

## The Comparison of Nutrient Intakes and Blood Profiles between Male Smokers and Non-Smokers

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### Abstract

The aim of this study was to compare nutrient intakes, dietary habits, and blood components of smokers with non-smokers in the Seoul area and its vicinity. The results showed that non-smokers had higher intakes of brown rice, grains, fruit, vegetable and *kimchi* than the smokers. Smokers consumed more protein ( $p<0.001$ ), vitamin B<sub>1</sub> ( $p<0.001$ ), vitamin B<sub>2</sub> ( $p<0.007$ ), niacin ( $p<0.0001$ ), zinc ( $p<0.031$ ) and phosphorus ( $p<0.005$ ) than did non-smokers, whereas non-smokers' intakes of vitamin A ( $p<0.037$ ), and folic acid ( $p<0.043$ ) was higher than that of smokers. Individuals who smoked tended to have significantly higher levels of hemoglobin and monocytes. There were no significant differences by smoking status for dihydrolipoic acid (DHLA), arachidonic acid (AA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which were in normal ranges. No significant differences by smoking status were shown for plasma homocysteine, HDL-cholesterol, LDL-cholesterol, vitamin C, and vitamin A. In conclusion, because smokers maintain a less healthy diet and life-style, it is to be recommended that educational programs be developed for smokers, guiding them into adopting better dietary habits in order to maintain and improve their health.

**Key words:** smokers, non-smokers, nutrient intakes, blood profiles

### INTRODUCTION

In Korea, lung cancer is the second leading cause of cancer mortality; it was the leading cause of cancer mortality in the late of 1990s. Consequently, a national stop-smoking program was introduced through broadcasting and educational programs to lower the smoking rate. However, according to national data from the National Statistical Office of 2004, the nation's smoking rate has been increased annually from 35% in 1999 to 40% in 2003. Compared to the smoking rates of China, Japan, England, and Sweden, our national smoking rate is slightly higher (1).

Cigarette smoking is beloved by a great number of people, but it is known to be very harmful to health because more than 4,000 carcinogenic, and toxic substances are contained in the cigarette smoke (2). Smoking is a major risk factor for cardiovascular disease, lung cancer, oral cancer, pharynx cancer, esophageal cancer, and pancreatic cancer (2,3). Especially, it was reported that smoking is a major risk factor for cardiovascular diseases related with abnormal plasma lipoprotein (4). Accordingly, it is very important to study the relationship between smoking and plasma lipoproteins.

Generally, smoking is associated with irregular meal

times, skipping breakfast, overeating, and overall problems in terms of dietary habits (4,5). The bad dietary habits associated with smoking lead to high contents of oxidized lipids in plasma, high levels of LDL-cholesterol and total cholesterol, and decreased plasma vitamin C and vitamin E levels (6,7), resulting in nutritional imbalances. In particular, cigarette smoke contains free radicals, including nitric oxide, which causes lipid oxidation, and losses of vitamin C, vitamin E, carotenoids, and glutathione. This means that cigarette smoke consumes the antioxidants that are protective for cellular systems (6).

According to previous reports (8-11), there were differences in food preferences by smoking status. Smokers have bad dietary habits because they tend to consume more fast foods, alcoholic beverages, coffee, and unhealthy favorite foods as compared to non-smokers. These bad dietary habits can result in nutritional imbalances and low intakes of protein, vitamin C, folic acid, vitamin B<sub>1</sub>, calcium, zinc, and fiber (11,12). Consequently, cigarette smoking is associated with bad dietary habits, low intakes of nutrients and desirable foods, and thus, greater health problems.

Indeed, it was true that smokers have a poor quality diet in terms of nutrient intakes and dietary choices.

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Also, smokers have lower intakes of health nutrients that are rich in antioxidants placing them at higher risk for cardiovascular disease and cancer.

Several recent studies (1,4-6) have investigated relationships between smoking and its related diseases, smoking rates, its related factors, the knowledge of smoking, and smoking attitudes. However, the studies on the relationship between smoking and plasma components are concentrated only on manual laborers and women college students. In addition, there is a lack of data on the intake of the healthy foods (for example, brown rice) among smokers and non-smokers in Korea.

The aim of this study was to compare nutrient intake, including healthy foods, and blood profiles of smokers with non-smokers in Seoul and its vicinity.

## MATERIALS AND METHODS

### Subjects and study period

A sample of 240 smokers and 269 non-smokers was randomly selected from Seoul and its vicinity and data collected during June to August, 2003, and November to December, 2005. The subjects, aged 24 to 26 year-old, participated by answering survey questions including a food frequency questionnaire (FFQ) including dietary intakes. 80 blood samples were collected from 40 smokers, and 40 non-smokers to analyze the plasma lipoprotein, vitamin A, and C.

### Anthropometric data, dietary assessment and measurement

Height (Sam Hwa Co., Korean) and weight (Tanita corporation, Japan) were checked accurately by one well-trained person.

Questionnaires were given to acquire occupation, education level, monthly income. Also, we surveyed smokers' smoking status, when they started smoking, smoking motive, smoking amount and duration of smoking. The food preference classified according to very often (more than 3 times weekly), sometimes (1~2 times weekly), almost never (0 times) on the principal foods, protein foods, fruits and vegetables was surveyed through the questionnaires.

Dietary intake information was collected through food-frequency questionnaires. Detailed descriptions of a total of 100 kinds of foods, including 14 kinds of grains and grain products, 10 kinds of meat products, 18 kinds of marine products, 13 kinds of fruits, 7 kinds of beverages, as well as information on snacks, dairy products, and others items were collected (13).

All collected nutrient data were analyzed according to the Computerized Nutrient Analysis Program 3.0.

### Analysis of blood samples

Among 509 subjects, 80 adults were randomly selected from among the smokers and non-smokers, respectively, for blood sample analysis.

The blood samples were collected and analyzed (ADVIA 120, Bayer, USA) for red blood cells (RBC), white blood cells (WBC), hematocrit, mean cell volume (MCV), mean cell hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and hemoglobin (Hb).

Plasma HDL-cholesterol and LDL-cholesterol were analyzed by a kit (Boehringer mannheim, Germany). Homocysteine, vitamin A, vitamin C, dihydrolipoic acid (DHLA), arachidonic acid (AA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) were analyzed using high performance liquid chromatography (HPLC; Acme 9000 HPLC, Young Lin Instrument Co., Ltd., Korea).

### Statistical analysis

All statistical analysis was conducted using SPSS version 12.0. Significant differences among groups were determined by  $\chi^2$ -test and *t*-test.

## RESULTS

### General parameters

There were no significant differences in height or weight by smoking status (Table 1). The body mass index (BMI) of the smokers was 22.71 and that of the non-smokers was 22.20 ( $p < 0.05$ ). The two major levels of education were high school and college. The average monthly income was under 1,000,000 won.

Among smokers, 49.2% began smoking while high school students, 27.5% started to smoke while middle school students, 22.5% began smoking as college students, and 0.8% began smoking while in elementary school. As motives for smoking, 33.8% of smokers began smoking because of curiosity, 27.1% of smokers started to smoke due to stress, 17.5% smoked first because of peer pressure and 11.7% began to smoke due to social relationships. Among smokers, 32.9% smoked 5 to 6 cigarettes daily and 10.4% smoked at least 20 per day. Among the persons who smoke, 36.7% had smoked for more than 5 years and 85.9% had smoked for more than 1 year.

### Food preference by smoking status

*Comparison of cereal and brown rice intake:* Among the smokers, 32.5% consumed cereals as a principal food, whereas 45.7% of the non-smokers consumed cereals as a principal food (Fig. 1). The percent of consuming brown rice of the smokers was 32.5%, while among

**Table 1.** Selected physiological characteristics of the non-smokers and smokers

Characteristics		Non-smokers (n=269)	Smokers (n=240)	Significance
Physiological characteristics				
Age (yrs)		22.98 ± 6.22 <sup>1)</sup>	23.95 ± 6.43	0.077 <sup>2)</sup>
Height (cm)		174.42 ± 5.42	174.00 ± 16.60	0.682 <sup>2)</sup>
Weight (kg)		67.61 ± 10.23	69.38 ± 10.74	0.077 <sup>2)</sup>
BMI (kg/m <sup>2</sup> )		22.20 ± 3.00	22.71 ± 2.60	0.039*
Demographic characteristics				
Occupation	Unemployed	—	—	0.992 <sup>2)</sup>
	Student	252 (93.7) <sup>3)</sup>	192 (80.0)	
	Official	6 (2.2)	12 (5.0)	
	Sales or service	1 (0.4)	13 (5.4)	
	Specialized	2 (0.7)	1 (0.4)	
	Management	2 (0.7)	6 (2.5)	
	Agriculture	—	2 (0.8)	
	Other	6 (2.2)	14 (5.8)	
Education	Elementary school	3 (1.1)	2 (0.8)	0.628 <sup>2)</sup>
	Middle school	3 (1.1)	5 (2.1)	
	High school	177 (65.8)	145 (60.4)	
	College	85 (31.6)	87 (36.3)	
	Graduate school	1 (0.4)	1 (0.4)	
Monthly income (unit: won × 10 <sup>4</sup> )	<100	246 (91.4)	197 (82.1)	0.817 <sup>2)</sup>
	100 ~ 200	8 (3.0)	30 (12.5)	
	200 ~ 300	7 (2.6)	9 (3.8)	
	300 ~ 500	8 (3.0)	4 (1.7)	
An attitude of smoking				
Smoking since	Elementary school	—	2 (0.8)	—
	Middle school	—	66 (27.5)	
	High school	—	118 (49.2)	
	College	—	54 (22.5)	
Motive for smoking	Curiosity	—	81 (33.8)	—
	Stress	—	65 (27.1)	
	Admonition	—	42 (17.5)	
	For show	—	24 (10.0)	
	From necessity	—	28 (11.7)	
Number of cigarettes smoked/day	1 ~ 2 units/day	—	15 (6.3)	—
	5 ~ 6 units/day	—	79 (32.9)	
	10 units/day	—	70 (29.1)	
	Below 20 units/day	—	51 (21.3)	
	Over 20 units/day	—	25 (10.4)	
A duration of smoking	Below 6 months	—	16 (6.7)	—
	6 months ~ a year	—	18 (7.5)	
	1 year ~ 3 years	—	66 (27.5)	
	3 years ~ 5 years	—	52 (21.7)	
	Over 5 years	—	88 (36.7)	

<sup>1)</sup>Mean ± SD. <sup>2)</sup>NS: Statistically no significant difference at p < 0.05 by *t*-test or  $\chi^2$ -test.

\*Significant at p < 0.05 by *t*-test.

<sup>3)</sup>N (%): Number of adults, the relative % of adults.

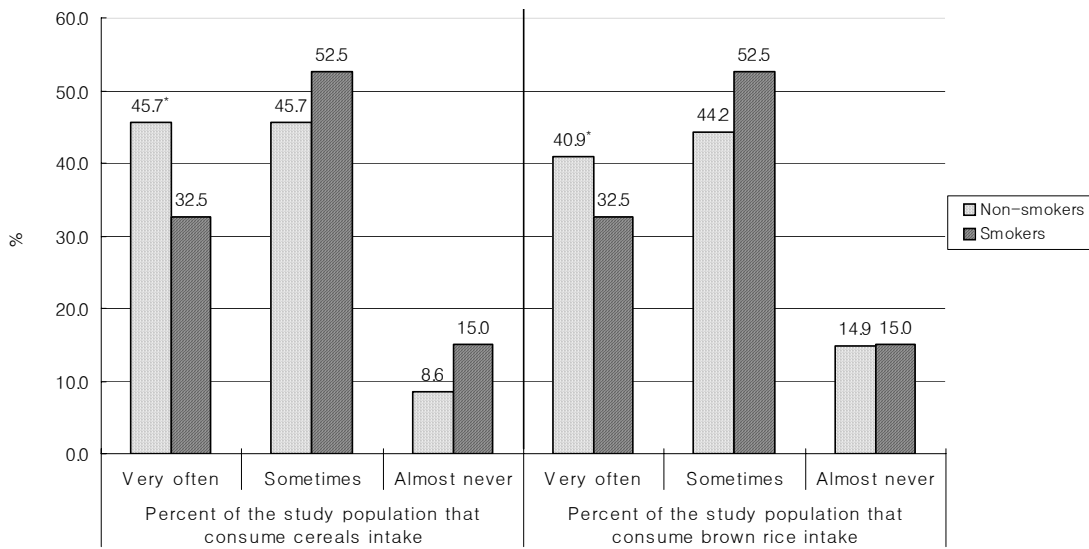
BMI: body mass index (kg/m<sup>2</sup>).

non-smokers it was 40.9%.

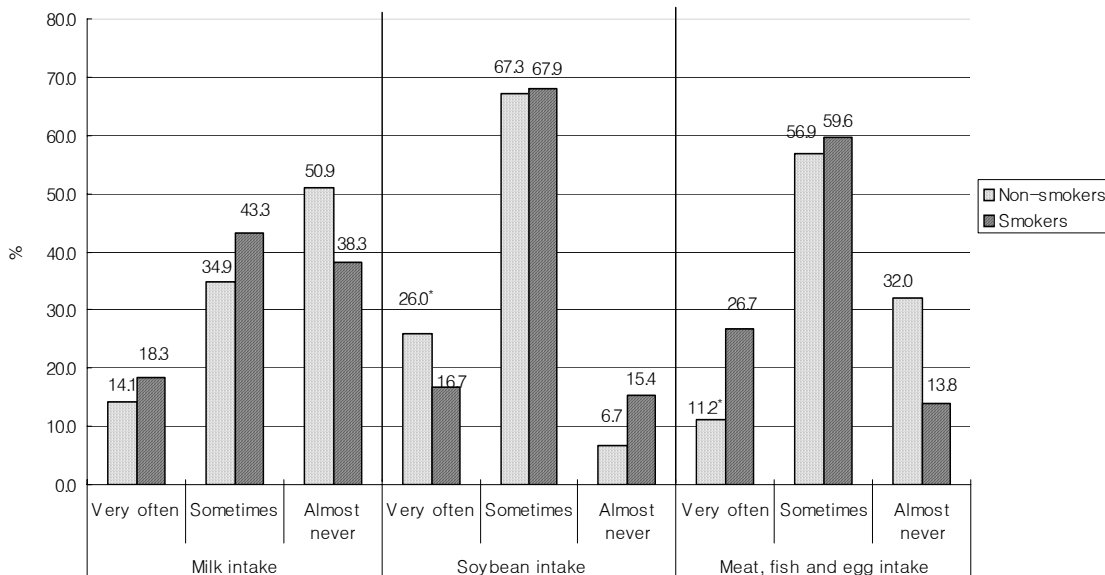
*Consumption of protein foods:* Among the smokers, the percentage who never consumed milk was 38.3%, while the percentage who never consumed milk was lower than 50.9% of the non-smokers (Fig. 2). Among the smokers, 26.7% consumed meat, fish, and egg very of-

ten, while only 11.2% of the non-smokers consumed meat, fish, and egg very often.

*Consumption of fruits and vegetables:* The percentage who were frequent consumers of fruit among the smokers was 15.0%, while among the non-smokers, the percentage who consumed fruits very often was 22.3% (Fig.



**Fig. 1.** Comparison of cereal and brown rice intake. \*Significant at  $p < 0.05$  by  $\chi^2$ -test.



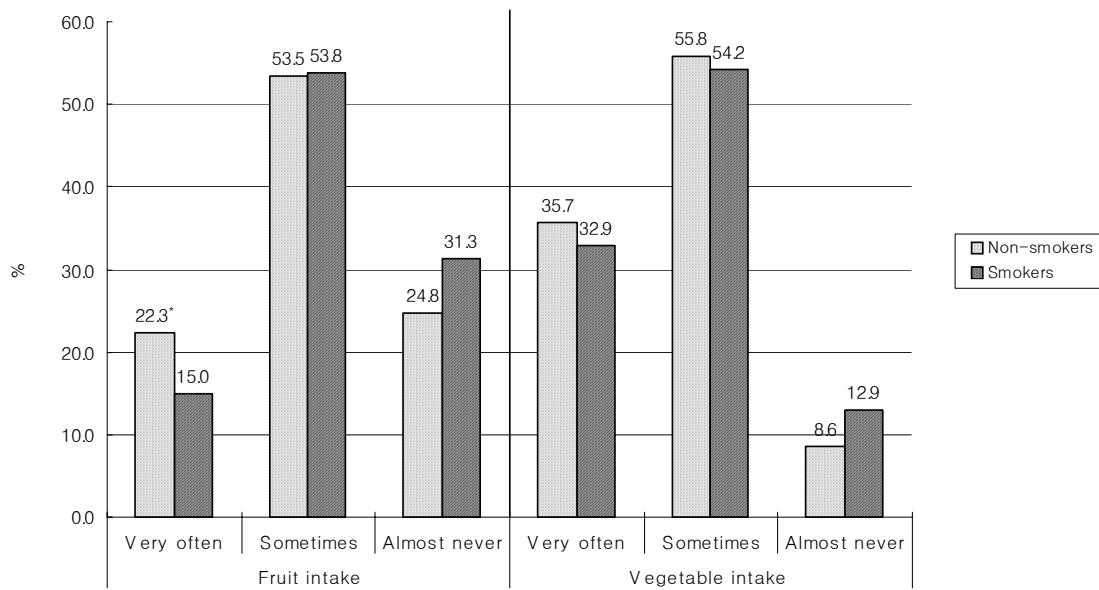
**Fig. 2.** Consumption of protein foods. \*Significant at  $p < 0.05$  by  $\chi^2$ -test.

3). The percentage who consumed vegetables, including *kimchi*, very often among the smokers were 32.9%, while 35.7% in the non-smokers consumed vegetables, including *kimchi* very often. Among the smokers, 12.9% ate vegetables almost never, while only 8.6% of the non-smokers rarely ate vegetables.

**Nutrient intakes**

The comparison of nutrient intakes between smokers and non-smokers is shown in Table 2. Energy expenditure was a little bit higher in smokers (2566.58 kcal) than in non-smokers (2529.48 kcal), but not significantly. Smokers' protein intake (174.03 mg) was significantly higher ( $p < 0.001$ ) than that of non-smokers'

(128.97 mg) and both of them were higher than that of recommended protein intake (55 mg). The intake of vitamin B<sub>1</sub> (3.14 mg) and vitamin B<sub>2</sub> (3.09 mg) for smokers was significantly higher ( $p < 0.001$ ) than that of vitamin B<sub>1</sub> (2.20 mg), and vitamin B<sub>2</sub> (2.45 mg) for non-smokers. The niacin intake (36.14 mg) was significantly higher in smokers compared with that (25.55 mg) of non-smokers ( $p < 0.0001$ ). The niacin intake of smokers was higher than the value of tolerable Upper Intake Level (35 mg). Zinc intake (16.86 mg) was significantly greater in smokers ( $p < 0.031$ ) than that (14.03 mg) in non-smokers. Phosphorus consumption of smokers (2222.29 mg) was significantly higher ( $p < 0.005$ ) than that of non-smokers



**Fig. 3.** Consumption of fruits and vegetables. \*Significant at  $p < 0.05$  by  $\chi^2$ -test.

**Table 2.** Nutrient intakes calculated from food frequency questionnaire for the non-smokers and smokers

Nutrients <sup>2)</sup>	Non-smokers (n=269)	Smokers (n=240)	p-value
Energy (kcal)	2529.48 ± 1150.24 <sup>1)</sup>	2566.58 ± 1564.65	0.889
Protein (g)	128.97 ± 57.20	174.03 ± 80.06	0.001*
Vitamin A (µgRE)	2453.57 ± 166.94	1824.33 ± 1207.86	0.037*
Vitamin B <sub>1</sub> (mg)	2.20 ± 0.77	3.14 ± 1.59	0.001*
Vitamin B <sub>2</sub> (mg)	2.45 ± 1.05	3.09 ± 1.29	0.007*
Vitamin B <sub>6</sub> (mg)	5.07 ± 1.94	4.92 ± 2.14	0.736
Niacin (mg)	25.55 ± 13.01	36.14 ± 16.63	0.0001*
Vitamin C (mg)	326.56 ± 160.54	284.20 ± 169.81	0.276
Vitamin E (mg)	35.24 ± 16.77	31.14 ± 15.28	0.214
Folic acid (µg)	585.26 ± 225.82	488.98 ± 222.66	0.043*
Calcium (mg)	1055.42 ± 444.64	985.88 ± 401.55	0.438
Iron (mg)	23.88 ± 9.34	24.17 ± 10.60	0.889
Zinc (mg)	14.03 ± 6.00	16.86 ± 8.16	0.031*
Phosphorus (mg)	1791.77 ± 752.52	2222.29 ± 929.19	0.005*
Sodium (mg)	8453.87 ± 3189.83	8457.01 ± 3687.54	0.996
Fiber (g)	14.47 ± 5.98	12.16 ± 5.86	0.088
Cholesterol (mg)	567.04 ± 353.61	923.91 ± 395.88	0.0001*

<sup>1)</sup>Mean ± SD. (n): Number of adults. Significant at  $p < 0.05$  by  $t$ -test. <sup>2)</sup>KDRIs: Dietary Reference Intakes for Koreans, 2005.

(1791.77 mg). Vitamin A intake (2453.57 µgRE) was significantly greater ( $p < 0.001$ ) in non-smokers. Folic acid intake (585.26 µg) was significantly higher ( $p < 0.043$ ) in non-smokers than in smokers (488.98 µg). Fiber intake between groups was not significantly different, but values in both groups were lower than the adequate intake (31 g). The intake of cholesterol of smokers was significantly greater than that of non-smokers ( $p < 0.0001$ ), however no significant different in plasma cholesterol between smokers and non-smokers was shown.

#### Blood profiles

The blood samples of 80 subjects (40 smokers, 40

non-smokers) were analyzed and are shown in Table 3. Hemoglobin levels were within the normal range (13.0 ~ 17.5 g/dL) both for the smokers and non-smokers, but hemoglobin levels for smokers were significantly higher than for non-smokers. The hematocrit values of smokers were also higher than those of non-smokers, but both had values within the normal range (40.00 ~ 54.00%). RBC and WBC values were normal in both smokers and non-smokers. Levels of MCV, MCH, MCHC, RDW, PDW, MPV, segmented neutrophils, lymphocytes, eosinophil, and basophils were normal in both smokers and non-smokers. But monocyte counts were significantly lower in the non-smokers than in smokers ( $p < 0.05$ ).

**Table 3.** Blood profiles of the non-smokers and smokers

Parameters	Non-smokers (n=40)	Smokers (n=40)	Significance
Hemoglobin (g/dL)	15.36 ± 0.93 <sup>1)</sup>	15.73 ± 0.68	0.046*
Hematocrit (%)	46.23 ± 2.36	47.15 ± 1.82	0.067
Red blood cells (×10 <sup>6</sup> /μL)	5.13 ± 0.28	5.21 ± 0.26	0.179
White blood cells (×10 <sup>3</sup> /μL)	6.34 ± 1.53	6.52 ± 1.33	0.579
Platelets (×10 <sup>3</sup> )	258.85 ± 46.12	260.70 ± 42.17	0.839
MCV (fL)	90.14 ± 2.62	89.10 ± 9.83	0.523
MCH (pg)	29.96 ± 1.13	33.27 ± 13.41	0.126
MCHC (g/dL)	33.23 ± 0.78	33.41 ± 0.88	0.270
RDW (%)	12.59 ± 0.44	12.72 ± 0.39	0.172
PDW (fL)	13.05 ± 1.48	12.69 ± 1.28	0.275
MPV (fL)	11.09 ± 0.81	10.94 ± 0.65	0.399
Segmented neutrophils (%)	55.20 ± 8.47	56.45 ± 8.58	0.521
Lymphocytes (%)	35.33 ± 7.02	33.65 ± 7.35	0.312
Monocytes (%)	6.28 ± 1.18	6.80 ± 1.34	0.051*
Eosinophils (%)	2.43 ± 1.45	2.63 ± 1.98	0.630
Basophils (%)	0.55 ± 0.50	0.53 ± 0.51	0.844

<sup>1)</sup>Mean ± SD. \*Significant at p<0.05 by *t*-test. (n): Number of adults.

MCV: mean cell volume, MCH: mean cell hemoglobin, MCHC: mean cell hemoglobin concentration, RDW: red cell distribution width, PDW: platelet distribution width, MPV: mean plasma volume.

Plasma lipoproteins were not affected by smoking status (Table 4). Dihydrolipoic acid (DHLA), arachidonic acid (AA), eicosapentaenoic acid (EPA), HDL-cholesterol, LDL-cholesterol, homocysteine, and docosahexaenoic acid (DHA) levels were normal in both smokers and non-smokers (Table 5).

Plasma vitamin A and vitamin C values were not significantly different, but their values were higher in non-smokers than in smokers (Table 6).

## DISCUSSION

The recent smoking rate for adult males is high at 61.7%, and the highest rate of smoking is in the 20~29 age group (4). Nutritional status and health are affected by smoking status, and smoking results in bad dietary

habits.

Among smokers, 49.2% began smoking while high school students, 33.8% of smokers reported that their motive for smoking is curiosity. Among smokers, 32.9% smoked 5 to 6 cigarettes daily, 36.7% have smoked for more than 5 years and 85.9% have smoked for more than 1 year.

Our results indicate dietary differences by smoking status. The non-smoking subjects had relatively higher intakes of brown rice, grains, legumes, fruits, and vegetables, including *kimchi*. The differences in food preferences by smoking status caused differences in nutrient intake.

Brown rice is richer in vitamin E, vitamin B<sub>1</sub>, vitamin B<sub>6</sub>, vitamin C, fiber and minerals such as Mg than white

**Table 4.** Concentrations of plasma lipids of the non-smokers and smokers

Parameters	Non-smokers (n=40)	Smokers (n=40)	Significance
DHLA (μg/mL)	34.48 ± 6.49 <sup>1)</sup>	36.45 ± 6.59	0.764 <sup>2)</sup>
AA (μg/mL)	138.93 ± 12.28	149.15 ± 15.75	0.354 <sup>2)</sup>
EPA (μg/mL)	15.18 ± 3.59	21.28 ± 6.22	0.201 <sup>2)</sup>
DHA (μg/mL)	46.60 ± 10.26	72.40 ± 18.15	0.144 <sup>2)</sup>

<sup>1)</sup>Mean ± SD. <sup>2)</sup>NS: Statistically no significant difference at p<0.05 by *t*-test. (n): Number of adults.

DHLA: dihydrolipoic acid, AA: arachidonic acid, EPA: eicosapentaenoic acid, DHA: docosahexaenoic acid.

**Table 5.** Homocysteine and cholesterol levels of the non-smokers and smokers

Parameters	Non-smokers (n=40)	Smokers (n=40)	Significance
Homocysteine (μmol/L)	13.70 ± 1.14 <sup>1)</sup>	13.99 ± 1.34	0.685 <sup>2)</sup>
HDL-cholesterol (mg/dL)	50.08 ± 3.75	53.90 ± 4.55	0.383 <sup>2)</sup>
LDL-cholesterol (mg/dL)	94.75 ± 13.96	95.00 ± 9.97	0.979 <sup>2)</sup>

<sup>1)</sup>Mean ± SD. <sup>2)</sup>NS: Statistically no significant difference at p<0.05 by *t*-test. (n): Number of adults.

HDL-cholesterol: high density lipoprotein cholesterol, LDL-cholesterol: low density lipoprotein cholesterol.

**Table 6.** Concentrations of plasma vitamin A and vitamin C of the non-smokers and smokers

Parameters	Non-smokers (n=40)	Smokers (n=40)	Significance
Vitamin A (mg/L)	1.07 ± 0.33 <sup>1)</sup>	1.00 ± 0.20	0.791 <sup>2)</sup>
Vitamin C (µg/mL)	14.25 ± 12.59	11.06 ± 8.82	0.706 <sup>2)</sup>

<sup>1)</sup>Mean ± SD. <sup>2)</sup>NS: Statistically no significant difference at  $p < 0.05$  by *t*-test. (n): Number of adults.

rice. Brown rice is known to be a healthy food. Cereals mixed with grains supply vitamin B-complex and vitamin E and help with intestinal movement and digestion (14). Smokers have higher and more frequent intakes of meat, egg, and fish, but less intake of soy protein ( $p < 0.05$ ) (Fig. 2). Smokers and non-smokers do not differ significantly in milk intake, which agrees with previous results which showed that smokers had higher intakes of whole milk and egg (10,15). The results showed smokers consumed less *kimchi*, vegetables, and fruits ( $p < 0.05$ ) (Fig. 3) which was the same tendency seen in previous reports (1,10,15). It is well known that vegetables and fruits have potential antioxidant compounds (15). It is recommended that vegetable and fruit intakes be higher for good health. Fruits and vegetables are rich in vitamin C, phytochemicals, and dietary fiber. Vitamin C is known as an antioxidant with the ability to react with, and scavenge or quench, the free radicals produced by smoking. Free radicals readily react with organic molecules such as lipids, proteins, and DNA, and thus damage cellular components unless they are removed (16-19). Previous studies report that beta-carotene reacted synergistically with vitamin E in scavenging radicals and attenuating oxidative damage due to smoking, and helped make LDL more resistant to lipid oxidation (20). Dietary fiber is considered to have beneficial effects, including detoxifying roles, in humans (20). It was also shown through several previous studies (1,15), as well as our results, that smokers consume less brown rice (our results only), vegetables, and fruits, placing them at high risk for developing chronic diseases related to poor dietary habits. Possible reasons for differences in food choice and consumption between those who smoke and those who do not might be differences in taste, habits, and intellectual interests between smokers, and non-smokers (21).

The comparisons between nutrient intakes are shown in Table 2. Energy expenditure for non-smokers, and smokers was lower than the average value (2600 kcal) for 20~29-year old men. The protein intake was greater than recommended Intake (55 mg) in both smokers (174.03 mg), and non-smokers (128.97 mg). Smokers had a significantly higher intake ( $p < 0.0001$ ) of niacin (36.14 mg) than that of non-smokers (25.55 mg). And

niacin intake of both groups was higher than that of the tolerable Upper Intake Level. Also, the intakes of vitamin B<sub>1</sub> ( $p < 0.001$ ), vitamin B<sub>2</sub> ( $p < 0.007$ ), zinc ( $p < 0.031$ ), and phosphorus ( $p < 0.005$ ) were significantly higher in smokers than those in non-smokers. But vitamin A ( $p < 0.037$ ), and folic acid ( $p < 0.043$ ) were significantly higher in smokers. Intake of folic acid in both groups was greater compared with that of recommended intake. In previous reports (22), folic acid intake of men older than twenty was significantly greater in non-smokers than that in smokers. The deficiency in folic acid caused the accumulation of homocysteine by blocking transformation of homocysteine to methionine, accordingly, accumulated homocysteine in plasma could cause increased risk of coronary artery disease (CAD) (22,23). Also, it was reported that smoking, and drinking could be associated with homocysteinemia (24,25). Fiber intake was lower than the adequate intake in both groups and there was no significant difference in smokers, and non-smokers. As a result, it is recommended that beneficial educational programs be developed for smoker, guiding them to adopt better dietary habits and healthier life-styles in order to maintain and improve their health, especially for the prevention of folic acid deficiency which is necessary to reduce the risk of CAD.

Hemoglobin values were higher among the smokers than the non-smokers ( $p < 0.05$ ) (Table 3). Furthermore, there were significant differences by smoking status in monocyte counts between smokers (6.80%) and non-smokers (6.28%) ( $p < 0.05$ ), but there were no significant differences in hematocrit, RBC, WBC, platelets, MCV, MCH, RDW, PDW, MVP, segmented neutrophils, lymphocytes, eosinophils, and basophils by smoking status. Whitehead et al. (26) reported that smokers who smoked more than 10 cigarettes per day showed increased hematocrit and hemoglobin values. Middleton and Morice (27) reported that hemoglobin values in smokers were higher than that of non-smokers because of the higher amount of CO in blood due to smoking.

No differences in DHLA, AA, EPA, and DHA were shown by smoking status (Table 4) Differences in homocysteine, HDL-cholesterol, and LDL-cholesterol were also not apparent (Table 5). Although, there was no significant difference in plasma cholesterol between smokers and non-smokers, the intake of cholesterol of smok-

ers was significantly greater than that of non-smokers.

Generally, cigarette smoke contains peroxy radicals, nitrogen dioxide, and superoxide anion, which initiate or increase lipid oxidation in the body (11,28,29), and thereby causing increased risk for heart and cardiovascular disease through increased susceptibility to LDL oxidation (30). However, many previous studies show different tendencies for lipid, and cholesterol values by smoking status. Several (4,6) have reported that no differences were shown in plasma lipid, and cholesterol values. Imamura et al. (31) reported that smokers who smoked 30 cigarettes per day had lower HDL-cholesterol levels than non-smokers. Dallongeville et al. (32) reported that smoking increased plasma LDL-cholesterol and TAG, and decreased plasma HDL-cholesterol. However, Sigurdsson et al. (33) reported that smoking decreased HDL-cholesterol only. On the other hand, Brischetto et al. (34) found that smokers had reduced total-cholesterol, LDL-cholesterol, and TG.

Although smoking-related diseases have latency in occurrence, smoking is increasingly a potential risk factor for health because the smoking-related diseases appear as the age is increased (4).

Vitamin C is a scavenger of free radicals caused by smoking. Triibble et al. (35) reported that vitamin C levels were decreased by smoking. Other researchers (6,36,37) have reported that plasma vitamin C levels were not affected by smoking status, which is the same as our results. Generally, it is known that plasma vitamin C, vitamin E, and vitamin A ( $\beta$ -carotene) are scavengers of free radicals that can cause chronic diseases. Specifically, vitamin C is decreased by smoking. Park and Kang (38) reported that plasma vitamin C decreased by smoking, and vitamin C deficiency was more frequent in smokers than in non-smokers. Consequently, smokers seemed to require a much higher consumption of vitamin C than 100 mg (Dietary Reference Intakes for Koreans; KDRI, 8th revision, 2005).

We found significant differences in nutrient intakes between smokers and non-smokers.

In conclusion, smokers consume fewer healthy nutrients than non-smokers placing them at higher risk for cardiovascular disease and cancer as a result of both dietary and smoking habits. Accordingly, it is recommended that beneficial educational programs be developed for smokers, guiding them to adopt better dietary habits and healthier lifestyles in order to maintain and improve their health.

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