Nutrition Research and Practice (*Nutr Res Pract*) 2012;6(4):340-348
http://dx.doi.org/10.4162/nrp.2012.6.4.340
pISSN 1976-1457 eISSN 2005-6168

A study on dietary habits, health related lifestyle, blood cadmium and lead levels of college students

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Abstract

This study was performed in order to investigate dietary habits, health related lifestyle and blood cadmium and lead levels in female college students. 80 college students (43 males and 37 females) participated in the survey questionnaires. Body weight and height, blood pressure, and body composition were measured. The systolic blood pressure of male and female students were 128.9 ± 13.9 and 109.8 ± 12.0, respectively. The diastolic blood pressure of male and female students were 77.1 ± 10.3 and 66.0 ± 6.9, respectively, showing that male students had significantly higher blood pressure than female students ($P < 0.001$). The BMI of male and female students were 23.4 ± 3.3 and 20.2 ± 2.3, respectively. Most male students were in the range of being overweight. The dietary habits score of female students was significantly higher than that of male students ($P < 0.01$).The blood cadmium level of male and female students were 0.54 ± 0.23 and 0.52 ± 0.36, respectively. There was no significant difference between male and female students. The blood lead level of male and female students were 1.09 ± 0.49 and 0.59 ± 0.45, respectively. The blood lead level of male students was significantly higher than that of female students ($P < 0.001$). The blood cadmium level of smokers and nonsmokers were 0.69 ± 0.29 and 0.49 ± 0.29 respectively ($P < 0.05$). The blood cadmium level of smokers was significantly higher than that of nonsmokers ($P < 0.05$). The blood lead level of smokers and nonsmokers were 1.09 ± 0.43 and 0.80 ± 0.54, respectively. The blood lead level of smokers was significantly higher than that of nonsmokers ($P < 0.05$). Therefore, proper nutritional education programs are required for college students in order to improve their dietary and health related living habits.

Key Words: Dietary habit, blood cadmium, blood lead, college students

Introduction

Adequate and balanced nutrient intake is necessary to maintain the health of the body as well as of the mind and to prevent diseases. Also, the establishment of proper dietary habits is very important for desirable nutritional practices. Proper dietary habits can decide physical and psychological health status of individuals, thus poor dietary habits not only impair physical growth but also greatly affect the emotional development [1].

College students are no longer under the supervision of their parents for their dietary life and may face many problems in the quality of their diets when they become to manage their lives independently without receiving proper education on dietary life [2]. Also, dietary behavior of college students is very sensitive to the changes of social environment and going towards much undesirable directions such as irregular meals, frequent meal skipping, eating out and overeating, excessive drinking and smoking that are affected by class schedules without considering meal time, increased free time, part time job, and get-together with friends and dating [3].

These could be confirmed from the results of regional survey [4,5] in college students that equivocally pointed large numbers of cases which caused obesity or underweight, anemia, gastrointestinal tract diseases, and nutritional imbalance by unbalanced intake of mainly cheap, convenient, and preferable foods rather than focusing on nutrition or hygiene due to dietary habits such as irregular meals, meal skipping, overeating, deviated food habit, late night snack, excessive intake of ready-to-eat products, excessive smoking and drinking, limited pocket money, and lack of nutritional knowledge.

While the smoking rate of men and women of 19 years and older has been decreased recently by 39.6% and 2.2%, respectively, in Korea, the smoking rates of men and women between 20-29 years were reportedly higher as 40.9% and 5.9%, respectively, than those of other age groups [6]. Not only smoking but also free radicals that are generated inside the body by carbon monoxide, nicotine, and tar contained in the cigarette itself are elucidated as risk factors for various diseases [7]. This smoking

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Received: July 19, 2012, Revised: August 10, 2012, Accepted: August 10, 2012

habit could even increase the chance of drinking, which ultimately changes dietary habit and life style, further affects nutrition and health status of the body.

Metals play important roles in numerous physiological actions inside the body, but if heavy metal concentrations are in excess above the normal level, these can threaten the health. Heavy metals are substances with specific gravity more than 5g/cm^3 and have been used for several thousand years, and can induce various diseases when inhaled or ingested through either air or food stuffs. Heavy metals, after being absorbed and bound to tissues, are not easily excreted from the body, and their accumulation is increased by age due to their long half-life, ultimately causing various health defects [8]. Major heavy metals that threaten health include cadmium, lead, and mercury [9]. It has been known that elevation of blood cadmium level, by increasing systolic blood pressure as well as diastolic blood pressure increased the risk of hypertension [9]. Acute lead poisoning induces headache, unstable emotion, abdominal pain, and various symptoms related to the nerves, and it has been known that chronic exposure to lead further develops renal tubule damages [8].

This study was conducted to provide the data which can be a database in improving dietary habit as well as lifestyle of college students in Korea by finding out current address of health status of college students and related factors through investigating difference between males and females in physical characteristics, health related factors, dietary habit, heavy metal levels in blood, and other blood profiles.

Subjects and Methods

Subjects

This study was conducted in 43 male college students and 37 female college students who did not have particular diseases in Gyeonggi-do area. Data were collected during 6th to 8th November, 2008, anthropometric measurements for the subjects were performed and blood samples were collected, and then survey questionnaires were distributed to the subjects for responding by filling it, and the responded contents were confirmed during interview session.

Anthropometic measurements

General characteristics of subjects including gender, age, residence type, and household income and health related parameters of exercise, drinking, and smoking status were investigated.

Height and weight of subjects were measured using Fatness measuring system (DS0102, JENIX, Korea) by making subjects stood after removing shoes while maintaining straight posture with light cloths on. Blood pressure of subjects was measured by Automatic blood pressure monitor (FT-500R, Korea) while subjects were seated on the chair and had rest to measure systolic blood pressure as well as diastolic blood pressure. For the analysis of body compositions, InBody was used implementing Direct Segmental Bioelectrical Impedance Analysis Method (DSM-BIA) per each body part. Subjects were asked to remove metal objects from their body and measurements were carried out by letting the subjects stood on the machine with bare feet.

Dietary habit

Dietary habits survey was conducted via questionnaire. Questionnaire was constituted with a total of 12 questions about meal regularity, breakfast skipping, deviated food habit, attitude during purchasing the foods, binge, cooking method, preference for sweet taste and salty taste, and the responses were categorized as 'Never', 'Sometimes', 'So-so', 'Almost always', and 'Always'. For positive questions, 1 point was given to 'Never', 2 points to ''Sometimes', 3 points to 'So-so' , 4 points to 'Almost always', and 5 points to 'Always', while for negative questions, inverse scoring were given accordingly.

Blood analysis

Fifteen ml of blood samples were collected from the subjects in the morning before breakfast after at least 10 hours of overnight fasting after dinner on the previous day of measurement. Ten ml of venous blood was collected into a plain tube using vacuum blood collecting tube to analyze iron, calcium, and magnesium levels in the blood. Collected blood samples were left at ambient temperature for 30 minutes for coagulation followed by centrifuge at 3,000 rpm for 5 minutes and then stored in the refrigerator. Five ml of venous blood was collected into an EDTA tube in which anticoagulant (EDTA) was contained using vacuum blood collecting tube for the analysis of plasma cadmium and lead levels, RBC, WBC, Hb, HCT, MCV, MCH, MCHC, and platelet. These anticoagulant and blood sample mixtures were mixed well for 6-8 hours and then kept under the ambient condition.

Blood cadmium and lead levels were analyzed by using atomic spectrophotometer (AA-6800, Shimadzu), and iron, calcium, and magnesium levels were analyzed using Automatic Blood Analyzer, and other parameters of RBC, WBC, Hb, HCT, MCV, MCH, MCHC, and Platelet were also measured.

Statistical analysis

The data were analyzed using SPSS (Statistical Package for the Social Science, version 14.0). Chi-square analysis was performed to find out general characteristics and health related parameters of the subjects, and student t-test was conducted to find out physical characteristics, dietary habit, and blood profiles between male and female students.

Results

General characteristics and anthropometric measurements

General characteristics of students are shown in Table 1. The average age of male students was higher than that of female students. The family size was 3-4 in 81.4% of male students, whereas the family size of 3-4 and a size of more than 5 were 45.9% in the female students group. The results reveal that more number of female students have a family size of more than 5 ($P < 0.001$).

Regarding the residence type, the number of male and female students living in dormitories was 51.2% and 54.1%, respectively, which is the largest proportion among the residence types. Meanwhile, the percentage of male students living at home was 18.6%, whereas the percentage of female students living at home was 43.2%, which is significantly higher ($P < 0.01$) than that of male students. The highest household income group was the group with income higher than KRW 3 million (USD 2,577) in 62.8% of male student and in 75.7% of female students.

The anthropometric measurements of the subjects are presented in Table 2. The mean height and weight of male students (175.7 ± 5.8 cm and 73.2 ± 11.9 kg) and female students (160.2 ± 4.3cm and 52.4 ± 6.9 kg), and the Body Mass Index (BMI) for male students (23.4 ± 3.3 kg/m^2) and for female students (20.2 ± 2.3 kg/m^2) show a significantly higher BMI in male students than

Table 1. General characteristics of the subjects N (%)

		Male	Female	Total	x^2 (df)	*P*
Age (yrs)	18	1 (2.3)	1 (2.7)	2 (2.5)	18.98 (4)**	0.001
	19-20	8 (18.6)	12 (32.4)	20 (25.0)		
	21-22	6 (14.0)	17 (45.9)	23 (28.8)		
	23-24	14 (32.6)	5 (13.5)	19 (23.8)		
	≥ 25	14 (32.6)	2 (5.4)	16 (20.0)		
Number of family	1-2	5 (11.6)	3 (8.1)	8 (10.0)	16.17 (2)***	0.000
	3-4	35 (81.4)	17 (45.9)	52 (65.0)		
	≥ 5	3 (7.0)	17 (45.9)	20 (25.0)		
Type of residence	Home	8 (18.6)	16 (43.2)	24 (30.0)	12.72 (3)**	0.005
	Dormitory	22 (51.2)	20 (54.1)	42 (52.5)		
	Self-boarding	11 (25.6)	1 (2.7)	12 (15.0)		
	Relative's	2 (4.7)	0 (0.0)	2 (2.5)		
Household income (10,000 won/month)	≤ 100	3 (7.0)	-	3 (3.8)	5.26 (3)	0.153
	100-199	5 (11.6)	1 (2.7)	6 (7.5)		
	200-299	8 (18.6)	8 (21.6)	16 (20.0)		
	≥ 300	27 (62.8)	28 (75.7)	55 (68.8)		
Total		43 (100.0)	37 (100.0)	80 (100.0)		

** $P < 0.01$, *** $P < 0.001$

Table 2. Anthropometric measurements of the subjects

	Male (n = 43)	Female (n = 37)	Total (n = 80)	t	*P*
Height (cm)	175.7 ± 5.8[1)]	160.2 ± 4.3	168.5 ± 9.3	13.5***	0.000
Weight (kg)	73.2 ± 11.9	52.4 ± 6.9	63.6 ± 14.4	9.39***	0.000
BMI (kg/m^2)[2)]	23.4 ± 3.3	20.2 ± 2.3	21.9 ± 3.3	5.07***	0.000
Underweight (<18.5)	1 (2.3)[7)]	6 (16.2)	7 (8.8)		
Normal (18.5-22.9)	20 (46.5)	26 (70.3)	46 (57.5)	14.69**[8)]	0.001
Overweight (≥23.0)	22 (51.2)	5 (13.5)	27 (33.8)		
Systolic pressure (mmHg)	128.9 ± 13.9	109.8 ± 12.0	120.1 ± 16.2	6.54***	0.000
Diastolic pressure (mmHg)	77.1 ± 10.3	66.0 ± 6.9	72.0 ± 10.5	5.60***	0.000
TBW (l)[3)]	42.8 ± 5.0	26.9 ± 1.9	35.5 ± 8.9	18.29***	0.000
SLM (kg)[4)]	55.2 ± 6.5	34.5 ± 2.5	45.6 ± 11.5	18.31***	0.000
FFM (kg)[5)]	58.5 ± 6.9	36.7 ± 2.6	48.4 ± 12.2	18.06***	0.000
SMM (kg)[6)]	33.0 ± 4.2	19.4 ± 2.0	26.7 ± 7.6	18.02***	0.000
Body Fat Mass (kg)	14.3 ± 7.2	15.2 ± 5.1	14.7 ± 6.3	-0.63	0.533
Body Fat (%)	18.8 ± 6.4	28.6 ± 5.8	23.3 ± 7.8	-7.17***	0.000

[1)] Mean ± SD
[2)] BMI : Body mass index
[3)] TBW : Total body water
[4)] SLM : Soft lean mass
[5)] FFM : Fat free mass
[6)] SMM : Skeletal muscle mass
[7)] N (%)
[8)] x^2 (df)
** $P < 0.01$, *** $P < 0.001$

that of female students ($P < 0.001$). According to the BMI standard set by the Korea society for the study of obesity [11], the body mass index is classified into underweight (below 18.5), normal weight (18.5-below 23.0), and overweight (more than 23). The result shows that 46.5% of male students and 70.3% of female students were normal weight, 51.2% of male students and 13.5% of female students were overweight, and 2.3% of male students and 16.2% of female students were underweight. The overweight group of male students was higher that of female students.

Systolic blood pressure of male students (128.9 ± 13.9 mmHg) was significantly higher than that of female students (109.8 ± 12.0 mmHg) ($P < 0.001$). Meanwhile, diastolic blood pressure of male students was also significantly higher (77.1 ± 10.3 mmHg) than female students (66.0 ± 6.9 mmHg) ($P < 0.001$). Muscle mass of male students(55.2 ± 6.5 kg) and female students (34.5 ± 2.5 kg), lean body mass of male students (58.5 ± 6.9 kg) and female students (36.7 ± 2.6 kg), and skeletal muscle mass in male students (33.0 ± 4.2 kg) and in female students (19.4 ± 2.0 kg) suggested significantly higher overall muscle measurement values in male students than those of female students ($P <$ 0.001). The percentage body fat percentage from male students (18.8 ± 6.4%) was significantly lower than female students (28.6 ± 5.8%) ($P < 0.001$).

Health-related lifestyle and dietary habits

Health-related lifestyle of subjects is shown in Table 3. The occupancy of students who are engaged in exercise during normal time was found significantly higher in male students (55.8%) than in female students (24.3%), which shows a quite less engagement in exercise ($P < 0.05$). As for exercise frequency, most of the students are found to be engaged in exercise at a frequency of 1-4 times a week with a figure of 1-2 times a week for male students (45.8%) and for female students (44.4%), and 1-4 times for male students (54.2%) and for female students (44.4%), which did not significantly differ between gender.

Drinking did not show a significant difference between male (86.0%) and female students (64.9%). Drinking frequency of more than once a week in male students was significantly higher than that of female student ($P < 0.001$).

The smoking rate of male students was significantly higher than that of female students ($P < 0.001$). Among male students, the largest proportion in the amount of smoking was 10-19 cigarettes a day (62.5%), followed by 5-9 cigarettes a day (31.3%), and below 5 cigarettes a day (6.3%).

The dietary habit scores of the subjects are shown in Table 4. The questions that showed a difference between males and females were 'I consider calorie intake at meal time (male students 1.53 ± 0.70, female students 2.38 ± 0.92), 'I consider calorie intake when eating out' (male 1.40 ± 0.66, female students 2.19 ± 0.94), 'I read the nutrition information label before I purchase foods' (male 2.30 ± 1.27, female 3.35 ± 0.98), and 'I prefer cooked foods with low calorie (steam/grill) recipes' (males 1.95 ± 0.90, females 2.41 ± 0.87). All of these questions show that the overall scores of female students are significantly higher than those of male students ($P < 0.001$-$P < 0.01$), clearly portraying that female students who practice a dietary life are more aware

Table 3. Health-related lifestyle practice of the subjects N (%)

		Male	Female	Total	x^2 (df)	*P*
Exercise	Yes	24 (55.8)	9 (24.3)	33 (41.3)	8.14 (1)**	0.004
	No	19 (44.2)	28 (75.7)	47 (58.8)		
Frequency of exercise	1-2 (times/wk)	11 (45.8)	4 (44.4)	15 (45.5)	2.79 (2)	0.248
	3-4 (times/wk)	13 (54.2)	4 (44.4)	17 (51.5)		
	5-6 (times/wk)	-	1 (11.1)	1 (3.0)		
	Daily	-	-	-		
Drinking alcohol	Yes	37 (86.0)	24 (64.9)	61 (76.3)	4.97 (2)	0.083
	No	4 (9.3)	8 (21.6)	12 (15.0)		
	Ex-drinker	2 (4.7)	5 (13.5)	7 (8.8)		
Frequency of drinking alcohol	1-2 (times/mo)	1 (2.7)	11 (45.8)	12 (19.7)	17.91 (3)***	0.000
	1-2 (times/wk)	26 (70.3)	11 (45.8)	37 (60.7)		
	3-4 (times/wk)	9 (24.3)	2 (8.3)	11 (18.0)		
	5-6 (times/wk)	1 (2.7)	-	1 (1.6)		
	Daily	-	-	-		
Smoking	Yes	16 (37.2)	-	16 (20.0)	24.76 (2)***	0.000
	No	20 (46.5)	36 (97.3)	56 (70.0)		
	Ex-smoker	7 (16.3)	1 (2.7)	8 (10.0)		
Number of cigarettes /day	< 5	1 (6.3)	-	1 (6.3)		
	5-9	5 (31.3)	-	5 (31.3)		
	10-19	10 (62.5)	-	10 (62.5)		
	≥20	-	-	-		

** $P < 0.01$, *** $P < 0.001$

Table 4. Comparison of dietary habit score between males and females

	Male (n = 43)	Female (n = 37)	Total (n = 80)	t	*P*
I take three meals a day.	2.56 ± 1.14,[1)]	2.84 ± 1.12	2.69 ± 1.13	-1.10	0.273
I have regular breakfast.	2.60 ± 1.20	2.81 ± 1.33	2.70 ± 1.26	-0.73	0.468
I tend to have a balanced diet.	4.05 ± 1.00	3.68 ± 1.11	3.88 ± 1.06	1.58	0.119
I consider calorie intake at mealtimes.	1.53 ± 0.70	2.38 ± 0.92	1.93 ± 0.91	-4.63***	0.000
When I eat out, I consider calorie intake.	1.40 ± 0.66	2.19 ± 0.94	1.76 ± 0.89	-4.42***	0.000
I purchase low-fat dairy products.	2.37 ± 1.25	2.89 ± 1.29	2.61 ± 1.29	-1.83	0.072
I hardly eat high-fat foods such as bacon, ramen (chinese noodles), snack, cake.	2.26 ± 1.00	2.46 ± 1.04	2.35 ± 1.02	-0.89	0.377
I barely consume foods with a high sugar content.	3.07 ± 1.08	3.05 ± 1.05	3.06 ± 1.06	0.07	0.948
I read nutrition labeling before I purchase foods.	2.30 ± 1.27	3.35 ± 0.98	2.79 ± 1.25	-4.10***	0.000
I prefer cooked foods with low calorie (steam/grill) recipe.	1.95 ± 0.90	2.41 ± 0.87	2.16 ± 0.91	-2.28**	0.025
I tend to be intemperate in eating.	3.02 ± 0.96	2.86 ± 1.00	2.95 ± 0.98	0.72	0.474
I season a dish with salt or soy sauce at the table.	3.37 ± 1.05	3.46 ± 1.19	3.41 ± 1.11	-0.35	0.728
Total	2.54 ± 0.54	2.86 ± 0.55	2.69 ± 0.57	-2.65*	0.010

[1)] Mean ± SD
* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

about calorie intake.

The mean dietary habit score of female students (2.86 ± 0.55) was significantly higher than that of male students (2.54 ± 0.54). This result shows that both male and female students did not have desirable dietary habits.

Blood biochemical profiles

Plasma cadmium and lead levels of male and female students are shown in Table 5. The plasma cadmium level from male students (0.54 ± 0.23 μg/L) and from female students (0.52 ± 0.36 μg/L) did not show a difference between gender. However, a significantly higher level of plasma lead was found in male students (1.09 ± 0.49 μg/dL) as compared to that in female students (0.59 ± 0.45 μg/dL) ($P < 0.0010$).

Plasma cadmium and lead levels from smoking are shown in Table 6. The plasma cadmium level was significantly high in smokers (0.69 ± 0.29 μg/L) as compared to nonsmokers (0.49 ± 0.29 μg/L) ($P < 0.05$). The plasma lead level was also significantly higher for smokers (1.09 ± 0.43 μg/dL) than that

Table 5. Plasma cadmium and lead levels of the subjects

	Male (n = 43)	Female (n = 37)	t	*P*
Cadmium (μg/L)	0.54 ± 0.23[1)]	0.52 ± 0.36	0.16	0.875
Lead (μg/dL)	1.09 ± 0.49	0.59 ± 0.45	4.71***	0.000

[1)] Mean ± SD
*** $P < 0.001$

Table 6. Plasma cadmium and lead level between nonsmokers and smokers

	Smoking status		t	*P*
	Nonsmokers (n = 64)	Smokers (n = 16)		
Cadmium (μg/L)	0.49 ± 0.29[1)]	0.69 ± 0.29	2.44*	0.017
Lead (μg/dL)	0.80 ± 0.54	1.09 ± 0.43	2.03*	0.046

[1)] Mean ± SD
* $P < 0.05$

Table 7. Blood clinical indices between males and females

	Male (n = 43)	Female (n = 37)	t	*P*
RBC[2)] (10^6/μl)	5.21 ± 0.3[1)]	4.40 ± 0.30	11.77***	0.000
WBC[3)] (10^3/μl)	6.33 ± 1.40	6.51 ± 1.29	-0.60	0.553
HCT[4)] (%)	48.11 ± 3.00	40.74 ± 2.74	11.46***	0.000
Hb[5)] (g/dL)	15.75 ± 1.04	12.98 ± 1.04	11.89***	0.000
MCV[6)] (fL)	92.38 ± 3.60	92.78 ± 4.62	-0.43	0.671
MCH[7)] (pg)	30.26 ± 1.27	29.57 ± 1.99	1.87	0.065
MCHC[8)] (g/dL)	32.75 ± 0.67	31.84 ± 0.89	5.20***	0.000
Platelet (10^3/μl)	252.47 ± 34.95	294.70 ± 65.92	-3.65***	0.000
Calcium (mg/dL)	10.25 ± 0.47	10.01 ± 0.41	2.40*	0.019
Magnesium (mg/dL)	2.27 ± 0.13	2.27 ± 0.16	0.08	0.937
Iron (μg/dL)	156.00 ± 62.67	123.03 ± 45.88	2.65*	0.010

[1)] Mean ± SD
[2)] RBC: Red blood cell
[3)] WBC: White blood cell
[4)] HCT: Hematocrit
[5)] Hb: Hemoglobin
[6)] MCV: Mean corpuscular volume
[7)] MCH: Mean corpuscular hemoglobin
[8)] MCHC: Mean corpuscular hemoglobin concentration
* $P < 0.05$, *** $P < 0.001$

Table 8. Blood clinical indices between nonsmokers and smokers

	Smoking status		t	*P*
	Nonsmokers (n = 64)	Smokers (n = 16)		
RB2[2)] (10^6/μl)	4.74 ± 0.50[1)]	5.22 ± 0.34	3.66***	0.000
WBC[3)] (10^3/μl)	6.24 ± 1.20	7.10 ± 1.69	2.35*	0.021
HCT[4)] (%)	43.69 ± 4.39	48.74 ± 3.45	4.28***	0.000
Hb[5)] (g/dL)	14.11 ± 1.65	15.91 ± 1.27	4.05***	0.000
MCV[6)] (fL)	92.36 ± 4.07	93.37 ± 4.18	0.88	0.382
MCH[7)] (pg)	29.80 ± 1.67	30.48 ± 1.60	1.45	0.150
MCHC[8)] (g/dL)	32.25 ± 0.92	32.61 ± 0.76	1.44	0.155
Platelet (10^3/μl)	273.52 ± 60.09	265.94 ± 31.58	-0.49	0.628
Calcium (mg/dL)	10.11 ± 0.45[1)]	10.26 ± 0.48	1.24	0.217
Magnesium (mg/dL)	2.26 ± 0.15	2.29 ± 0.13	0.66	0.510
Iron (μg/dL)	140.28 ± 58.72	142.63 ± 54.83	0.15	0.885

[1)] Mean ± SD
[2)] RBC: Red blood cell
[3)] WBC: White blood cell
[4)] HCT: Hematocrit
[5)] Hb: Hemoglobin
[6)] MCV: Mean corpuscular volume
[7)] MCH: Mean corpuscular hemoglobin
[8)] MCHC: Mean corpuscular hemoglobin concentration
* $P < 0.05$, *** $P < 0.001$

Table 9. Pearson's correlation coefficient among blood clinical indices for males

	Ca	Iron	Mg	RBC	WBC	HCT	Hb	MCV	MCH	MCHC	Platelet	Cd
Cd	0.117	-0.112	-0.073	0.172	0.318*	0.282	0.266	0.175	0.172	-0.001	0.042	
Pb	0.023	-0.004	-0.182	0.032	0.082	-0.010	-0.063	-0.052	-0.139	-0.185	-0.030	0.126

* $P<0.05$

Table 10. Pearson's correlation coefficient among blood clinical indices for females

	Ca	Iron	Mg	RBC	WBC	HCT	Hb	MCV	MCH	MCHC	Platelet	Cd
Cd	0.012	0.206	0.082	0.400*	0.138	0.337*	0.323	-0.084	-0.017	0.115	-0.098	
Pb	0.036	0.163	-0.110	0.251	-0.075	0.165	0.112	-0.125	-0.136	-0.098	-0.129	0.768***

* $P<0.05$, *** $P<0.001$

of nonsmokers (0.80 ± 0.54 μg/dL) ($P < 0.05$).

Blood clinical indices other than heavy metals between male and female subjects are shown in Table 7. A significantly higher red blood cell level was found in males (5.21 ± 0.32 10^6/μl) than females (4.40 ± 0.30 10^6/μl) ($P < 0.001$), while the number of white blood cell was higher in females (6.51 ± 1.29 10^3/μl) than in males (6.33 ± 1.40 10^3/μl) but with no significant differences. The hemoglobin and hematocrit levels of male students (15.75 ± 1.04 g/dL and 48.11 ± 3.00%) were significantly higher than those of female students (12.98 ± 1.04 g/dL and 40.74 ± 2.74%) ($P < .001$). There was no difference in the mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) found between gender, while the mean corpuscular hemoglobin concentration (MCHC) was significantly higher in male students (32.75 ± 0.67 g/dL) than in female students (31.84 ± 0.89 g/dL) ($P < 0.001$). Meanwhile, the number of platelets was significantly higher in female students (294.70 ± 65.92 10^3/μl) than in male students (252.47 ± 34.95 10^3/μl) ($P < 0.001$).

Plasma calcium level was significantly higher in male students (10.25 ± 0.47 mg/dL) than in female students (10.01 ± 0.41 mg/dL) ($P < 0.05$), whereas plasma iron level was also significantly higher in male students (156.00 ± 62.67 μg/dL) than in female students (123.03 ± 45.88 μg/dL) ($P < 0.05$).

The blood clinical indices by smoking is shown in Table 8. The number of red blood cells as well as white blood cells in smokers were significantly higher than (5.22 ± 0.34 10^6/μl and 7.10 ± 1.69 10^3/μl) that in nonsmokers (4.74 ± 0.50 10^6/μl and 6.24 ± 1.20 10^3/μl). Both indices in smokers were significantly higher than those in nonsmokers ($P < 0.001$, $P < 0.05$). Also, hemoglobin and hematocrit of smokers (15.91 ± 1.27 g/dL and 48.74 ± 3.45%) were significantly higher than those of nonsmokers (14.11 ± 1.65 g/dL and 43.69 ± 4.39%) ($P < 0.001$).

Discussion

The general characteristics of subjects in this study revealed that the age of male students was higher than that of female students, and male students had less family members. Residence type showed a higher rate in residing either in a dormitory, self-boarding arrangement, or at a boarding house, in the case of male students. In female students, there was a higher rate of residing at home. The higher rate of staying at home in female subjects was similar to the report in which a higher residing rate at home was found in female students than in male students, with no significant differences in the research about the nutritional intake. This rate was also subjected to college students in Daejeon, Korea [12]. The significant difference in residence type between male and female students might be due to regional location difference of the subjects' area.

The mean height and weight among anthropometric measurements of subjects were compared with the Anthropometric standards for age 19-29 as per Dietary Reference Intakes for Koreans [13]. The height of both male and female students was nearer to the standard, the weight of male students was within the heavier range than the standard, whereas the weight of female students was lighter than the standard. The mean body weight of male students in this study was even heavier than that of male students from Gwangju [14]. The mean Body Mass Index(BMI) was in a normal range for both male and female students, but was still higher than those values of students from Daejeon for males (21.5 kg/m^2) and for females (19.1 kg/m^2) [15], and for males (21.7 kg/m^2) and for females (19.6 kg/m^2) [12], measured in two separate studies. Also, per the BMI standard set by the Korea society for the study of obesity subjected to Asian adults [11], the body mass index below 18.5 was classified as underweight, 18.5- below 23.0 as normal weight, and more than 23 as overweight. As a result, 51.2% of male students and 13.5% of female students in this study were found to be overweight, meaning more than half of the male students were overweight. Also, the underweight group was higher in female students (16.2%), while a smaller percentage of male students (2.3%) was in the state of being underweight ($P < 0.01$). When compared with the results conducted with students from Daejeon [11], the percentage of the underweight group was higher in females (27.7%) as against males (4.7%), overweight was higher in male students (25.2%) than in female students (6.2%). The overweight percentage of male students in this study was particularly high.

Systolic pressure and diastolic pressure, lean body mass, and skeletal muscle mass were all significantly higher in male than in female students ($P < 0.001$). However, Percentage body fat in female students was higher than in male students ($P < 0.001$). Percentage body fat in male students (18.8 ± 6.4%) and female students (28.6 ± 5.8%) had higher levels over the normal range

[16]. In this study, the percentage body fat in female students was particularly higher than that of female students from Gwangju [14]. In the case of female students, although their body mass index was normal, since they were more likely to overestimate their weight, they need to have a proper conception about body type and receive nutritional education in order to control their body types.

Male students were engaged in exercise more frequently than female students ($P < 0.05$). Though there was a difference in the research findings about regular exercise practiced by students, such that no difference was found in the frequency of exercise between male and female students from Busan [17], similar differences existed in the research subjected to college students from Chungcheongnam-do [5]. However, most of the students engaged in exercise for 1-4 times a week with no difference between genders. In the research finding subjected to the students from Daejeon [12], the exercise frequency of male and female students were similar in both genders as on an average for male (3.6 times a week) and female students (3.8 times a week).

In the rate of drinking, there was no significant difference in gender, as 86.0% of male and 64.9% of female students drink alcohol. The drinking rate was more or less lower than that of the results conducted with students from Chungcheongnam-do, where 92.8% of male students and 91.5% of female students drink [5], and 91.6% of male students and 83.7% of female students drink in another study [12], which is a large number of students involved in drinking. It has been known that drinking makes meal intake not as sufficient, changes lifestyle and dietary habits, thereby badly affecting nutrition as well as the healthy state of body. Moreover, since there is large interrelationship between smoking and drinking (smokers have a high drinking rate), the smoking amount as well as the drinking amount correlate with each other [18]. The drinking frequency of male students is significantly higher than that of female students ($P < 0.001$). Though drinking frequency in female students was lower than that in male students, approximately half of the female students drink more than once a week, which reflects the high drinking practice in young woman. High drinking frequency could have been attributed by the residence type, as more than 50% of students are lodged either in dormitories or self-boarding. This result seems to appear as a problem since Korean college students did not receive proper health education amidst the competition for the college entrance examination. They were also liberated from parental control all of a sudden, and had to manage his/her life independently [1]. It is supported by the fact that the score of health improvement practice in students residing in dormitory was significantly lower than that of students living at home [19]. Therefore, a systematic education is required in order to maintain proper life and health control for students in Korea.

The smoking rate was 37.2% in male students, whereas it was 0% in female students ($P < 0.001$). The smoking rate in this study was lower than the rate of 59.8% in males and 1.7% in females from Daejeon. 62.5% of male smoker students smoked on an average 10-19 cigarettes a day, which was a similar level as the report by Rhim *et al*. [20].

In the investigation of dietary habit of subjects, the highest score was found in 'intake balanced diet'; the scores for 'not adding salt or soy sauce in dishes' and 'less intake of sweet foods containing high amount of sugar' were high. This result could be regarded as a similar trend in the research result conducted with college students from the Mid-Western USA [21]: 66.4% of respondents answered as 'Yes' and 'Very much likely' for the balanced diet question, which gives an idea of high cognition as to the balanced diet by students. Lower scores were obtained in 'considering calories while eating out' and 'considering calories at table'. This result could be related with the overweight level of more than 50% of the male students in this study. Nutrition education about calorie intake might be required. The questions associated with calorie intake (such as 'eating while calculating calories', 'considering calories during eating out', 'read nutrition label before purchasing foods, and 'prefer cooked foods with low calorie (steam/grill) recipe' showed higher scores in female students than male students ($P < 0.001$-$P < 0.01$), reflecting that female students are more aware of calorie intake and managing a dietary life. The dietary habit score was significantly higher in female students (2.86 ± 0.55) than in male students (2.54 ± 0.54) ($P < 0.05$). It has been reported that dietary habits of male and female students from Daejeon exhibited desirable changes in male students, whereas changes in female students were not as desirable as changes in male students [22]. In a later study about the dietary habits of college students, dietary habits of female students was better than that of male students [14], similar to the result as those in this study. However, since dietary habits of both male and female students are not desirable, shown in the poor dietary habit scores, dietary improvement education should be executed in order to improve nutrition and health for college students.

Plasma cadmium level of subjects did not show a gender difference, while higher plasma cadmium level was reported in female adults from the city center [23]. From the survey results of the nation's plasma heavy metal level conducted by the Ministry of Environment, the plasma cadmium level from these subjects was lower than the average level. 1.46 μg/L of average cadmium level was reported in the subjects in their 20s [24], and levels of 1.21 μg/L and 1.66 μg/L was reported in adult men and women living in city centers [23], which is far lower than the 5 μg/L recommended by WHO [25]. However, the cadmium levels of male and female students in this study were higher than the measured level 0.06 μg/L from middle school students [26]. Since cadmium is absorbed into the body through digestive organs and respiratory tracts during a person's growth, it has been reported as being associated with age and smoking; Accumulation of heavy metals with long half life in body is increased with age [27]. In this study, plasma lead level of male students was significantly higher than that of female students

($P < 0.001$). This result is in conformity with the survey research of adults living in city centers [23]. Plasma lead level in male students in this study is below the average lead level (2.25 μg/dL) of people in their 20s reported in plasma heavy metals level conducted by the Ministry of Environment, Korea during the year 2006, and WHO recommended value (20 μg/dL) [25].

The plasma cadmium and lead levels of smokers were significantly higher than those of nonsmokers in this study ($P < 0.05$). Many researches have reported a similar increasing effect of smoking on the plasma cadmium level and lead levels [8, 28]. It has been known that large amounts of cadmium and lead are contained in cigarettes, and these heavy metals are absorbed into the body through smoking and are concentrated inside the body tissues. Also, researchers suggested that plasma cadmium concentration and biophysical indices (mobility, density, and survival capability) of male sperms are inversely proportional to each other. Furthermore, high plasma cadmium level can be a cause of oligo-astheno-tetratozoospermia syndrome [29]. In addition, the necessity of research has been raised as to the correlation for the effect of heavy metal level increases on skeletal health along with the decreased intake of fruits and vegetables due to smoking [30].

In blood clinical indices other than heavy metals from male and female students, the number of red blood cells, hemoglobin, hematocrit level, and mean corpuscular hemoglobin concentration (MCHC) were significantly higher in male students than in female students ($P < 0.001$). The number of platelets was significantly higher in female students ($P < 0.001$) than in male students. When the anemia related indices of subjects were compared with the anemia assessment by the WHO [31], both male as well as female students showed normal levels. Plasma calcium and iron levels of male students were significantly higher than those of female students ($P < 0.05$).

Blood clinical indices of subjects by smoking showed that the number of red blood cells, number of white blood cells, hemoglobin level, and hemacrit levels in smokers were significantly higher than those of nonsmokers ($P < 0.001$-$P < 0.05$). The smoking effect on the increase of hemoglobin level could be confirmed as these results were in agreement with the report by Kwak *et al.* [32]. Increase in the hemoglobin level may be due to an enhancing effect of red blood cells and platelet biosynthesis, triggered by increases in carbon dioxide concentration and decreases in oxygen partial pressure in the blood [33]. Beser *et al.* [34] reported that hematocrit of men and women smokers was significantly higher than that in nonsmokers. When a smoker gave up smoking, the hemoglobin level, hematocrit level, and number of white blood cells have been decreased.

As shown from the results, it was found that there is a clear distinction in the physical characteristics between male and female students, higher muscle mass was observed in male students whereas higher percentage of body fat were found in female students. In dietary habits, there was also a difference between gender with high scores obtained from female students. The plasma cadmium level did not show a difference between male and female students, but a higher level of lead was found in male students. There have been differences between male and female students in their physical characteristics, dietary habit, and blood profile. Therefore, nutrition education programs and educational materials for college students should be developed in order to suggest positive changes in students' lifestyles and dietary habits.

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