RESEARCH COMMUNICATION

# Relationship Between BMI, Body Image, and Smoking in Korean Women as Determined by Urine Cotinine: Results of a Nationwide Survey

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## Abstract

**Background: This study examined the influence of body mass index (BMI), subjective body perception (SBP), and the differences between BMI and SBP influence on smoking among women. Methods: This study used the Korea National Health and Nutrition Examination Survey IV-2, 3 2008–2009. A urinary cotinine test was administered to 5485 women at least 19 years of age. Individuals whose cotinine level was at least 50 ng/mL were categorized as smokers. A multiple logistic regression analysis was performed to estimate the extent to which body-related variables affect female smoking. Results: Women with a lower BMI who perceived themselves to be normal or very fat were 2.09 times (1.14-3.83) more likely to smoke than women with a normal BMI and SBP. Women who were never married with a low BMI and thin SBP were 3.11 times (1.47–6.55) more likely to smoke than women with a normal BMI and SBP. Married women with a high BMI who considered themselves very fat were 0.63 times (0.43-0.94) less likely to smoke than women with a normal BMI and SBP. In contrast, divorced and widowed women with a low or normal BMI who considered themselves very fat were 26.1 times (1.35–507.3) more likely to smoke. Conclusions: Discrepancies between the objective physical condition (BMI) and the subjective body image (SBP) influence the female smoking rate. To reduce the number of female smokers, public education on the association between smoking behavior and weight issues is needed, especially among women with low BMI and distorted weight perception.**

**Key words:** Smoking rate - cotinine assessment - body mass index - body image - Korean women

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## Introduction

The percentage of smokers in Korea has been slowly declining from 34.6% in 1989 to 25.6% in 2009. During this period, the percentage of male smokers has decreased from 65.7% to 44.3%, although Korea had the highest smoking rate among countries in the Organization for Economic Cooperation and Development (OECD). However, in the same period, the percentage of female smokers increased from 6.4% to 7.0%. The percentage of smokers in the entire nation and the percentage of male smokers decreased while the percentage of female smokers remained slightly increased (Organization for Economic Co-operation and Development (OECD), 2011) The survey results are discouraging and the real number of female smokers is expected to be even higher than these values.

Because there are different risks associated with smoking in males and females, different trends in the smoking rate in the two gender groups might have an impact on public health (Moran et al., 2003; Rahmanian et al., 2011). Women are more likely to die from smoking than men (McCartney et al., 2011), and females who smoke heavily are more likely to develop cancer than their male counterparts (Gandini et al., 2008). Female smokers have higher rates of various types of cancer than non-smoking women (Kenfield et al., 2008; Martiniuk et al., 2010). In particular, smoking affects a woman's pregnancy. Smoking by the mother increases the likelihood of intrauterine growth retardation, low birth-

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weight, preterm delivery, infant respiratory infections, and increases the risk of Sudden Infant Death Syndrome (SIDS).(Floyd et al., 1993; Wen et al., 2005)

Women smoke for different reasons than men. Whereas men smoke in response to social stimuli related to their environment and social structure, women are more likely to smoke to relieve stress and induce weight loss.(Tsai et al., 2008),(Fidler and West, 2009) Although enjoyment and stress relief are well-known motivations for smoking, many people also believe that smoking helps to control weight,(Grunberg, 1997) leading to many studies on the relationship between smoking and weight loss.(Mack et al., 2004; Spring et al., 2009) A recent study showed that current smokers were greatly concerned with their weight and former smokers were on a diet to prevent cessation-related weight gain.(French and Jeffery, 1995; Wane et al., 2010) In particular, younger women were more interested in the weight-reducing effects of smoking than older women.(Hjartaker et al., 2001; Wee et al., 2001) Among Asian women, smoking is not only associated with weight control but also with their marital status. According to studies regarding the role of gender in smoking habits, marital status affects smoking behaviors in women to a much greater degree than in men, and marriage plays a greater role as a preventive factor for smoking among women.(Cho et al., 2008; Khang and Cho, 2006)

Most studies on smoking use standard self-reporting surveys to measure smoking rates. However, surveys based on conventional questionnaires do not fully reflect reality as the respondents tend to under-report their smoking habits and it is evident that the accuracy of self-reporting for smoking behavior is limited.(Patrick et al., 1994; Vartiainen et al., 2002) Therefore, in this study we used cotinine levels in urine as an indicator for smoking status. Body mass index (BMI) was measured as an objective indication of body weight. In addition to BMI, subjective body perception (SBP) was evaluated because it is hypothesized that the subjective self-recognition of body image may also play a role in smoking. Smoking behavior was analyzed based on these two parameters, BMI and SBP, and the differences between them.

The purpose of this study was to determine the extent of female smoking and analyze the correlation between body-related factors and smoking behavior among women.

## Materials and Methods

*Data*

This study used data from the 2008–2009 Korea National Health and Nutrition Examination Survey (KNHANES) performed by the Ministry of Health & Welfare. The KNHANES is the nationwide survey on health and nutrition. Complying with Article 16 of the National Health Promotion Law (1995), the survey has been administered every 3 years since 1998 and has produced reliable statistics on the status of health, health awareness, health-related behaviors, and nutritional intake among Koreans at the national and municipal levels.

The fourth sample-based KNHANES was conducted year-round during 2007–2009. Survey samples were divided into 29 categories based on population and housing type in each administrative division (such as Dong, Eup, and Myun) reported in the 2005 Population and Household Census. In each category, proportional allocation was used to ensure an identical distribution ratio between the sample and the population. Through proportional allocation, a certain number of people from Dong, Eup, and Myun were selected to survey 4,600 households in total. The statistical data were collected from questionnaires on health and nutrition and medical examinations. The data were used as a basis to establish national health policies and develop plans and programs for health promotion throughout the nation.

*Study population*

The subjects were women of at least 19 years of age who participated in the second and third year (2008–2009) of the fourth period of the KNHANES. Among the total survey population, 6,345 participants were selected as smokers through the urinary cotinine test. Of these, 5,485 subjects were selected for further analysis because complete data concerning their socioeconomic and health factors and body-related variables were available.

*Smoking variable*

Cotinine levels in urine were used as an indicator to define smokers. Urinary cotinine is widely used as a biomarker for smoking because of its high sensitivity and specificity. Among the different biomarkers for smoking, such as plasma or saliva cotinine and breath carbon monoxide, urinary cotinine has the highest relevancy, with a widely accepted cut-off of 50 ng/mL(SRNT Subcommittee on Biochemical Verification, 2002) although there are variations in cut-off values between pregnant and non-pregnant women, and within the general population in each country. In this study, subjects with urinary cotinine levels equal to or greater than 50 ng/mL were identified as smokers.

Urinary cotinine levels were analyzed using tandem mass spectrometry and gas chromatograph-mass spectrometry with cotinine (Sigma, USA) and diphenylamine (Aldrich, USA) as standards at Seoul Medical Science Institute, Korea and NeoDIN Medical Institute, respectively. The Seoul Medical Science Institute performed the research for the Centers for Disease Control and Prevention.

*Body-related variables*

Among the body-related factors, BMI was used as the indicator of objective body shape. The BMI evaluation was adopted from the World Health Organization's standard for Asian people: under 18.5

**Table 1. Characteristics of the Study Population**

| | | General analysis, N (%) | | | Analysis of design, % (SE) | |
|---|---|---|---|---|---|---|
| | | Smoking | Non-smoking | Total | Smoking | p-value |
| Age | 19-29 | 158 (22.4) | 546 (77.6) | 704 | 23.1 (2.0) | <0.0001 |
| | 30-39 | 178 (16.6) | 897 (83.4) | 1075 | 17.3 (1.3) | |
| | 40-49 | 134 (12.8) | 912 (87.2) | 1046 | 13.5 (1.2) | |
| | 50-59 | 97 (9.7) | 904 (90.3) | 1001 | 9.3 (1.0) | |
| | 60-69 | 70 (4.6) | 849 (92.4) | 919 | 7.5 (1.1) | |
| | ≥70 | 87 (11.8) | 653 (88.2) | 740 | 12.1 (1.5) | |
| Household income, quartile | 1 (lowest) | 214 (15.6) | 1131 (84.4) | 1375 | 16.7 (1.2) | 0.0269 |
| | 2 | 203 (14.6) | 1186 (85.4) | 1389 | 15.5 (1.2) | |
| | 3 | 144 (10.7) | 1200 (89.3) | 1344 | 11.8 (1.2) | |
| | 4 (highest) | 163 (11.8) | 1214 (88.2) | 1377 | 14.2 (1.4) | |
| Marital status | Married | 429 (11.3) | 3380 (88.7) | 3809 | 12.2 (0.7) | <0.0001 |
| | Divorced/widowed | 165 (15.5) | 899 (84.5) | 1064 | 17.4 (1.5) | |
| | Never married | 130 (21.2) | 482 (78.8) | 612 | 21.7 (2.0) | |
| Education level | Elementary school and below | 201 (10.3) | 1748 (89.7) | 1949 | 10.8 (0.9) | <0.0001 |
| | Middle school graduate | 63 (11.2) | 498 (88.8) | 561 | 10.7 (1.5) | |
| | High school graduate | 323 (17.9) | 1485 (82.1) | 1808 | 19.3 (1.2) | |
| | College and above | 137 (11.7) | 1030 (88.3) | 1167 | 12.8 (1.5) | |
| Type of occupation | Manager, professional | 49 (11.4) | 381 (88.6) | 430 | 13.6 (2.2) | <0.0001 |
| | Service and sales worker | 220 (18.8) | 950 (81.2) | 1170 | 20.0 (1.4) | |
| | Skilled agricultural, forestry, fishery | 46 (9.0) | 464 (91.0) | 510 | 9.5 (2.1) | |
| | Assemblers/manual laborer | 71 (13.4) | 458 (86.6) | 529 | 14.0 (1.9) | |
| | Unemployed (housewife, student) | 338 (11.9) | 2508 (88.1) | 2846 | 12.7 (0.8) | |
| Alcohol drinking | No | 77 (6.6) | 1094 (93.4) | 1171 | 6.4 (0.8) | <0.0001 |
| | Yes | 647 (15.0) | 3667 (85.0) | 4314 | 16.3 (0.8) | |
| Stress recognition level | Very often | 57 (19.5) | 235 (80.5) | 292 | 23.1 (3.2) | <0.0001 |
| | Occasionally | 226 (16.4) | 1150 (83.6) | 1376 | 18.0 (1.4) | |
| | A few times/never | 441 (11.6) | 3376 (88.4) | 3817 | 12.5 (0.7) | |
| Depression | No | 562 (12.9) | 3808 (87.1) | 4370 | 14.1 (0.8) | 0.1365 |
| | Yes | 162 (14.5) | 953 (85.5) | 1115 | 16.2 (1.4) | |
| Chronic disease, cancer | ≥2 | 78 (8.3) | 863 (91.7) | 941 | 8.5 (1.0) | <0.0001 |
| | 1 | 161 (10.6) | 1106 (89.4) | 1237 | 11.5 (1.1) | |
| | None | 515 (15.6) | 2792 (84.4) | 3307 | 16.7 (0.9) | |
| Weight change | No change | 387 (11.1) | 3093 (88.9) | 3480 | 11.8 (0.8) | <0.0001 |
| | Weight loss | 125 (15.4) | 687 (84.6) | 812 | 17.5 (1.7) | |
| | Weight gain | 212 (17.8) | 981 (82.2) | 1193 | 19.4 (1.5) | |
| Body-mass index (BMI) | Normal range | 324 (13.8) | 2021 (86.2) | 2345 | 15.2 (1.0) | <0.0001 |
| | Underweight | 67 (23.7) | 216 (76.3) | 283 | 24.6 (3.2) | |
| | Overweight | 128 (10.5) | 1093 (89.5) | 1221 | 11.5 (1.2) | |
| | Obese | 205 (12.5) | 1431 (87.5) | 1636 | 13.7 (1.1) | |
| Subjective body perception | Normal | 226 (12.1) | 1929 (87.9) | 2195 | 13.6 (0.9) | 0.0004 |
| | Thin | 122 (15.7) | 656 (84.3) | 778 | 17.1 (1.6) | |
| | Slightly fat | 238 (12.1) | 1730 (87.9) | 1968 | 13.1 (1.0) | |
| | Vary fat | 98 (18.0) | 446 (82.0) | 544 | 20.2 (2.0) | |
| BMI - Subjective body perception | | | | | | <0.0001 |
| | Normal range - normal | 177 (12.4) | 1256 (87.7) | 1433 | 14.0 (1.1) | |
| | Normal range - thin | 60 (13.9) | 373 (86.1) | 433 | 15.7 (2.0) | |
| | Normal range - fat | 57 (18.2) | 392 (81.8) | 479 | 18.1 (1.9) | |
| | Underweight - thin | 51 (23.0) | 181 (77.0) | 222 | 22.9 (3.1) | |
| | Underweight - normal, fat | 16 (26.2) | 45 (73.8) | 61 | 30.1 (6.4) | |
| | Overweight - fat | 74 (10.6) | 625 (89.4) | 699 | 12.2 (1.6) | |
| | Overweight - thin, normal | 54 (10.3) | 468 (89.7) | 522 | 10.3 (1.6) | |
| | Obese - fat | 174 (13.1) | 1158 (86.9) | 1332 | 14.4 (1.2) | |
| | Obese - thin, normal | 31 (10.2) | 273 (89.8) | 304 | 9.5 (1.8) | |
| Total | | 724 (13.2) | 4761 (86.8) | 8485 | 14.5 (0.7) | |

BMI, Body-mass index; SE, Standard error

kg/m$^2$ is underweight, 18.5–23 kg/m$^2$ is normal weight, 23–25 kg/m2 is overweight, and over 25 kg/m$^2$ is obese. (WHO Expert Consultation, 2004; Zheng et al., 2011) To measure the SBP, subjects were asked the following question: "How would you categorize your current body shape?" They were then asked to check one of the following five choices: very thin, slightly thin, normal, slightly fat, and very fat. The differences between BMI

and SBP were compared in a total of four categories by combining "slightly thin" and "very thin" into the same category. The differences between BMI and SBP were divided into a total of nine categories as follows: in the case of a normal BMI, the SBP categories were normal, thin, and fat; in the case of a low-weight BMI, the SBP categories were thin and normal/fat; in the case of overweight BMI, the SBP categories were thin/normal and fat; and in the case of obese BMI, the SPB categories were thin/normal and fat.

*Demographic, socioeconomic, and health-related variables*

Socioeconomic and demographic variables affecting female smoking included age, income (monthly equalized household average = total household income / √number of household members), marital status, and occupation. Drinking, stress recognition level, history of depression, history of chronic diseases or cancer, and weight changes in the past year were listed as health-related variables.

*Statistical analyses*

The sampling design of the KNHANES was not by random selection but by a complex sampling design using proportional allocation and systematic sampling. The estimates for the total, average, and ratio were the same as the general sampling design but the estimation of distribution was different. As a result, to achieve accuracy in complex sampling design data analysis, great emphasis was placed on the sampling ratio, answering rate, and the population makeup of Korea. This sampling method represents the Korean general population and makes it possible to correctly estimate their level of health and health-related behavior.

To analyze the socioeconomic, health-related, and body factors affecting smoking behavior, multiple logistic regression analysis was performed. To examine the suitability of models, the AIC (Akaike Information Criterion) model and c-statistics (indicated as the area under the curve of the ROC curve in SAS) were used. SAS ver. 9.2 (SAS Institute Inc., USA) was used for statistical analysis.

## Results

Table 1 shows the differences in various parameters for general analysis and the complex sampling design analysis. In total, 13.2% of the subjects were smokers and this increased to 14.5% when body weight was considered. Based on the age demographics, the age range of 19–29 had the highest smoking rate of 23.1%. The results showed that the smoking rate was higher in subjects with a lower income level. With respect to martial status, single women had the highest smoking rate (21.7%). High school graduates had the highest smoking rate among various education levels, and service and sales workers had the highest rate (20%) among various occupations. Women with a history of drinking and with higher stress levels were more likely to smoke. As for illness history, those without any history of chronic diseases or cancer were more likely to smoke than those with such a history. Subjects with changes in their body weight in the last year were more likely to smoke more than those whose body weight remained stable. In particular, women who experienced weight gain in the past year had a higher smoking prevalence. In terms of Body Mass Index, underweight subjects with the subjective body perception of fatness had a higher smoking rate. When the variables between the two body indexes, BMI and SBP, were examined underweight subjects who viewed themselves as normal or fat and overweight subjects who viewed themselves as fat showed a higher prevalence of smoking.

Table 2 presents the results of multiple logistic regression analysis between body-related factors for three different models.

Socioeconomic factors, health-related factors, and body-related factors were all found to be related. Model 1 examined the relationship between these factors and the BMI; Model 2 examined the relationship between these factors and the SBP; and Model 3 examined the relationship between smoking behavior and the differences between BMI and SBP. The socioeconomic and health-related factors had the same significant variables in all models. In terms of age, older subjects were less likely to smoke. With respect to marital status, single and widowed women were 2.1 times more likely to smoke than married women. For subjects with different education levels, those who had a high school diploma or less than an elementary school education were more likely to smoke than college graduates. In terms of occupation, the prevalence of smoking was higher among mechanical technicians, people working in office jobs, and those in the service industry than for other professions. Subjects with a history of alcohol drinking were 2.0 times more likely to smoke than those who had not consumed alcohol before. Higher stress levels also contributed to a higher rate of smoking. Subjects without a history of chronic diseases or cancer were 1.5 times more likely to smoke than those with a history of such illnesses. Subjects who showed changes in their weight in the past year showed a higher rate of smoking; in particular, those who experienced weight gain were considerably more likely to smoke.

The BMI values in Model 1 indicated that underweight subjects were 1.6 times more likely to smoke than subjects with normal weight. In Model 2, there was no statistical significance between SBP and smoking behavior. In Model 3, when the differences between the objective indicator (BMI) and the subjective body image (SBP) were analyzed, subjects with underweight BMI and thin SBP, and those with underweight BMI and normal or fat SBP were more likely to smoke. Model 3 appears to be more valuable than Models 1 & 2.

Table 3 displays the results of sub-group analysis with respect to marital status. In subjects who were single,

**Table 2. Results of Multiple Logistic Regression Analysis of Smoking Prevalence by Socio economic and Health-related, Body-related Variables (OR, 95% CI)**

| | | Model 1 | Model 2 | Model 3 |
|---|---|---|---|---|
| Age (years) | 19–29 | 1.00 | 1.00 | 1.00 |
| | 30–39 | 0.71 (0.51, 1.00) | 0.71 (0.51, 1.00) | 0.71 (0.35, 0.99) |
| | 40–49 | 0.51 (0.35, 0.74) | 0.50 (0.34, 0.71) | 0.51 (0.24, 0.74) |
| | 50–59 | 0.38 (0.24, 0.61) | 0.37 (0.24, 0.58) | 0.38 (0.18, 0.60) |
| | 60–69 | 0.32 (0.18, 0.57) | 0.30 (0.17, 0.53) | 0.31 (0.24, 0.56) |
| | ≥70 | 0.47 (0.25, 0.88) | 0.44 (0.24, 0.81) | 0.46 (0.70, 0.86) |
| Household income, quartile | 1 (lowest) | 1.00 | 1.00 | 1.00 |
| | 2 | 0.77 (0.59, 1.01) | 0.94 (0.69, 1.29) | 0.77 (0.59, 1.02) |
| | 3 | 0.97 (0.74, 1.27) | 0.95 (0.73, 1.25) | 0.97 (0.74, 1.27) |
| | 4 (highest) | 0.77 (0.71, 1.32) | 0.94 (0.13, 1.29) | 0.96 (0.70, 1.31) |
| Marital status | Married | 1.00 | 1.00 | 1.00 |
| | Divorced/widowed | 2.17 (1.61, 2.91) | 2.17 (1.62, 2.92) | 2.14 (1.59, 2.88) |
| | Never married | 0.97 (0.68, 1.37) | 1.01 (0.72, 1.43) | 0.97 (0.69, 1.38) |
| Education level | Elementary school and below | 1.00 | 1.00 | 1.00 |
| | Middle school | 1.75 (1.30, 2.34) | 1.72 (1.29, 2.30) | 1.75 (1.31, 2.35) |
| | High school | 1.29 (0.82, 2.03) | 1.28 (0.81, 2.01) | 1.29 (0.82, 2.02) |
| | College and above | 1.58 (1.03, 2.43) | 1.54 (1.01, 2.37) | 1.57 (1.02, 2.42) |
| Type of occupation | Manager, professionals | 1.00 | 1.00 | 1.00 |
| | Service and sales workers | 1.51 (1.02, 2.23) | 1.49 (1.01, 2.20) | 1.51 (1.02, 2.25) |
| | Skilled agricultural, forestry and fishery | 1.20 (0.63, 2.27) | 1.18 (0.62, 2.24) | 1.18 (0.62, 2.25) |
| | Assemblers/manual laborer | 1.24 (0.77, 1.99) | 1.23 (0.77, 1.96) | 1.23 (0.77, 1.98) |
| | Unemployed (housewife, student) | 1.04 (0.71, 1.52) | 1.03 (0.71, 1.51) | 1.04 (0.71, 1.53) |
| Alcohol drinking | No | 1.00 | 1.00 | 1.00 |
| | Yes | 2.06 (1.53, 2.76) | 2.07 (1.54, 2.78) | 2.06 (1.53, 2.77) |
| Stress | Very often | 1.00 | 1.00 | 1.00 |
| | Occasionally | 1.31 (1.05, 1.62) | 1.29 (1.04, 1.60) | 1.31 (1.05, 1.62) |
| | A few times/never | 1.91 (1.36, 2.69) | 1.87 (1.34, 2.61) | 1.91 (1.36, 2.68) |
| Depression | No | 1.00 | 1.00 | 1.00 |
| | Yes | 1.10 (1.36, 2.69) | 1.09 (0.87, 1.38) | 1.10 (0.87, 1.38) |
| Chronic disease, cancer | ≥2 | 1.00 | 1.00 | 1.00 |
| | 1 | 1.27 (0.90, 1.79) | 1.28 (0.90, 1.80) | 1.28 (0.91, 1.80) |
| | None | 1.48 (1.02, 2.15) | 1.49 (1.02, 2.17) | 1.49 (1.02, 2.18) |
| Weight change | No change | 1.00 | 1.00 | 1.00 |
| | Weight loss | 1.39 (1.07, 1.82) | 1.38 (1.06, 1.79) | 1.38 (1.06, 1.81) |
| | Weight gain | 1.53 (1.21, 1.92) | 1.46 (1.16, 1.85) | 1.51 (1.19, 2.00) |
| BMI | Normal range | 1.00 | | |
| | Underweight | 1.60 (1.12, 2.30) | | |
| | Overweight | 0.79 (0.59, 1.06) | | |
| | Obese | 0.98 (0.77, 1.26) | | |
| Subjective body perception | Normal | | 1.00 | |
| | Thin | | 1.28 (0.99, 1.67) | |
| | Slightly fat | | 0.89 (0.71, 1.11) | |
| | Vary fat | | 1.24 (0.93, 1.65) | |
| BMI - Subjective body perception | Normal range - normal | | | 1.00 |
| | Normal range - thin | | | 1.31 (0.92, 1.86) |
| | Normal range - fat | | | 1.10 (0.80, 1.51) |
| | Underweight - thin | | | 1.57 (1.03, 2.39) |
| | Underweight - normal, fat | | | 2.09 (1.14, 3.84) |
| | Overweight - fat | | | 0.79 (0.55, 1.14) |
| | Overweight - thin, normal | | | 0.96 (0.62, 1.49) |
| | Obese - fat | | | 1.08 (0.82, 1.42) |
| | Obese - thin, normal | | | 0.93 (0.55, 1.58) |
| AIC | | 9,640,974 | 9,652,956 | 9,630,421 |
| C-statistics | | 0.687 | 0.685 | 0.688 |

BMI, Body-mass index; AIC, Akaike Information Criterion.

the prevalence of smoking was 2.48 and 2.20 times higher for underweight BMI and thin SBP, respectively. When the differences between the BMI and SBP were analyzed, subjects who had underweight BMI and thin SBP exhibited a smoking rate 3.11 times higher than those with normal BMI and normal SBP. In terms of marital status, married subjects with overweight BMI and slightly fat or fat SBP had a smoking rate 0.63 times

**Table 3. Multiple Logistic Regression Analysis of Smoking Prevalence by Marital Status[a]**

| | | Never married | Married | Divorced/widowed |
|---|---|---|---|---|
| BMI | Normal range | 1.00 | 1.00 | 1.00 |
| | Underweight | 2.48 (1.34, 4.61) | 1.19 (0.70, 2.02) | 2.38 (1.06, 5.21) |
| | Overweight | 1.53 (0.70, 3.36) | 0.74 (0.54, 1.02) | 0.51 (0.30, 0.85) |
| | Obese | 1.56 (0.73, 3.34) | 0.94 (0.70, 1.25) | 0.72 (0.45, 1.14) |
| AIC | | 1900434 | 5987022 | 1576721 |
| C-statistics | | 0.717 | 0.663 | 0.702 |
| Subjective body perception | Normality | 1.00 | 1.00 | 1.00 |
| | Thin | 2.20 (1.12, 4.34) | 0.85 (0.57, 1.28) | 1.92 (1.18, 3.10) |
| | A little fat | 1.56 (0.86, 2.84) | 0.77 (0.58, 1.01) | 0.69 (0.39, 1.24) |
| | Very fat | 1.54 (0.67, 3.57) | 1.18 (0.85, 1.64) | 1.07 (0.52, 2.18) |
| AIC | | 1914081 | 5979342 | 1575410 |
| C-statistics | | 0.713 | 0.66 | 0.698 |
| BMI - Subjective body perception | Normal range - normal | 1.00 | 1.00 | 1.00 |
| | Normal range - thin | < 0.001 (< 0.001, < 0.001) | 0.88 (0.52, 1.50) | 2.07 (1.08, 3.98) |
| | Normal range - fat | 1.59 (0.81, 3.10) | 1.03 (0.71, 1.41) | 0.62 (0.21, 1.79) |
| | Underweight - thin | 3.11 (1.47, 6.55) | 0.98 (0.53, 1.81) | 2.16 (0.89, 5.28) |
| | Underweight - normal, fat | 2.17 (0.77, 6.07) | 1.90 (0.72, 4.99) | 26.14 (1.35, 507.33) |
| | Overweight - fat | 1.85 (0.77, 4.45) | 0.63 (0.43, 0.94) | 0.47 (0.19, 1.13) |
| | Overweight - thin, normal | 1.03 (0.09, 11.35) | 0.98 (0.59, 1.61) | 0.83 (0.39, 1.78) |
| | Obese - fat | 1.90 (0.86, 4.19) | 0.94 (0.68, 1.31) | 0.94 (0.47, 0.88) |
| | Obese - thin, normal | 0.21 (0.01, 9.60) | 0.86 (0.42, 1.78) | 0.87 (0.39, 1.94) |
| AIC | | 1879323 | 5974762 | 1547674 |
| C-statistics | | 0.729 | 0.664 | 0.703 |

[a]Adjusted for demographic, socioeconomic, and health-related variables; BMI, Body-mass index; AIC, Akaike Information

higher than those with normal BMI and normal SBP. Divorced or widowed subjects had similar significant variables to those of single women. In these subjects, the prevalence of smoking in underweight BMI subjects was 2.38 times higher than that of normal BMI, and thin SBP was 1.92 times higher than normal SBP. When the differences between BMI and SBP were examined, subjects with normal BMI and thin SBP were 2.07 times more likely to smoke than those with normal range BMI and normal SBP. The prevalence of smoking in subjects with underweight BMI and normal or fat SBP was 26.14 times higher than in those with normal range BMI and normal SBP.

## Discussion

This study was performed to analyze differences in the objective indicator, BMI, and the subjective body image, SBP, in 5485 female smokers over 19 years of age using the 2008–2009 KNHANES data. An additional aim was to understand the major contributing factors influencing smoking behavior.

The percentage of Korean female smokers reported in previous surveys was only 7.0%.(Organization for Economic Co-operation and Development (OECD), 2011) However, the results of the urinary cotinine test in this study indicated that this value was actually 14.5%. This difference reflects the fact that many of the female respondents were not entirely honest in the self-reporting surveys because there is a social stigma associated with female smoking in Korea.

Age was one of the socioeconomic factors influencing female smoking habits; the younger subjects smoked more. This higher rate of smoking in the younger female generation correlates with the overall trend of a higher smoking rate among Korean woman. Over time, there was a decline in the number of female smokers over 65 years of age, but an increasing number of younger women tended to smoke.(Khang and Cho, 2006) In previous studies, single, divorced, and widowed women were found to smoke more than those who were married.(Lim et al., 2010) When age was considered, unmarried young women smoked more than unmarried old women.(Cho et al., 2008) Furthermore, among divorced or widowed women, those who did not have children smoked more than those who did. In terms of education level, elementary school graduates and high school graduates were more likely to smoke. In another study on Korean women's smoking habits that divided the education levels into three categories, subjects who were high school graduates, middle school graduates, or lower smoked more than others.(Park et al., 2010) In previous studies, a high number of women with a higher education level (high school or college and above) had never smoked before. Although the same group showed an increased rate of smoking from 1998 to 2005, when compared with groups of other education levels they were still less likely to be current smokers.(Kim and Ruger, 2010) More office workers and service industry workers smoked than those in other occupations. This result was consistent with the occupation analysis of smoking habits in previous studies.(Cho et al., 2006)

In terms of health-related factors, those most related to female smoking were drinking and stress, and subjects who had no history of chronic diseases or cancer were more likely to smoke. Also, women who

experienced changes in their weight (both weight loss and gain) were more likely to smoke, which indicates that smokers may be especially sensitive to their weight and SBP. Smoking has detrimental effects on the body organs and is recognized worldwide as a major health risk factor. Thus, there is a lower likelihood of smoking in people who are suffering from a disease; in contrast, healthy people were more likely to smoke because they are less concerned about their health.

When socioeconomic and health-related factors were calibrated and body-related factors were analyzed, an underweight BMI and thin SBP were found to correlate with a higher smoking rate. When the differences between the two indexes (i.e., distorted body image) were analyzed, there was a significant correlation between these differences and smoking behavior. In particular, women with underweight BMI who considered themselves to be normal or fat were more likely to smoke than women with the same BMI but who considered themselves thin. Thus, although the objective indicator BMI may have an effect on one's smoking behavior, subjective recognition of one's body seems to have an even higher impact on the act of smoking. Such correlation was found to be more prevalent in underweight women who were single, divorced, or widowed. Previous studies also found that Korean women were more likely to smoke when they were single, divorced, or widowed.(Cho et al., 2008; Lim et al., 2010) When these facts were considered with weight-related factors, underweight women were more likely to smoke. Weight and marital status were considered as important factors in female smoking, and these two factors were correlated when subjects were divided into different marital status groups. Studies conducted in western countries also suggested that smokers had a lower BMI.(Bamia et al., 2004; Healton et al., 2006; Owen-Smith and Hannaford, 1999; Twardella et al., 2006)

In contrast, other studies have reported that young and obese women had the highest smoking rate. (Akbartabartoori et al., 2005) In addition, when one considers the long-term relationship between female smoking and BMI, a woman's BMI tends to increase when she continues to smoke.(Rasmussen et al., 2003) Based on these data, the correlation between smoking and weight gain was established. Our study suggested that the subjective recognition of one's body had as much influence on smoking behavior as the objective physical index; therefore, there is a great need to educate women about smoking, particularly those who are underweight.

The limitations in this study are as follows: First, as the study focuses on cross-sectional results during a set period, it may have weaknesses in fully explaining the causal relationship between weight-related factors and smoking. However, since the study indicates that there is a correlation between female smoking and BMI and SBP, weight-related factors can be considered especially powerful motivations for smoking in a high-risk group of women. Second, there is a drawback associated with using the urinary cotinine test to separate smokers from nonsmokers because urinary cotinine can be detected in both smokers and people who are exposed to secondhand smoke. It has also been reported that there are interindividual differences in nicotine intake levels depending on their metabolic capacity for nicotine.(Al-Delaimy et al., 2002) However, the urinary cotinine level of 50 ng/mL used in this study is a generally accepted standard as an indicator to identify smokers vs. non-smokers.(SRNT Subcommittee on Biochemical Verification, 2002)

In Korea, the number of female smokers is rising while the number of male smokers is on the decline. Measurement of urinary cotinine levels indicated that the percentage of female smokers was actually 14.5%, more than double the percentage found in previous surveys. In particular, women who were in their 20 seconds had the highest smoking rate among all age groups. The difference between BMI and SBP was the most important factor determining female smoking behavior. Women with low BMI who perceived themselves as normal or fat were most likely to smoke; these results suggested that subjective body recognition plays as important a role as objective physical measures such as BMI in smoking behavior. Moreover, in women who were never married, divorced or widowed, underweight BMI was highly correlated with smoking. Thus, it is necessary to educate the public to have a correct self-body perception and a good understanding of the relationship between smoking and weight issues in order to reduce female smoking. In particular, women who were never married and had low BMI were especially susceptible to smoking and require special attention and preventative care.

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