RESEARCH ARTICLE

Biochemically-verified Smoking Rate Trends and Factors Associated with Inaccurate Self-reporting of Smoking Habits in Korean Women

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Abstract

Background: Lung cancer is a major cause of Korean female mortality and is clearly associated with smoking. The Korean National Health and Nutrition Examination Survey (KNHANES IV-2,3), which included both self-reports of smoking and urinary cotinine data, revealed a significant discrepancy between the prevalence of self-reported and biochemically-verified female smokers. The factors associated with accurate self-reporting of current smoking status remain poorly understood, however. Materials and Methods: We assessed the prevalence of smoking in KNHANES using both self-report and urinary cotinine data. Subsequently, using univariate and multivariate tests, we assessed whether age, intensity of smoking, marital status, relationship with cohabitants, education, occupation, residential area, or annual household income were associated with inaccurate self-reporting in Korean females. We also investigated whether the prevalence of inaccurate self-reports changed over the survey period, 2008-2009. Results: The prevalence of self-reported smoking was 47.8% in males and 6.6% in females. By contrast, the prevalence of smoking as assessed by urinary cotinine levels was 52.2% in males and 14.5% in females. Of the 746 females with urinary cotinine levels >50ng/ml, 407 (56.0%) provided inaccurate self-reports. In a multivariate model, age group(40-49: OR 3.54, 95%CI 1.42-8.86, p=0.007; ref :20-29), cotinine intensity(OR 0.999, 95%CI 0.998-0.999, p<0.001), marital status (married but without spouse: OR 0.37, 95%CI 0.15-0.94, p=0.037; ref :never married), relationship with cohabitants (living with a spouse and unmarried child: OR 2.63, 95%CI 1.44-4.80, p=0.002; living with 2 generations except unmarried child: OR 2.53, 95%CI 1.09-5.87, p=0.030; living with ≥3 generations: OR 3.25, 95%CI 1.48-7.10, p=0.003; ref :spouse only) and education(college or higher: OR 2.73, 95%CI 1.04-7.18, p=0.042; ref :elementary or less) were independently associated with inaccurate self-reports. Conclusions: The trend of smoking prevalence of Korean females is likely to decrease. However, an elevated prevalence of inaccurate self-reports by females remains. Factors related to the intensity of smoking and family status appear to influence whether a Korean female provides an accurate self-report when asked about smoking behavior.

Keywords: Smoking rates - cotinine - surveillance and monitoring - self-reporting - Korean females

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Introduction

Cancer is the first cause of death in Korea and lung cancer is the most common type of cancer among Korean female (mortality rate is 9.1 per 10,000 persons in 2010) (Jung et al., 2013). Especially, female lung cancer mortality has grown up continuously year by year (Bae et al., 2002).

Meanwhile, Smoke load cause a large cancer burden including lung cancer in Korean female, according to Park et al. (2007)and Population attributable fraction of smoking to female lung cancer is expected to 50% in the future (Martiniuk et al., 2010). Korean female smoking rate from OECD health data was just 5.2% and this is lower value than average of OECD countries (16.8%). But when the smoking status verified with chemical, female smoking rate was reported as 14.8% (Jung-Choi et al., 2012). The data collecting method, self-report or with chemical, caused this gap.

Nationwide surveys facilitate the analysis of social behaviors such as smoking. Behavioral data are primarily based on self-reports, which provide fairly accurate information in large samples (Connor Gorber et al., 2009). However, for certain behaviors, such as smoking, self-report tends to result in underreporting (Wagenknecht et al., 1992; Wong et al., 2012).

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Measuring urinary cotinine is an accurate, objective method of determining the current smoking status of an individual (Jarvis et al., 1987). A major metabolite of nicotine that is present in tobacco smoke, cotinine has a half-life of 16 to 20 hours in the body but can remain in the system for up to 2 weeks (Zielinska-Danch et al., 2007). The concentration of cotinine found in the serum, urine, or even saliva is directly related to the extent of an individual's smoking. A widely accepted cut-off value for active smoking is 50ng/ml in urine; values below this point may reflect environmental exposure to cigarette smoke (Verification, 2002). In heavy smokers, urinary cotinine levels can exceed 500-1,000 ng/ml (Jarvis et al., 2008).

By verifying self-reports of tobacco use and cessation with urinary cotinine measurements, researchers can identify inaccurate self-reports and study the factors that lead to them (Verification, 2002). Using this method, past studies have revealed startling levels of underreporting in Korean females relative to males (Jung-Choi et al., 2012). And previous research has characterized the relationship between marital status, BMI, body image, and smoking in Korean women (Cho et al., 2008; Jang et al., 2012).

In this study we attempted to analyze the gap of smoking rate between verbal and chemical method for two years and underlying reasons for underreporting in Korean women. We explored whether smoking, demographic, and familial factors influenced the accuracy of self-reports by analyzing urinary cotinine levels in tandem with smoking self-report data from the Korean National Health and Nutrition Examination Survey (KNHANES).

Materials and Methods

KNHANES IV-2,3; 2008-2009 data were used retrospectively to determine significance. This survey was designed as cross-sectional studies using stratified, multistage sampling based on age, gender, and residential area, so that the results would be representative of the entire Korean population in a given year (Jung-Choi et al., 2012).

The 2008-2009 survey included 20,777 individuals (9,213 males and 11,064 females). Individuals without urinary cotinine values (3,632males and 4,719females) or who were under 20 years of age (920 males and 696 females) were excluded from our analysis. In addition, any individual who responded to the question "Are you a current smoker?" with "I don't know" (1 male and 1 female) or who was missing a response to this question (n=33) was excluded. This left a total of 10,275 individuals (4,645 males and 5,630 females) for analysis (Table 1).

Weights were applied to the sample to supply a population-representative overview of cotinine-assessed versus self-reported smoking status. Then the validity of self-reported smoking status was determined for each sex and year-by-year, with each year assigned a different weight.

After eliminating all urinary cotinine-verified nonsmoking females (<50ng/ml cotinine, n=4,884), the remaining female sample (n=746) was stratified according to whether individuals identified themselves as current smokers or non-smokers. Age, intensity of smoking habit as determined by urinary cotinine levels, marital status, relationship with cohabitants, education, occupation, residential area, annual household income, and survey year were compared between the two groups to determine which factors affected an individual's propensity to provide accurate self-reports. Age was divided into five decade-long categories, starting at 20 years old. We categorized marital status as: *i*) never married; *ii*) living with a spouse; and *iii*) has been married but is not currently living with a spouse. Relationship with cohabitants encompassed six categories: *i*) Living alone; *ii*) living with spouse only; *iii*) living in a conformation that included only one generation but was not described by the prior two categories; *iv*) living with both a spouse and an unmarried child; *v*) living in a conformation that included two generations but was not described by the prior category; and *vi*) living with three or more generations. Residential areas were classified as the capital (Seoul), major cities (Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan), and other province areas (Gyeonggi-do, Gangwon-do, Chungcheongbuk-do, Chungcheongnam-do, Jeollabuk-do, Jeollanam-do, Gyeongsangbuk-do, Gyeongsangnam-do, and Jeju Special Self-Governing Province).

Statistical analyses were performed using the SAS 9.2 program. Bivariate independent t-tests, chi-square analyses, and multivariate binary logistic regression models were used to assess the significance of the various potential predictor variables described above. For all procedures, the appropriate statistical weights were assigned using the nomcar option so that the results would be representative of the entire Korean population. This study received no specific funding and did not be obtained Ethics committee/Institutional Review Board approval because used secondary data which are processed to be anonymous.

Results

General characteristics of the total population are shown in Table 1. Among males, individuals in the 30-49 year old category were most common, whereas females tended to be older. While 34.5% of males had a college education or higher and only 13.1% had an elementary education or less, only 24.6% of females had completed college or higher and 29.0% had an elementary education or less. The higher proportion of elderly females may have contributed to this relatively low education level. More than two-thirds of males were employed, but nearly half of females were unemployed. An Annual household income of male is higher than female's about 1.2 million won (1USD=1,064won, 2013). The distributions of residential areas and the year in which data were obtained were similar between the sexes.

There were statistical differences between the sexes in the 'reported smoking,' 'urine cotinine level,' and 'cotinine intensity' variables (Table 1). The prevalence of self-reported smoking was 47.8% in males and 6.6% in females ($p<0.001$). By contrast, smoking prevalence as assessed using urinary cotinine levels was 52.2% in males and 14.5% in females ($p<0.001$). Mean subject cotinine intensity was also significantly different between

Table 1. General Characteristics of Total Population (n=10,275)

			Male (n=4,645) n (*%)	Female (n=5,630) n (*%)	p value
Individual factors	Age (yrs) [*mean(SE)]		43.7(±0.2)	46.5(±0.2)	<0.001
	Age by group	20-29	628(20.3)	685(17.9)	<0.001
		30-39	972(23.7)	1,100(20.4)	
		40-49	952(23.0)	1,069(21.2)	
		50-59	818(16.9)	1,025(17.8)	
		≥60	1,275(16.2)	1,751(22.7)	
	Self-reported smoking	Yes	2,072(47.8)	350(6.6)	<0.001
		No	2,573(52.2)	5,280(93.4)	
	Urine cotinine level	≥50	2,285(52.2)	746(14.5)	<0.001
		<50	2,360(47.8)	4,884(85.5)	
	Cotinine Intensity (ng/ml) [*mean(SE)]		697.8(±14.5)	104.7(±4.7)	0.006
Familial factors	Marital status	Never married	785(24.1)	586(15.9)	<0.001
		With spouse	3,587(71.3)	3,800(66.0)	
		Married but without spouse	252(4.5)	1,221(18.2)	
	Relationship with cohabitant	Spouse only	972(14.2)	981(13.5)	<0.001
		Living alone	224(4.4)	529(6.8)	
		**1 generation	81(2.4)	72(1.5)	
		Spouse with unmarried child	2,275(54.2)	2,386(48.5)	
		**2 generation	460(10.5)	776(13.7)	
		≥3 generation	626(14.2)	880(15.9)	
Socioeconimic foactors	Education	Elementary or less	881(13.1)	2,040(29.0)	<0.001
		Middle	587(10.7)	580(10.1)	
		High	1,696(41.7)	1,815(36.2)	
		College or higher	1,470(34.5)	1,190(24.6)	
	Occupation by sector	None	1,104(22.4)	2,944(51.6)	<0.001
		Agriculture, Industry	1,818(35.7)	1,186(18.1)	
		Services	1,005(24.4)	1,050(21.2)	
		Managerial, Specialist	691(17.5)	436(9.1)	
	Residential area	Seoul	786(21.2)	956(21.2)	0.937
		Other cities	1,209(26.1)	1,502(26.4)	
		Rural area	2,650(52.7)	3,172(52.4)	
	Annual household income (1,000,000 won) [*mean(SE)]		38.7(±0.9)	35.4(±0.7)	0.005
	Year	2008	2,451(47.5)	3,126(47.1)	0.696
		2009	2,194(52.5)	2,504(52.9)	

*Weighted %, weighted mean; SE:standard error; **1 generation: except spouse only; **2 generation: except spouse with unmarried child

males (697.8±14.5ng/ml) and females (104.7±4.7ng/m, p=0.006). Table 2 shows the Population overview of cotinine-assessed versus self-reported smoking status. Of the men with urinary cotinine levels >50ng/ml (n=2,285), only 250 (10.3%) provided inaccurate self-reports. Of the 746 women in the same situation, however, 407 (56.0%) failed to provide accurate self-reports. Thus, while according to self-report the prevalence of female smokers in Korea was 6.6%, the prevalence obtained using cotinine levels was 14.5%. The sensitivity of self-report was only 44.0% in females, a much lower value than was found in males, 89.7% (Table 2). Two temporal trends were identified. First, smoking prevalence in females, as assessed using both methods, declined between 2008 and 2009. Second, the sensitivity of self-report in females decreased over time.

Table 3 shows the characteristics of self-reported smokers and non-smokers among cotinine-verified female smokers. Although there were no statistically significant differences between the two groups when using unweighted, bivariate tests, individuals in the 40-49 year age group were more common among self-reported nonsmokers (25.8%) than self-reported smokers (16.1%). By contrast, the results of a weighted bivariate analysis revealed significant differences in the intensity of cotinine (p<0.001), marital status (p<0.001), relationship with cohabitants (p<0.001), education (p=0.007), and annual household income (p<0.001) between accurate and inaccurate self-reporters.

Table 2. Population Overview of Cotinine-assessed Versus Self-reported Smoking Status and Validity of Self-reported Smoking Status

Self-reported status		Cotinine-assessed status		
		Smoker, n (*%)	Nonsmoker, n (*%)	Total, n (*%)
Male	Smoker	2,035 (89.7)	37 (2.2)	2,072 (47.8)
	Nonsmoker	250 (10.3)	2,323 (97.8)	2,574 (52.2)
	Total	2,285 (100.0)	2,361 (100.0)	4,646 (100.0)
Female	Smoker	339 (44.0)	11 (0.3)	350 (6.6)
	Nonsmoker	407 (56.0)	4,874 (99.7)	5,281 (93.4)
	Total	746 (100.0)	4,885 (100.0)	5,631 (100.0)

	Male			Female		
	Total (%)	2008 (%)	2009 (%)	Total (%)	2008 (%)	2009 (%)
Self-reported prevalence	47.8	47.8	47.9	6.6	7.3	6.0
Cotinine-verified prevalence	52.2	52.7	51.7	14.5	15.7	13.4
Sensitivity	89.7	88.9	90.4	44.0	44.9	43.0
Specificity	97.8	98.2	97.5	99.7	99.7	99.8
Positive predictive value	97.8	98.2	97.5	96.6	96.7	96.4
Negative predictive value	89.7	88.8	90.5	91.3	90.7	91.9
Accuracy	93.6	93.3	93.8	91.6	91.1	92.1

*Weighted %, calculated by weighted frequency

Table 4 shows crude and adjusted odds ratios (or estimated parameters) for various smoking, demographic, and family-related factors, where the outcome was an

Table 3. Difference in Proportion (or mean) of Covariates between Self-reported Smoker and Nonsmoker in the Cotinine-verified Female Smoker (Total=746)

Individual factors	Age (yrs)		42.1	(±0.9)	42.7	(±0.8)	0.596
	Age by group	20-29	78	(31.1)	77	(25.6)	0.158
		30-39	76	(24.6)	107	(22.9)	
		40-49	54	(16.1)	85	(25.8)	
		50-59	40	(10.1)	59	(10.7)	
		≥60	91	(18.1)	79	(15.1)	
	Cotinine Intensity	(ng/ml)	987.2	(±39.5)	416.8	(±28.2)	<0.001
Familial factors	Marital status	Never married	72	(26.3)	56	(19.0)	<0.001
		With spouse	150	(44.1)	280	(66.1)	
		Married but without spouse	115	(29.6)	71	(14.9)	
	Relationship with cohabitant	Spouse only	43	(11.5)	47	(7.3)	<0.001
		Living alone	49	(11.2)	30	(5.2)	
		**1 generation	17	(6.7)	7	(1.7)	
		Spouse with unmarried child	104	(34.8)	200	(56.1)	
		**2 generation	71	(19.6)	62	(13.0)	
		≥3 generation	55	(16.1)	61	(16.6)	
Socioeconimic foactors	Education	Elementary or less	112	(25.7)	102	(19.3)	0.007
		Middle	31	(10.7)	33	(6.8)	
		High	150	(49.1)	174	(47.4)	
		College or higher	46	(14.6)	97	(26.5)	
	Occupation by sector	None	162	(47.8)	190	(46.5)	0.652
		Agriculture, Industry	55	(15.6)	89	(18.6)	
		Services	98	(29.9)	96	(26.4)	
		Managerial, Specialist	22	(6.6)	29	(8.5)	
	Residential area	Seoul	77	(24.9)	72	(22.0)	0.559
		Other cities	84	(26.5)	110	(24.2)	
		Rural area	178	(48.7)	225	(53.8)	
	Annual household income (1,000,000 won)		30.0	(±3.5)	37.0	(±1.7)	<0.001
	Year	2008	189	(52.2)	253	(50.2)	0.702
		2009	150	(47.8)	154	(49.8)	

*Weighted %, weighted mean; SE:standard error; **1 generation: except spouse only; **2 generation: except spouse with unmarried child

Table 4. Crude and Adjusted Odds Ratio (or Estimated Parameter) of Inaccurate Self-responses (as "NO") about Smoking Habit in Cotinine-verified Female Smoker

		Crude			Adjusted		
		OR	(95%CI)	p value	OR	(95%CI)	p value
Individual factors							
Age by group (reference="20-29")	30-39	1.17	(0.67-2.04)	0.575	1.23	(0.59-2.56)	0.574
	40-49	***2.04**	**(1.12-3.73)**	**0.021**	***3.54**	**(1.42-8.86)**	**0.007**
	50-59	1.30	(0.72-2.34)	0.388	2.32	(0.94-5.73)	0.069
	≥60	0.89	(0.46-1.73)	0.737	2.62	(0.89-7.70)	0.080
Cotinine Intensity (ng/ml)		***0.999**	**(0.998-0.999)**	**<0.001**	***0.998**	**(0.998-0.999)**	**<0.001**
Familial factors							
Marital status (reference="Never married")	With spouse	***1.94**	**(1.18-3.17)**	**0.009**	**1.58**	**(0.71-3.54)**	**0.267**
	Married but without spouse	0.67	(0.34-1.30)	0.237	*0.37	(0.15-0.94)	0.037
Relationship with cohabitant	Living alone	0.78	(0.35-1.74)	0.536	1.89	(0.70-5.07)	0.209
(reference="Spouse only")	**1 generation	0.41	(0.13-1.33)	0.136	1.21	(0.20-7.39)	0.836
	Spouse with unmarried child	***2.45**	**(1.38-4.35)**	**0.002**	***2.63**	**(1.44-4.80)**	**0.002**
	**2 generation	1.08	(0.58-2.03)	0.806	*2.53	(1.09-5.87)	0.030
	≥3 generation	1.67	(0.79-3.51)	0.179	*3.25	(1.48-7.10)	0.003
Socioeconimic foactors							
Education (reference="Elementary or less")	Middle	0.88	(0.40-1.94)	0.757	1.04	(0.33-3.23)	0.951
	High	1.28	(0.77-2.15)	0.343	1.46	(0.64-3.31)	0.371
	College or higher	***2.34**	**(1.37-3.98)**	**0.002**	***2.73**	**(1.04-7.18)**	**0.042**
Occupation by sector (reference="none")	Agriculture, Industry	1.20	(0.70-2.05)	0.518	1.37	(0.67-2.81)	0.392
	Services	0.89	(0.56-1.40)	0.605	0.84	(0.48-1.46)	0.534
	Managerial, Specialist	1.29	(0.65-2.55)	0.464	1.30	(0.50-3.39)	0.586
Residential area (reference="Seoul")	Other cities	1.00	(0.59-1.68)	0.992	1.06	(0.55-2.03)	0.867
	Rural area	1.17	(0.69-1.99)	0.562	1.24	(0.65-2.35)	0.522
Annual household income (1,000,000 won)		1.01	(0.99-1.02)	0.302	1.00	(1.00-1.01)	0.667
Year (reference="2008")	2009	1.03	(0.70-1.53)	0.872	1.24	(0.77-1.98)	0.376

*Significant, p value<0.05; CI:confidence interval; **1 generation: except spouse only; **2 generation: except spouse with unmarried child

inaccurate self-report regarding smoking status (i.e. a "NO" in a cotinine-verified female smoker). In the crude logistic analysis, cotinine intensity (OR 0.999, 95%CI 0.998-0.999, p<0.001), marital status (living with spouse: OR 1.94, 95%CI 1.18-3.17, p<0.001; ref :never married), relationship with cohabitants (living with a spouse and unmarried child: OR 2.45, 95%CI 1.38-4.35, p=0.002; ref :spouse only) and education (college or higher: OR 2.52, 95%CI 1.40-4.52,p=0.002; ref :elementary or less) were significantly associated with the probability

of an inaccurate self-report. After including all factors associated with the accuracy of self-reports, Age group (40-49: OR 3.54, 95%CI 1.42-8.86, p=0.007; ref :20-29), cotinine intensity (OR 0.999, 95%CI 0.998-0.999, p<0.001), marital status (married but without spouse: OR 0.37, 95%CI 0.15-0.94, p=0.037; ref :never married), relationship with cohabitants (living with a spouse and unmarried child: OR 2.63, 95%CI 1.44-4.80, p=0.002; living with 2 generations except unmarried child: OR 2.53, 95%CI 1.09-5.87, p=0.030; living with ≥3 generations: OR 3.25, 95%CI 1.48-7.10, p=0.003; ref :spouse only) and education (college or higher: OR 2.73, 95%CI 1.04-7.18, p=0.042; ref: elementary or less) continued to be significantly associated with the accuracy of self-reports. The year in which survey data was collected was not associated with the accuracy of self-reporting.

Discussion

KNHANES data revealed a significant discrepancy between self-reported and biochemically-verified active smoking status in Korean females. In 2008, the prevalence of Korean female smokers according to self-report was 7.3%, whereas the cotinine-assessed prevalence was 15.7% in this study. This finding was consistent with prior studies that have revealed a discrepancy between cigarette smoking status as assessed by self-report and that confirmed via measurement of a biochemical marker, such as 'cotinine' (Wagenknecht et al., 1992; Caraballo et al., 2001). Similarly, previous studies have reported a discrepancy between the accuracy of males' and females' self-reported smoking status, a phenomenon that appears to be global (Jung-Choi et al., 2012). The underreportings of smoking rate in female were commonly reported. In England,15% of Bangladeshi female immigrants underreport their personal tobacco use, while in Iran, where female self-reported smoking prevalence is 1.3%, serum cotinine-verified prevalence is 6.7% (Sarraf-Zadegan et al., 2004; Roth, 2009). Female under-reporting has also been documented in Tunisia and Canada and so on (Russell et al., 2004; Fakhfakh et al., 2011; Wong et al., 2012).

We assessed whether smoking, demographic, and family-related factors were associated within accurate self-reports of current smoking status, with the understanding that smoking may be perceived as a socially undesirable behavior. Living with several generations including an unmarried child was a significant predictor of an inaccurate self-report in Korean females. By contrast, individuals whose urinary cotinine levels were higher, indicating that they smoked heavily, and marital status which living without spouse were more likely to give an accurate self-report of their smoking status. Although it seemed that multicollinearity among our variables could be problematic, the maximum variance inflation factor (VIF) identified in our models was 2.74 (for age group). Our results suggested that living with several generations including an unmarried child was a strong predictive factor of their smoking status. If this is correct, then variables related to family, include an educational effect of mother's smoking to her child, may have to be considered in a future study.

Several important limitations of this study should be considered. First, this was a cross-sectional study. Therefore, we could not demonstrate a causal relationship between the variables we examined and the likelihood of giving an inaccurate self-report. But although we cannot be quite sure that there are causal relationship between these variables and likelihood of inaccurate self-report in females, we could see an association. And it is more nature interpretation that factors such as cohabitation type are dealt with as a causal factor in this situation.

Second, the urinary cotinine cut-off values used to identify active smokers are a subject of some controversy, and the appropriate cut-off may vary according to race or ethnicity (Benowitz et al., 2009). One Korean study suggested a cut-off of 20ng/ml to maximize sensitivity but a cut-off of 100ng/ml to exclude individuals exposed to second-hand smoke; another Korean study also reported varying sensitivity levels depending on the cut-off levels employed (Kang, 2003; Jung-Choi et al., 2012). Because the ideal cut-off for Asian populations is unknown, we used the 50ng/ml cut-off proposed by the Society for Research on Nicotine and Tobacco (Verification, 2002).

Third, the short half-life of urinary cotinine hampers the detection of current smokers. Failure to smoke for even a few days prior to urine collection may decrease cotinine concentrations and yield misleading data, as can be seen in Table 2. However, there is evidence that urinary cotinine is a good biomarker of smoking, (Nagano et al., 2010) one that remains useful even in chronic smokers (Jarvis et al., 1987; Lerman et al., 1993; Kang, 2003). Finally, exposure to secondhand smoke was not considered in our study design. It is possible that cotinine levels in some individuals could be elevated by exposure to secondhand smoke, resulting in their misclassification as inaccurate self-reporters. Cotinine also used as biomarker to verify secondhand smoke. The cut-off point for secondhand smoke exposure is roughly 2.0ng/ml cotinine in saliva, with a 30ng/ml of cotinine:creatinine ratio (Keskinoglu et al., 2007; Jarvis et al., 2012). The Centers for Disease Control and Prevention (CDC) in the U.S. uses a serum cotinine cut-off of 0.5ng/ml. By applying a 4.5:1 urine cotinine to serum cotinine correction factor, we arrive at a cut-off point for secondhand smoke of about 3ng/ml (Centers for Disease and Prevention, 2010; Yarnall et al., 2012). Because our cut-off point is substantially higher than 3ng/ml, exposure to secondhand smoke should not result in appreciable levels of misclassification.

Even with these limitations, this study provides a unique analysis of the factors associated with inaccurate self-reporting of smoking behavior in Korean women. One major strength of this study is the relatively large sample size, which results in findings representative of the female population of Korea. This accords with the findings of a prior study, in which the prevalence of smoking among females in high-income countries was found to be declining (Amos et al., 2012). Nevertheless, elevated prevalence of inaccurate self-reports by females remained present in our sample. This finding suggests that the problem of inaccurate self-reports will persist among Korean women even as the prevalence of smoking

falls. Our results suggest that such self-reports may be associated with factors that are not easily changed, such as family status. The lung is a major site that makes cancer burden and smoking is major attributable factor to lung cancer. Policy makers should be aware that even as self-reports of smoking prevalence fall, a hidden subgroup of smoking women may exist in Asian cultural ethnic group, including Korea.

References

Amos A, Greaves L, Nichter M, Bloch M (2012). Women and tobacco: a call for including gender in tobacco control research, policy and practice. *Tob Control*, **21**, 236-43.

Bae JM, Jung KW, Won YJ (2002). Estimation of cancer deaths in Korea for the upcoming years. *J Korean Med Sci*, **17**, 611-5.

Benowitz NL, Bernert JT, Caraballo RS, et al (2009). Optimal serum cotinine levels for distinguishing cigarette smokers and nonsmokers within different racial/ethnic groups in the United States between 1999 and 2004. *Am J Epidemiol*, **169**, 236-48.

Caraballo RS, Giovino GA, Pechacek TF, Mowery PD (2001). Factors associated with discrepancies between self-reports on cigarette smoking and measured serum cotinine levels among persons aged 17 years or older: Third National Health and Nutrition Examination Survey, 1988-1994. *Am J Epidemiol*, **153**, 807-14.

Centers for Disease C, Prevention (2010). Vital signs: nonsmokers' exposure to secondhand smoke --- United States, 1999-2008. *MMWR Morb Mortal Wkly Rep*, **59**, 1141-6.

Cho HJ, Khang YH, Jun HJ, Kawachi I (2008). Marital status and smoking in Korea: the influence of gender and age. *Soc Sci Med*, **66**, 609-19.

Connor Gorber S, Schofield-Hurwitz S, Hardt J, et al (2009). The accuracy of self-reported smoking: a systematic review of the relationship between self-reported and cotinine-assessed smoking status. *Nicotine Tob Res*, **11**, 12-24.

Fakhfakh R, Klouz A, Lakhal M, et al (2011). Validity of self-reported smoking among women hospital staff in Tunisia. *Tob Control*, **20**, 86.

Jang SY, Kim JH, Lim MK, et al (2012). Relationship between BMI, body image, and smoking in Korean women as determined by urine cotinine: results of a nationwide survey. *Asian Pac J Cancer Prev*, **13**, 1003-10.

Jarvis MJ, Fidler J, Mindell J, et al (2008). Assessing smoking status in children, adolescents and adults: cotinine cut-points revisited. *Addiction*, **103**, 1553-61.

Jarvis MJ, Sims M, Gilmore A, Mindell J (2012). Impact of smoke-free legislation on children's exposure to secondhand smoke: cotinine data from the Health Survey for England. *Tob Control*, **21**, 18-23.

Jarvis MJ, Tunstall-Pedoe H, Feyerabend C, et al (1987). Comparison of tests used to distinguish smokers from nonsmokers. *Am J Public Health*, **77**, 1435-8.

Jung-Choi KH, Khang YH, Cho HJ (2012). Hidden female smokers in Asia: a comparison of self-reported with cotinine-verified smoking prevalence rates in representative national data from an Asian population. *Tob Control*, **21**, 536-42.

Jung KW, Won YJ, Kong HJ, et al (2013). Cancer statistics in Korea: incidence, mortality, survival and prevalence in 2010. *Cancer Res Treat*, **45**, 1-14.

Kang YH LY-J, Kim HK, et al (2003). Usefulness of urinary cotinine test ot distinguish smokers from nonsmokers. *Korean J Lab Med*, **23**, 92-7.

Keskinoglu P, Cimrin D, Aksakoglu G (2007). Which cut-off level of urine cotinine:creatinine ratio (CCR) should be used to determine passive smoking prevalence in children in community based studies? *Tob Control*, **16**, 358-9.

Lerman C, Orleans CT, Engstrom PF (1993). Biological markers in smoking cessation treatment. *Semin Oncol*, **20**, 359-67.

Martiniuk A, Lee CM, Woodward M, Huxley R (2010). Burden of lung cancer deaths due to smoking for men and women in the WHO Western Pacific and South East Asian regions. *Asian Pac J Cancer Prev*, **11**, 67-72.

Nagano T, Shimizu M, Kiyotani K, et al (2010). Biomonitoring of urinary cotinine concentrations associated with plasma levels of nicotine metabolites after daily cigarette smoking in a male Japanese population. *Int J Environ Res Public Health*, **7**, 2953-64.

Park HY, Leistikow B, Tsodikov A, et al (2007). Smoke load/cancer death rate associations in Korea females, 1985-2004. *Prev Med*, **45**, 309-12.

Roth MA A-SA, Wardle H, Mindell J. (2009). Under-reporting of tobacco use among Bangladeshi women in England. *J Public Health (Oxf)*, **31**, 9.

Russell T, Crawford M, Woodby L (2004). Measurements for active cigarette smoke exposure in prevalence and cessation studies: why simply asking pregnant women isn't enough. *Nicotine Tob Res*, **6**, 141-51.

Sarraf-Zadegan N, Boshtam M, Shahrokhi S, et al (2004). Tobacco use among Iranian men, women and adolescents. *Eur J Public Health*, **14**, 76-8.

Verification SSoB (2002). Biochemical verification of tobacco use and cessation. Nicotine Tob Res, 4, 149-59.

Wagenknecht LE, Burke GL, Perkins LL, et al (1992). Misclassification of smoking status in the CARDIA study: a comparison of self-report with serum cotinine levels. *Am J Public Health*, **82**, 33-6.

Wong SL, Shields M, Leatherdale S, et al (2012). Assessment of validity of self-reported smoking status. *Health Rep*, **23**, 47-53.

Yarnall NJ, Hughes LM, Turnbull PS, Michaud M (2012). Evaluating the effectiveness of the US Navy and Marine Corps Tobacco Policy: an assessment of secondhand smoke exposure in US Navy submariners. *Tob Control*, **22**, 66-72.

Zielinska-Danch W, Wardas W, Sobczak A, Szoltysek-Boldys I (2007). Estimation of urinary cotinine cut-off points distinguishing non-smokers, passive and active smokers. *Biomarkers*, **12**, 484-96.