	. ,	. ,	. ,	
≤ 9 years	874	319 (29.9)	317 (26.8)	1.00	120 (15.4)	1.00	
10–12 years	921	218 (34.1)	272 (39.2)	0.86 (0.62-1.20)	280 (44.8)	0.97 (0.66-1.43)	
12 + years	828	221 (36.0)	247 (34.0)	0.73 (0.51-1.05)	231 (39.8)	0.69 (0.45-1.06)	
5				P: 0.0450		P: 0.0939	
Monthly household income (10,000 KRW/month) ^a							
<200	1021	372 (40.8)	370 (39.3)	1.00	152 (23.3)	1.00	
200-400	890	215 (33.6)	236 (31.3)	0.94 (0.69-1.29)	277 (44.3)	1.48 (1.04-2.11)	
400 +	659	153 (25.5)	206 (29.4)	1.23 (0.87-1.76)	196 (32.5)	1.52 (1.07-2.17)	
				P: 0.3207		P: 0.0042	
Drinking alcohol ^a							
Non-drinker	873	323 (39.4)	311 (35.8)	1.00	135 (19.9)	1.00	
Drinker	1753	435 (60.6)	527 (64.2)	1.09 (0.86-1.38)	497 (80.1)	2.12 (1.59-2.82)	
Frequency of drinking alcohol ^b							
Non-drinker	873	323 (39.4)	311 (35.8)	1.00	135 (19.9)	1.00	
1 time per month	231	64 (9.9)	73 (9.9)	1.06 (0.69-1.64)	56 (9.4)	1.48 (0.92-2.38)	
2–4 times per month	671	159 (25.1)	177 (24.6)	0.94 (0.68-1.29)	224 (35.8)	2.09 (1.47-2.98)	
Over 2 times per week	851	212 (25.7)	277 (29.7)	1.26 (0.94-1.69)	217 (34.9)	2.35 (1.68-3.30)	
*		. ,	. ,	P: 0.2939	. ,	P: <0.0001	
Status of self-reported smoking experience ^a	Status of self-reported smoking experience ^a						
Never smoker	1040	309 (44.0)	300 (41.0)	1.00	250 (40.9)	1.00	
Former smoker	1588	450 (56.0)	539 (59.0)	1.31 (1.02-1.69)	382 (59.1)	1.24 (0.94-1.64)	
Smoking period of self-reported smoking experience ^b		. ,	. ,	. ,	. ,	. ,	
Never smoker	1040	309 (44.0)	300 (41.0)	1.00	250 (40.9)	1.00	
<10 years	317	83 (11.8)	97 (14.1)	1.29 (0.87-1.92)	82 (13.4)	1.06 (0.69-1.62)	
10-20 years	439	111 (15.7)	126 (16.3)	1.20 (0.86–1.68)	139 (22.8)	1.18 (0.81–1.71)	
20-30 years	353	102 (13.6)	100 (11.0)	1.03 (0.70-1.52)	96 (15.3)	1.35 (0.89-2.03)	
30 + years	479	154 (14.9)	216 (17.7)	1.84 (1.30-2.60)	65 (7.6)	1.46 (0.91-2.37)	
				P: 0.0045		P: 0.0455	

Cotinine verified SHS exposure is based on a 5 ng/ml threshold of urinary cotinine concentration.

OR: odds ratio; CI: confidence interval; P: P for trend.

Group 1 (reference group): non-SHS exposure; group 2: cotinine verified SHS exposure alone; group 3: both self-reported and cotinine verified SHS exposure. The group of self-reported SHS exposure alone was omitted in the table even though it was included in the multinomial logistic regression analysis.

Multinomial logistic regression models adjusting for age, marital status, education, monthly household income, drinking alcohol, and status of self-reported smoking experience.

^b Multinomial logistic regression models adjusting for age, marital status, education, monthly household income, frequency of drinking alcohol, and smoking period of self-reported smoking experience.

Despite these meaningful implications, the current study has some limitations. First, there is a possibility that a substantial number of female smokers did not report their smoking habits due to reluctance, as suggested by Jung-Choi et al. (2012), and were subsequently misclassified as nonsmokers. This may have resulted in an overestimation of the cotinine verified SHS exposure among nonsmokers due to the inclusion of some current smokers. To test this, we carried out the same analysis excluding subjects who showed a cotinine concentration of more than 100 ng/ml, which has been frequently suggested as the threshold to discriminate smokers from nonsmokers (Haufroid and Lison, 1998; Jhun et al., 2010); we obtained the same results. Therefore, the possibility of misclassification would not have distorted the current study results. Second, we used 5 ng/ml as a threshold for nonsmokers exposed to SHS, whereas some previous studies have suggested a higher optimal value, such as 10 ng/ml or 30 ng/ml (Haufroid and Lison, 1998). However, these higher threshold values have been proposed when testing children, who can present with higher cotinine concentrations than adults due to differences in body distribution and nicotine metabolism. The argument that our cotinine concentration threshold for SHS exposure was too low can generally be disregarded because there is ample evidence to support a 5 ng/ml or similar value as an optimal threshold (Benowitz, 1996; Haufroid and Lison, 1998; Moyer et al., 2002). Additionally, we could not consider other factors associated with urinary cotinine excretion, such as the consumption of food that contains nicotine, the use of nicotine replacement therapy, or impaired nicotine metabolism caused by genetic polymorphisms (Benowitz, 1996; Haufroid and Lison, 1998; Ino et al., 2011; Jung-Choi et al., 2012). However, it is unlikely that these factors affected our results. Lastly, urinary cotinine measures were not available for a considerable number of subjects (30.9% of participants had complete information on smoking status) due to the urine not being submitted for testing. However, this would not mislead the study results because when we regarded the other factors including general characteristics and smoking status, these variables were not much different when stratified by whether the subject submitted their urine for testing or not.

Conclusion

The most notable finding of the present study is that self-reported SHS exposure assessments significantly underestimate the actual exposure to SHS in Korea, as shown by the discrepancy between



B) Self-reported smoking duration



Fig. 1. Urinary cotinine concentration among subjects with cotinine verified exposure to second-hand smoke (\geq 5 ng/ml) by (A) frequency of alcohol drinking and by (B) self-reported smoking duration.

self-reported SHS exposure and cotinine verified SHS exposure. Furthermore, lifestyle choices that put one in an environment that is tolerant toward smoking, such as being a former smoker or a frequent alcohol drinker, may be potential indicators of unrecognized SHS exposure. Because of the high exposure to SHS and a tolerance to smoking in Korea, efforts to de-normalize smoking in the Korean culture need to be strengthened. In addition, the partial ban on smoking in public places should be expanded to include all public places and should be strictly enforced.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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