

Self-rated Subjective Health Status Is Strongly Associated with Sociodemographic Factors, Lifestyle, Nutrient Intakes, and Biochemical Indices, but Not Smoking Status: KNHANES 2007-2012

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Despite advertised health warnings regarding the deadly hazards of smoking, many people have not heeded recommendations to quit smoking. We examined factors that affect self-rated subjective health status (SRH) scores among lifestyle, nutrient intake and biochemical parameters, and the association of SRH scores and smoking status in a large Korean adult population. Adjusted odd ratios for SRH were calculated for smoking status, selected biochemical data, and food and nutrient intake obtained using the 24-hr recall method after covariate adjustment in the 2007-2012 Korean National Health and Nutrition Examination Survey (27,534 men and women aged ≥ 20 yr). Age, sex, income, education, drinking, exercise and stress levels were associated with SRH scores, regardless of smoking status ($P < 0.001$). Interestingly, people in any smoking status groups considered the well-known indicators for metabolic diseases (HDL cholesterol, glucose, aspartate aminotransferase, and alanine aminotransferase in the circulation), and the intake of fiber, total vitamins A, and vitamin C as indicators of SRH. Especially in current smokers, higher intake of nutritious food groups such as grains (OR = 1.227), vegetables (OR = 1.944), and milk (OR = 2.26) significantly increased the adjusted odds ratio of SRH. However, smoking status was not associated with SRH scores. In conclusion, SRH is affected by the indices related to health but not smoking status in Korean adults. The development of a new indicator of the direct adverse effects of smoking at regular health check-ups might be required to modulate the SRH in smokers and a nutritional education should not include the possible attenuation of adverse effects of smoking by good nutrition.

Keywords: Self-rated Subjective Health Status; Smoking; Vitamin C; HDL; Serum Glucose

INTRODUCTION

Smoking remains one of the most preventable causes of morbidity and mortality worldwide (1). Smoking has been documented to induce various harmful diseases including lung cancer, leukemia, coronary heart disease and peptic ulcer disease over the past 50 yr, and successful smoking cessation results in immediate health improvements (2-4). Educational efforts have focused on increasing public knowledge about the deleterious effect of smoking on health, and various cessation methods have been applied to smokers (5, 6). However, public educational efforts have not succeed to decrease smoking rates in Korea including Asian countries and still the smoking rates (adult males: 48.3% in 2010) rank at the top among Organization for Economic Cooperation and Development (OECD) countries (7). Quit rates among smokers are low, even in smokers who in-

tend to quit (8-10). However, some smokers have no intention of quitting, as smoking helps relieve mental stress (11, 12). In addition, many smokers fear weight gain, even though recent studies reported that the benefits of quitting smoking far exceeded the risks associated with the amount of weight gained (13). For these reasons, it is difficult to convince smokers to quit smoking, as behavior modification is preceded by changes of intention (13, 14). Furthermore, knowledge about adverse effects of smoking does not help smokers quit smoking (14). Thus, it is important to understand which factors affect the changes of intention, as having the intention to quit smoking plays an important role in a successful smoking cessation program.

The self-rated subjective health status (SRH) assessment is a comprehensive measure of the general health status according to the individual's perception. The SRH reflects both mental and physical health (15) and also incorporates elements of health-

related behaviors and social well-being (16, 17). The SRH may be involved in modulating the intention to quit smoking, as smoking is the most important risk factor for chronic disease. SRH is obtained typically by asking the individuals to describe their health status on a Likert scale (18). Persons who report SRH as poor have increased mortality from cardiovascular disease, cancer and other diseases (19, 20), and the SRH has been shown to have high reliability, validity and predictive power for various illnesses and conditions in large scale surveys (21). The SRH is a useful predictor of various health outcomes, including mortality (20, 21). The SRH is affected by a variety of lifestyle, diet and biochemical factors, with smoking as one of the major factors (22, 23). Smokers with low SRH might be motivated to quit smoking by education about the adverse effects of smoking on health. However, some smokers who have favorable SRH scores will not give the motivation to quit smoking by the education. Therefore, smokers with high SRH scores may not respond to smoking cessation interventions that explain the adverse effects of smoking.

To our knowledge, no study has examined the association of SRH and smokers in a large population-based sample, especially using a Korean population. Thus, in the present study, the factors that affected SRH scores were examined among lifestyle, dietary intake and biochemical parameters and the association of SRH and smoking status was determined in a large Korean population study with a stratified multistage probability sampling design. This study described the factors that modulated SRH and those that increased SRH scores in smokers. This study provided basic information about smokers with high SRH scores, which will be useful for planning future smoking cessation programs and nutrition education.

MATERIALS AND METHODS

Design and data collection

This study was based on data obtained from the Korea National Health and Nutrition Examination Survey (KNHANES) IV (2007-2009) and the KNHANES V (2010-2012) surveys. KNHANES surveys are conducted annually using a rolling sampling design that involves a complex, stratified, multistage probability-cluster survey of a large representative sample of the non-institutionalized civilian population in South Korea. The survey is performed by the Korean Centers for Disease Control and Prevention and Korean Ministry of Health and Welfare.

The present cross-sectional analysis was restricted to adult participants ≥ 20 yr of age who completed the health examination survey and the nutrition survey ($n = 27,534$). Detailed information on the design of the survey has been reported previously (24, 25). Briefly, the information on age, residence area, income, occupation, stress, education, exercise, SRH, smoking history and alcohol intake was collected during the health in-

terview. Obesity was categorized into three groups: lean ($BMI < 18.5$), normal ($18.5 \leq BMI < 25$), and obese ($BMI \geq 25$). Income level was categorized into four quartile groups (1st Q-4th Q). Education level was categorized into three groups: below high school, high school, and college or higher. Smoking status was divided into three categories: current smoker, past smoker and never-smoker. Smoking status was defined based on self-reported cigarette use: never-smokers had smoked fewer than 100 cigarettes in their lifetime, and participants who smoked 100 or more cigarettes were classified as past or current smokers, based on current smoking habits. Alcohol consumption was assessed by asking the participants about their drinking behavior during the month prior to the interview. The responses were converted into the amount of pure alcohol (in grams) consumed per day. Alcohol consumption status was categorized into four groups according to average daily alcohol consumption: nondrinkers, and light (1-15 g), moderate (16-30 g), and heavy (> 30 g) drinkers. Regular exercise was defined as exercising on a regular basis for ≥ 30 min at a time at least five times per week in moderate exercise activities, or for ≥ 20 min at a time at least three times per week in vigorous exercise activities. Regular walk was specified as walking for ≥ 30 min at a time at least five times per week. The stress level to be recognized was checked with none, mild, moderate and heavy during the routine daily life.

Self-rated subjective health status

The original SRH questionnaire included five-level categorical variables: 1 = very good, 2 = good, 3 = fair, 4 = poor and 5 = very poor. For this study, we categorized this variable into three levels: 1 = very good or good, 2 = fair, and 3 = poor or very poor.

Laboratory test

Blood samples were obtained in the morning following an overnight fast. The serum concentrations of glucose, low-density lipoprotein cholesterol (LDL), high-density lipoprotein cholesterol (HDL), triglycerides (TG), aspartate transaminase (AST), and alanine transaminase (ALT) were measured using a Hitachi automatic analyzer 7600 (Tokyo, Japan). Low-density lipoprotein cholesterol (LDL) was calculated using the Friedewald equation [$LDL = \text{total cholesterol} - HDL (TG/5)$] if the TG concentration was not above 400 mg/dL. If the TG concentration was above 400 mg/dL, LDL was measured directly using a Hitachi automatic analyzer 7600.

Dietary assessment method and food grouping

Dietary intake information was collected by administering a validated semi-quantitative food-frequency questionnaire to each participant. This questionnaire requested information regarding the participant's consumption of 63 food items until 2011 KNHANES. Food frequency data were used from 2007-2011 KN-

HANES. The participant's food intake frequency was quantified using nine categories: "never or seldom," "once a month," "two to three times a month," "one to two times a week," "three to four times a week," "five to six times a week," "once a day," "twice a day," and "three times or more every day." Sixty-three food items were further categorized into 10 subgroups: grain 1 (rice, breads and noodles), grain 2 (cereals, rice cakes and potatoes), legume, meat, fish, vegetable, fruit, milk, sugar, and other.

Assessment of nutrient intake

Dietary intake was collected using the 24-hr recall method. Daily intake of energy and nutrients such as protein, carbohydrates, fat, fiber, total vitamin A, vitamin C, Na, Ca, and K was calculated using the Can-Pro 2.0 nutrient intake assessment software developed by the Korean Nutrition Society. Daily energy, carbohydrate, protein and fat intake were calculated as the percentage of the Korean Dietary Reference Intake (DRI) according to sex and age (Committee of Dietary Reference Intake in Korean Nutrition Society, 2010) (26).

Statistical analysis

Statistical analyses were performed using the SAS software (version 9.4; SAS Institute, Cary, NC, USA) and SUDAAN (Release 11.0; Research Triangle Institute, Research Triangle Park, NC, USA), a software package that incorporates sample weights and adjusts analyses for the complex sample design of the survey. Survey sample weights were used in all analyses to produce estimates that were representative of the non-institutionalized civilian Korean population.

Descriptive statistics of participants according to smoking status were obtained by determining frequency distributions of categorical variables of demographic, lifestyle and stress level, and their statistical significances were analyzed using chi-squared tests.

Adjusted odds ratios (ORs) and 95% confidence interval (CI) values for SRH according to smoking status were calculated for demographic, life style variables, and stress level using ordinal logistic regression analysis after covariate adjustment. Covariates were sex, age, residence area, income, occupation, education level, drinking status and physical activities.

Next, to evaluate the possible association of selected laboratory tests and nutrient intake with SRH, adjusted ORs for SRH were calculated for selected biochemical data and nutrient intake obtained using the 24-hr recall method after covariate adjustment. Furthermore, adjusted means and 95% CI of biochemical data, and food and nutrient intakes according to smoking status were calculated using analysis of covariance (ANCOVA) with the Proc Regress function. The covariates used for adjusted means were gender, age, residence area, income, occupation, drinking status, education, stress level, obesity and physical activity.

Finally, adjusted ORs for SRH were calculated for selected food intake groups after covariate adjustment. Food intake groups were categorized into three levels: deficient, adequate and excess intake.

Ethnic statement

The study protocol was approved by the institutional review board of the Korean Centers for Disease Control and Prevention (approval nos. 2008-04EXP-01-C, 2009-01CON-03-2C, and 2010-02CON-21-C). Informed consent was exempted by the board.

RESULTS

Significant differences in the frequency distribution were found among most classification variables: Current smokers were associated with lower income and who partake of less exercise, clerical work, more drinking, higher stress levels, and obesity (Table 1). In the subjects with over 60 yr, a greater number of past smokers had better SRH scores than current smokers. However, there were fewer current smokers with poor or very poor SRH scores than non-smokers.

All classification variables were significant predictors of SRH after covariate adjustment, indicating that males with younger age, living in urban areas, higher income, employed in clerical and manual settings, higher education, normal weight, regular physical activity, and low stress levels had higher rates of good or very good SRH scores (Table 2). Surprisingly, no apparent differences in ORs were found in the classification variables according to smoking status. The adjusted OR for SRH was about six fold higher in the no-stress group than the heavy stress group, regardless of smoking status, indicating that stress levels were highly associated with SRH.

Adjusted ORs and their 95% CI of SRH were calculated after adjusting for covariates according to smoking status (Table 3). In the non-smoker group, with the exception of total energy intake as a recommended percent, all biochemical and nutrient variables were significant predictors for SRH after covariates adjustment. In the past smoker group, only serum glucose levels were significant predictors. On the other hand, in the current smoker group, serum glucose, HDL, AST and ALT levels, fiber intake, and log transformed vitamin C and total vitamin A were significant predictors of SRH.

Of 11 food intake groups, 5 groups (grain 1, vegetable, fruit, milk, and sugar) were significant predictors of SRH according to their food intake level among the three smoking status groups. The non-smoker group had significant ORs regarding adequate intake or adequate/excess intake of vegetables, fruit and sugar (Table 4). The past smoker group had significant ORs in all intake groups, with the exception of grain 1. On the other hand, the current smoker group had significant ORs in the grain 1, ve-

Table 1. Distribution of smoking status by classification variables in adult population (n = 27,534) according to 2007-2012 Korea National Health and Nutrition Examination Survey

Classification	Non-smoker (n = 16,590)	Former smoker (n = 5,454)	Current-smoker (n = 5,490)	P value*
Gender				< 0.001
Male	2,074 (16.8)	4,551 (82.9)	4,608 (86.1)	
Female	14,516 (83.1)	903 (17.1)	882 (13.8)	
Age (yr)				< 0.001
20-29	1,864 (18.4)	410 (13.0)	789 (21.8)	
30-39	3,321 (20.9)	839 (18.8)	1,358 (27.2)	
40-49	3,312 (23.0)	891 (21.7)	1,175 (23.6)	
50-59	3,135 (17.7)	984 (20.1)	910 (15.3)	
60-	4,958 (19.7)	2,330 (26.2)	1,258 (11.9)	
Residence area				0.375
Urban	12,519 (79.3)	4,113 (80.4)	4,132 (79.4)	
Rural	4,071 (20.6)	1,341 (19.6)	1,358 (20.5)	
Income				< 0.001
1st Q	3,812 (24.5)	1,195 (22.4)	1,586 (29.8)	
2nd Q	4,041 (24.7)	1,392 (26.7)	1,437 (26.2)	
3rd Q	4,220 (25.8)	1,424 (25.8)	1,217 (23.1)	
4th Q	4,255 (24.9)	1,359 (25.0)	1,158 (20.7)	
Occupation				< 0.001
Clerical	5,727 (39.4)	1,960 (42.1)	2,296 (45.9)	
Manual	2,809 (13.7)	997 (14.6)	980 (14.1)	
Technical	620 (4.37)	714 (15.8)	949 (19.1)	
Unemployed	7,434 (42.5)	1,783 (27.2)	1,265 (20.6)	
Drinking status				< 0.001
Non drinker	6,220 (32.9)	1,170 (17.3)	673 (9.62)	
Mild drinker	9,038 (57.5)	2,396 (46.6)	2,138 (40.6)	
Moderate drinker	903 (6.29)	969 (17.5)	1,116 (19.3)	
Heavy drinker	429 (3.16)	919 (18.4)	1,563 (30.4)	
Education level				< 0.001
< High school	8,849 (46.9)	2,815 (45.5)	2,426 (39.5)	
High school	3,289 (21.4)	1,048 (21.0)	1,335 (25.4)	
College and more	4,452 (31.6)	1,591 (33.4)	1,729 (35.0)	
Stress level				< 0.001
Heavy	773 (4.57)	179 (3.24)	328 (6.19)	
Moderate	3,682 (22.7)	1,055 (21.0)	1,336 (25.1)	
Little	9,489 (58.4)	3,091 (59.5)	2,997 (56.3)	
None	2,644 (14.2)	1,129 (16.1)	821 (12.3)	
Obesity				< 0.001
Underweight	817 (5.54)	182 (3.46)	278 (4.48)	
Normal	10,898 (66.0)	3,439 (62.0)	3,450 (60.9)	
Obese	4,875 (28.4)	1,833 (34.5)	1,762 (34.5)	
Regular exercise				< 0.001
Yes	3,492 (21.2)	1,367 (25.1)	1,262 (23.5)	
No	13,098 (78.7)	4,087 (74.8)	4,228 (76.5)	
Regular walk				0.011
Yes	6,748 (41.1)	2,459 (43.7)	2,335 (42.7)	
No	9,842 (58.8)	2,995 (56.2)	3,155 (57.2)	
Self-rated subjective health status				< 0.001
Good or very good	6,008 (37.8)	2,176 (40.7)	1,984 (35.9)	
Fair	6,823 (42.4)	2,195 (42.3)	2,447 (47.0)	
Poor or very poor	3,759 (19.7)	1,083 (16.9)	1,059 (16.9)	

*P value by Satterwaite chi-square test.

getable, fruit and milk intake groups (Table 4).

As expected, the mean values of selected biochemical tests differed significantly between the good/very good group and the poor/very poor group. In the non-smoking group, all variables, with the exception of LDL and TG, were significantly different according to SRH (Table 5). In addition, all nutrient intake variables, with the exception of carbohydrate percent intake, had significantly higher values in the good/very good group

compared to the poor/very poor group among non-smokers (Table 5). However, in the past-smoker group, the means of only three items (Ca, K, and total vitamin A intake) were significantly different according to SRH (Supplementary 1). In the current smoker group, the means of serum HDL, AST, and ALT levels, daily total energy intake, protein intake as recommended percent, fiber, K, vitamin C and total vitamin A in were significantly different (Table 6).

Table 2. Adjusted odds ratio of self-rated subjective health status by demographic and lifestyle variables according to smoking status in the 2007-2012 Korea National Health and Nutrition Examination Survey*

Classification	Non-smoker (n = 16,590)	Former smoker (n = 5,454)	Current-smoker (n = 5,490)
Gender			
Male	1.484 (1.305-1.687)	1.24 (1.011-1.522)	1.422 (1.171-1.726)
Female	Ref (1.0)	Ref (1.0)	Ref (1.0)
Age (yr)			
20-29	Ref (1.0)	Ref (1.0)	Ref (1.0)
30-39	0.824 (0.719-0.944)	0.802 (0.609-1.056)	0.857 (0.707-1.039)
40-49	0.801 (0.697-0.920)	0.831 (0.625-1.105)	0.798 (0.648-0.981)
50-59	0.630 (0.539-0.736)	0.684 (0.515-0.910)	0.650 (0.513-0.823)
60-	0.394 (0.334-0.465)	0.596 (0.445-0.797)	0.506 (0.389-0.657)
Residence area			
Urban	1.123 (1.018-1.238)	1.203 (1.021-1.416)	1.022 (0.878-1.191)
Rural	Ref (1.0)	Ref (1.0)	Ref (1.0)
Income			
1st Q	Ref (1.0)	Ref (1.0)	Ref (1.0)
2nd Q	1.167 (1.053-1.292)	1.127 (0.942-1.350)	1.253 (1.065-1.475)
3rd Q	1.273 (1.148-1.412)	1.158 (0.968-1.386)	1.327 (1.113-1.583)
4th Q	1.403 (1.259-1.563)	1.544 (1.262-1.890)	1.452 (1.218-1.731)
Occupation			
Clerical	1.209 (1.111-1.315)	1.593 (1.333-1.904)	1.250 (1.036-1.508)
Manual	1.160 (1.034-1.302)	1.470 (1.179-1.832)	1.316 (1.030-1.683)
Technical	0.979 (0.805-1.190)	1.879 (1.494-2.362)	1.299 (1.037-1.626)
Unemployed	Ref (1.0)	Ref (1.0)	Ref (1.0)
Education level			
< High school	Ref (1.0)	Ref (1.0)	Ref (1.0)
High school	1.232 (1.110-1.367)	1.328 (1.116-1.579)	1.288 (1.099-1.510)
College and more	1.432 (1.279-1.604)	1.719 (1.426-2.073)	1.315 (1.101-1.570)
Drinking status			
Non drinker	Ref (1.0)	Ref (1.0)	Ref (1.0)
Mild drinker	1.179 (1.092-1.273)	1.330 (1.108-1.598)	1.306 (1.050-1.624)
Moderate drinker	1.303 (1.095-1.550)	1.433 (1.168-1.758)	1.318 (1.043-1.666)
Heavy drinker	1.260 (0.996-1.595)	1.351 (1.093-1.670)	1.193 (0.948-1.500)
Obesity			
Lean	Ref (1.0)	Ref (1.0)	Ref (1.0)
Normal	1.34 (1.136-1.581)	1.589 (1.074-2.351)	1.379 (1.000-1.901)
Obese	1.138 (0.950-1.363)	1.461 (0.969-2.203)	1.098 (0.789-1.530)
Regular exercise			
Yes	1.185 (1.076-1.304)	1.24 (1.064-1.445)	1.377 (1.181-1.605)
No	Ref (1.0)	Ref (1.0)	Ref (1.0)
Regular walk			
Yes	1.234 (1.137-1.340)	1.239 (1.091-1.408)	1.24 (1.091-1.409)
No	Ref (1.0)	Ref (1.0)	Ref (1.0)
Stress level			
Heavy	Ref (1.0)	Ref (1.0)	Ref (1.0)
Moderate	1.619 (1.330-1.973)	2.500 (1.645-3.799)	1.750 (1.312-2.333)
Little	3.451 (2.853-4.174)	3.912 (2.594-5.898)	3.372 (2.593-4.385)
None	5.908 (4.786-7.293)	6.427 (4.213-9.806)	5.908 (4.331-8.059)

*Adjusted for gender, age, residence area, income, occupation, smoking and drinking status, education, stress level, obesity, and physical activities.

Table 3. Adjusted odds ratio of self-rated subjective health status by selected biochemical data and nutrient intakes in adult subjects according to 2007-2012 Korea National Health and Nutrition Examination Survey*

Classification	Units	Non-smokers (n = 16,590)	Former smokers (n = 5,454)	Current smokers (n = 5,490)
Serum high density lipoprotein cholesterol (mg/dL)	10	1.071 (1.039-1.104)	1.050 (0.995-1.108)	1.078 (1.020-1.138)
Serum triglyceride (mg/dL)	10	0.994 (0.989-0.999)	0.996 (0.990-1.002)	0.995 (0.990-1.000)
Serum glucose (mg/dL)	10	0.949 (0.931-0.967)	0.910 (0.883-0.937)	0.930 (0.904-0.956)
Serum alanine aminotransferase (U/L)	10	0.929 (0.888-0.972)	0.978 (0.943-1.015)	0.952 (0.922-0.984)
Serum aspartate aminotransferase (U/L)	10	0.941 (0.903-0.980)	0.978 (0.953-1.004)	0.965 (0.937-0.994)
Energy (% EER)	10	1.015 (0.906-1.138)	0.956 (0.759-1.203)	0.848 (0.699-1.027)
Protein (% RI)	10	1.009 (1.000-1.017)	1.001 (0.983-1.019)	1.006 (0.994-1.018)
Carbohydrate (% of energy)	10	0.945 (0.914-0.977)	0.986 (0.928-1.047)	1.005 (0.956-1.055)
Fat (% of energy)	2	1.017 (1.007-1.026)	1.001 (0.981-1.021)	1.005 (0.988-1.022)
Fiber (g)	2	1.011 (1.003-1.02)	1.003 (0.99-1.016)	1.014 (1.000-1.027)
Log transformed Vitamin C (mg)		1.118 (1.067-1.171)	1.041 (0.952-1.138)	1.157 (1.069-1.253)
Log transformed total Vitamin A (μg RE)		1.062 (1.015-1.110)	1.065 (0.988-1.148)	1.114 (1.036-1.197)

*Adjusted for gender, age, residence area, income, occupation, smoking and drinking status, education, stress level, obesity, and physical activities. EER, energy requirement estimation; RI, recommended intake; RE, retinol equivalent.

Table 4. Adjusted odds ratio of self-rated subjective health status by selected food groups in adult subjects according to 2007-2012 Korea National Health and Nutrition Examination Survey*

Food intake groups	Self-rated subjective health status		
	Non-smokers (n = 16,590)	Former smokers (n = 5,454)	Current smokers (n = 5,490)
Grain 1			
Deficient	Ref (1.0)	Ref (1.0)	Ref (1.0)
Adequate	1.065 (0.949-1.195)	1.173 (0.990-1.389)	1.110 (0.950-1.296)
Excess	1.082 (0.992-1.180)	1.115 (0.969-1.284)	1.227 (1.052-1.431)
Vegetable			
Deficient	Ref (1.0)	Ref (1.0)	Ref (1.0)
Adequate	1.125 (1.037-1.22)	1.159 (1.011-1.328)	1.266 (1.112-1.443)
Excess	1.205 (0.974-1.491)	1.205 (0.832-1.745)	1.944 (1.418-2.665)
Fruits			
Deficient	Ref (1.0)	Ref (1.0)	Ref (1.0)
Adequate	1.153 (1.067-1.246)	1.212 (1.056-1.392)	1.297 (1.129-1.491)
Excess	1.294 (0.968-1.729)	1.06 (0.572-1.965)	1.419 (0.714-2.820)
Milk			
Deficient	Ref (1.0)	Ref (1.0)	Ref (1.0)
Adequate	1.057 (0.978-1.142)	1.178 (1.020-1.360)	1.138 (0.993-1.303)
Excess	0.843 (0.558-1.274)	1.882 (0.739-4.793)	2.26 (1.155-4.424)
Sugar			
Deficient	Ref (1.0)	Ref (1.0)	Ref (1.0)
Adequate	1.206 (1.112-1.309)	1.169 (1.012-1.350)	0.993 (0.855-1.153)
Excess	1.305 (1.173-1.452)	1.270 (1.068-1.510)	1.115 (0.956-1.302)

*Adjusted for gender, age, residence area, income, occupation, smoking and drinking status, education, stress level, obesity, and physical activities.

Table 5. Means and 95% confidence intervals of selected biochemical data, blood pressure and selected 24-hr individual food intake by self-rated subjective health status in a non-smoking population after covariate adjustment*

Variables	Self-rated subjective health status			P value†
	Good or very good (n = 6,008)	Fair (n = 6,823)	Poor or very poor (n = 3,759)	
Biochemical tests				
Serum high density lipoprotein (mg/dL)	53.97 (53.51-54.42)	53.12 (52.68-53.56)	52.48 (51.88-53.07)	0.003
Serum low density lipoprotein (mg/dL)	109.7 (108.7-110.7)	112.1 (111.1-113.1)	110.8 (109.3-112.3)	0.08
Serum triglyceride (mg/dL)	108.1 (105.6-110.6)	112.0 (108.9-115.1)	114.5 (110.9-118.1)	0.119
Serum aspartate transaminase (U/L)	19.88 (19.59-20.17)	20.59 (20.30-20.88)	20.96 (20.47-21.45)	< 0.001
Serum alanine transaminase (U/L)	17.71 (17.19-18.23)	19.18 (18.74-19.62)	19.78 (18.88-20.68)	< 0.001
24 hr food intake				
Energy (% EER)	87.98 (86.77-89.18)	87.61 (86.52-88.71)	86.28 (84.57-87.98)	0.399
Protein (% RI)	137.2 (134.8-139.7)	135.3 (133.2-137.4)	131.5 (128.5-134.4)	0.008
Carbohydrate (% of energy)	67.66 (67.26-68.06)	67.94 (67.58-68.31)	68.86 (68.35-69.36)	0.048
Fat (% of energy)	17.82 (17.54-18.10)	17.74 (17.47-18.01)	16.95 (16.57-17.32)	0.022
Fiber (g)	7.293 (7.109-7.477)	7.080 (6.901-7.260)	6.802 (6.565-7.038)	0.002
Na (mg)	4,539.5 (4,440.2-4,638.8)	4,400.1 (4,312.4-4,487.8)	4,297.0 (4,169.5-4,424.6)	0.021
Ca (mg)	476.4 (465.9-487.0)	476.7 (466.2-487.1)	458.3 (442.4-474.2)	0.045
K (mg)	2,914.1 (2,864.1-2,964.0)	2,849.3 (2,800.0-2,898.6)	2,765.5 (2,697.1-2,833.8)	0.005
Vitamin C (mg)	81.36 (79.09-83.69)	78.82 (76.63-81.08)	72.58 (69.76-75.53)	0.002
Total vitamin A (ug RE)	1,001.2 (970.58-1,032.7)	1,024.4 (992.27-1,057.5)	907.23 (863.67-952.98)	0.032

*Adjusted for gender, age, residence area, income, occupation, smoking and drinking status, education, obesity, and physical activities; †P value for Satterwaite chi-square test. EER, energy requirement estimation; RI, recommended intake; RE, retinol equivalent.

DISCUSSION

Public health warnings about the adverse effects of smoking have been advocated intensively, but these warnings have been ineffective (6, 12). Such failure may be related to the fact that smokers in Korea have good SRH scores and consider smoking as a compensatory mechanism of relieving stress to maintain good health. Subjects with poor/very poor SRH tend to smoke less than those with very good/good SRH. We investigated the

factors that influence current smokers to consider themselves to have good and fair health, and examined which components contributed to their high SRH scores. Our results showed that the proportion of poor SRH scores in current smokers was similar to those in past smokers but lower than those in non-smokers, indicating that current smokers might not believe that smoking endangered their health despite public health warnings. Interestingly, regardless of smoking status, people considered well-known indicators of metabolic diseases (serum HDL, glucose,

Table 6. Means and 95% confidence intervals of selected biochemical data, blood pressure and selected 24-hr individual food intake by self-rated subjective health status in a smoking population after covariate adjustment*

Variables	Self-rated subjective health status			P value [†]
	Good or very good (n = 1,984)	Fair (n = 2,447)	Poor or very poor (n = 1,059)	
Biochemical tests				
Serum high density lipoprotein (mg/dL)	50.23 (49.56-50.90)	48.91 (48.30-49.51)	48.63 (47.69-49.58)	0.002
Serum low density lipoprotein (mg/dL)	107.1 (105.2-108.9)	107.1 (105.3-109.0)	107.5 (104.8-110.3)	0.967
Serum triglyceride (mg/dL)	152.3 (145.7-158.9)	161.8 (155.9-167.8)	162.3 (153.6-170.9)	0.067
Serum aspartate transaminase (U/L)	23.34 (22.69-24.00)	24.71 (23.92-25.50)	24.77 (23.63-25.90)	0.025
Serum alanine transaminase (U/L)	25.18 (23.90-26.46)	27.19 (26.15-28.22)	27.38 (25.67-29.08)	0.033
24 hr food intake				
Energy (% EER)	100.8 (98.19-103.5)	98.30 (96.15-100.4)	95.18 (91.83-98.54)	0.032
Protein (% RI)	164.2 (158.7-169.7)	159.7 (154.9-164.5)	150.5 (143.9-157.0)	0.012
Carbohydrate (% of energy)	60.61 (59.78-61.43)	60.80 (60.13-61.47)	62.03 (60.95-63.12)	0.107
Fat (% of energy)	18.87 (18.39-19.35)	19.02 (18.62-19.42)	18.05 (17.34-18.76)	0.058
Fiber (g)	7.965 (7.667-8.262)	7.614 (7.339-7.889)	7.208 (6.788-7.629)	0.017
Na (mg)	6,064.2 (5,849.1-6,279.3)	5,901.3 (5,727.2-6,075.3)	5,699.0 (5,392.0-6,006.1)	0.151
Ca (mg)	562.5 (541.4-583.5)	531.8 (514.8-548.7)	524.0 (484.4-563.6)	0.095
K (mg)	3,434.9 (3,337.4-3,532.4)	3,282.0 (3,196.7-3,367.3)	3,150.0 (3,009.2-3,290.9)	0.003
Vitamin C (mg)	82.73 (78.83-86.81)	76.20 (73.20-79.33)	72.71 (68.15-77.58)	0.003
Total vitamin A (μg RE)	1,152.6 (1,094.0-1,214.3)	1,096.0 (1,047.3-1,147.1)	1,013.4 (939.26-1,093.3)	0.025

*Adjusted for gender, age, residence area, income, occupation, smoking and drinking status, education, obesity, and physical activities; [†]P value for Satterwaite chi-square test. EER, energy requirement estimation; RI, recommended intake; RE, retinol equivalent.

AST and ALT levels, and intake of food groups of milk, vegetables, grain and total vitamins A and C) as indicators of SRH. Thus, the development of a new indicator that showed the direct adverse effects of smoking might be useful to promote discussion at regular health check-ups.

Previous studies have demonstrated that SRH is affected by several factors, such as gender, education, drinking status, income, exercise, walking and stress levels. These results were mostly consistent with findings reported previously, although previous studies lacked sub-categorization according to smoking status (27, 28). However, the influence of gender in SRH is inconsistent among the previous studies (17, 29-31). The present study demonstrated that females had lower SRH scores than males. Some studies reported results consistent with ours (29), while others did not (17, 30, 31). Camelo et al. (30) reported that females had lower SRH scores than males, especially when smoking females were compared with smoking males. The effect of smoking on SRH in various age groups has been also controversial (28, 32). The present study showed that the number of non-smokers and former smokers with poor SRH was higher than that in smokers, indicating that smoking was not one of the main modulators for determining SRH. The adjusted OR for SRH was highest in participants in their 20s, which decreased significantly in smokers. However, no significant decline was detected until participants reached their 30s and 40s in smokers and former smokers, respectively. Jia et al. (32) reported that smoking did not alter the SRH in Chinese subjects with different ages. No significant associations between smoking status change and SRH were found over time, with the exception of females in their 20s. Quitting smoking was associated with more positive SRH in older age group over time in an Australian lon-

gitudinal study (28). These results suggested that the SRH might play an important role in smoking cessation only in the elderly. Accordingly, public health warnings for smoking cessation should be designed differently to target each age category and their SRH relationship to smoking.

SRH in the Korean adult population is affected by biochemical parameters, possibly because people are informed of their biochemical results every 1-2 yr at medical checkups. The present study indicated that the adjusted ORs of SRH were higher in serum HDL and lower in serum glucose, ALT, and AST regardless of smoking status in Korean adults. In the Oslo Health Study, increasing HDL levels were associated with increasing ORs for good SRH; a 1 mM/L increase in HDL elevated the OR for reporting good health by 2.06-2.50 ($P < 0.001$), when adjusting for gender, age group, time since food intake and use of cholesterol-lowering drugs (33). Their SRH result for HDL was considerably higher than that in the present study. We showed that the adjusted OR for good SRH was elevated about 1.07-fold at a 0.26 mM/L increase in HDL regardless of smoking status. Thus, HDL might be a good candidate indicator of SRH. Other biochemical factors have not been investigated as indicators of SRH. However, the present study suggested that not only serum HDL levels but also serum concentrations of glucose, ALT, and AST can be predictors of SRH. Therefore, the biochemical factors, directly and immediately related to smoking status, need to be developed for recognizing smoking as detrimental for their health status.

The SRH is influenced by being underweight or obese (23, 34). In the present study the adjusted OR was higher in the normal weight than underweight groups regardless of smoking status. Thus, people with a normal BMI had better SRH than did the

other BMI groups. As body weight is influenced by energy and nutrient intake, the daily intake may alter SRH. However, few studies have been performed in healthy adults (35). We showed that higher intakes of protein and fat and lower intake of carbohydrates elevated the SRH in non-smokers. Former and current smokers showed a similar relationship as non-smokers, but the differences did not reach significance. Higher intake of fiber, total vitamin A and vitamin C also increased the adjusted OR of SRH in non-smokers and current smokers, but showed no difference among smokers. Consistent with our results, Södergren et al. (35) reported that fruit and vegetable intake was positively associated with self-rated health in Australian older adults. These results suggested that since people considered fruits and vegetables containing total vitamin A and vitamin C as healthy foods, their consumption increased SRH.

To our knowledge, this is the first study to determine the association of SRH with lifestyle, biochemical and nutrient intake parameters according to smoking status in a large representative sample of the Korean population. This study had limitations. First, the results cannot be taken to indicate causality since this was a cross-sectional study. Second, the results may be skewed by under-reporting of negative behaviors and over-reporting of positive behaviors, as all behavior measures were self-reported (36). Third, food intake could be under-reported knowingly or accidentally, despite being determined by trained dietitians.

In conclusions, smoking status did not influence the SRH in a Korean adult population and SRH was affected by serum HDL, glucose, AST and ALT levels, and intake of fiber and total vitamins A and vitamin C. These results indicate that people think good nutrition and good values of biochemical markers can compensate for adverse effects of smoking. Thus, smoking cessation program needs the reasons beyond emphasizing the adverse effects for health. These findings have significant implications for designing tobacco smoking prevention programs for the public. The development of a new direct biochemical parameter would facilitate alteration of the values according to smoking status and sensitivity to SRH. Nutritional education should not empathize that good nutrition attenuates the harmful effect of smoking.

DISCLOSURE

All the authors declare that there are no conflicts of interest.

AUTHOR CONTRIBUTION

Study design: Ahn J, Park S. Data collection and statistical analysis: Lee BK. Writing manuscript: Ahn J, Park S. Final acceptance of manuscript: all authors.

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Supplement Table 1. Means and 95% confidence intervals of selected biochemical data, blood pressure and selected 24-hr individual food intake by self-rated subjective health status in a former-smoking population after covariate adjustment*

Variables	Self-rated subjective health status			P value [†]
	Good or very good (n = 2,176)	Fair (n = 2,195)	Poor or very poor (n = 1,083)	
Biochemical tests				
Serum high density lipoprotein (mg/dL)	50.23 (49.56-50.90)	48.91 (48.30-49.51)	48.63 (47.69-49.58)	0.071
Serum low density lipoprotein (mg/dL)	107.1 (105.2-108.9)	107.1 (105.3-109.0)	107.5 (104.8-110.3)	0.409
Serum triglyceride (mg/dL)	152.3 (145.7-158.9)	161.8 (155.9-167.8)	162.3 (153.6-170.9)	0.587
Serum aspartate transaminase (U/L)	23.34 (22.69-24.00)	24.71 (23.92-25.50)	24.77 (23.63-25.90)	0.079
Serum alanine transaminase (U/L)	25.18 (23.90-26.46)	27.19 (26.15-28.22)	27.38 (25.67-29.08)	0.095
24 hr food intake				
Energy (% EER)	100.8 (98.19-103.5)	98.30 (96.15-100.4)	95.18 (91.83-98.54)	0.061
Protein (% RI)	164.2 (158.7-169.7)	159.7 (154.9-164.5)	150.5 (143.9-157.0)	0.108
Carbohydrate (% of energy)	60.61 (59.78-61.43)	60.80 (60.13-61.47)	62.03 (60.95-63.12)	0.199
Fat (% of energy)	18.87 (18.39-19.35)	19.02 (18.62-19.42)	18.05 (17.34-18.76)	0.503
Fiber (g)	7.965 (7.667-8.262)	7.614 (7.339-7.889)	7.208 (6.788-7.629)	0.059
Na (mg)	6,064.2 (5,849.1-6,279.3)	5,901.3 (5,727.2-6,075.3)	5,699.0 (5,392.0-6,006.1)	0.166
Ca (mg)	562.5 (541.4-583.5)	531.8 (514.8-548.7)	524.0 (484.4-563.6)	0.002
K (mg)	3,434.9 (3,337.4-3,532.4)	3,282.0 (3,196.7-3,367.3)	3,150.0 (3,009.2-3,290.9)	0.005
Vitamin C (mg)	82.73 (78.83-86.81)	76.20 (73.20-79.33)	72.71 (68.15-77.58)	0.101
Total vitamin A (μg RE)	1,152.6 (1,094.0-1,214.3)	1,096.0 (1,047.3-1,147.1)	1,013.4 (939.26-1,093.3)	0.011

*Adjusted for gender, age, residence area, income, occupation, smoking and drinking status, education, obesity, and physical activities; [†]P value for Satterwaite chi-square test. EER, energy requirement estimation; RI, recommended intake; RE, retinol equivalent.