지 역 사 회 영 양 학 회 지 3(5) : 685~694, 1998
Korean J Community Nutrition 3(5) : 685~694, 1998

☐ Original Article ☐

Changes of Plasma Cardiovascular Disease Risk Factors according to the Health Practice and Dietary Habits in Healthy Male University Students

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ABSTRACT

This cross-sectional study was conducted to describe the changes of plasma cardiovascular disease(CVD) risk factors in relation to health practice and dietary habits among 140 healthy male university students in Korea. Overnight fasting plasma levels of total cholesterol, high density lipoprotein(HDL)-cholesterol, triacylglycerol and glucose were analyzed. Blood pressure and anthropometric data were also measured. Health practice factors such as smoking status, alcohol consumption and frequency of exercise were evaluated by a self-administered questionnaire. Questions regarding dietary habits and food preferences were also asked. Seventy eight percent of the subjects had more than one CVD risk factor. Plasma total cholesterol, triacylglycerol, and fasting blood glucose were significantly increased according to the subjects body mass index(kg/m^2, BMI), whereas HDL-cholesterol, low density lipoprotein(LDL)-cholesterol and blood pressure showed no significant differences with BMI. Current smokers had significantly high plasma total cholesterol, LDL-cholesterol and triacylglycerol levels. Alcohol consumption significantly increased plasma total cholesterol and fasting blood sugar, but regular exercise had no effects on the plasma CVD risk factors. Overeating and frequency of fast food consumption were positively correlated with the CVD risk score, whereas intake of grains, meats and vegetables were negatively correlated with that score. A stepwise multiple regression analysis was performed to examine the effects of specific dietary factors on plasma lipid levels. For plasma total cholesterol level, the frequency of fast food intake explained 8% of the variance, followed by habitual overeating, frequency of grain intake and high cholesterol food intake (Model $R^2=22.4\%$). For plasma triacylglycerol level, preference of oily foods accounted for 7.5% of the variance, followed by eating breakfast, preference of fruit and frequency of grain intake (Model $R^2=22.0\%$). The findings suggest that intervention programs to reduce the risk of CVD should focus on health practice through reducing BMI, smoking cessation and moderate or no alcohol drinking. Moreover, desirable dietary habits such as eating breakfast, not overeating and reduced intake of fast food may improve CVD risk. (*Korean J Community Nutrition* 3(5) : 685~694, 1998)

KEY WORDS : cardiovascular disease risk factor · plasma cholesterol · health practice · smoking · BMI · dietary habit.

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Introduction

Cardiovascular disease(CVD) has been linearly increasing year by year and has recently become one of the major causes of death in Korea(National Statistical Office 1995). Many risk factors have been implicated in the causation of CVD(McNamara 1990). Hypercholesterolemia and hypertension are widely accepted as major risk factors for CVD(Blackburn 1994). The positive association of CVD with blood cholesterol is attributed to the low density lipoprotein(LDL) fraction(Stamler et al. 1986), while the high density lipoprotein(HDL) remains as a significant protective factor(Gordon et al. 1989).

Health practice factors seem to contribute to CVD mortality. Cigarette smoking, alcohol consumption, physical inactivity, weight status, sleeping time and dietary behaviors have been regarded as important health related behaviors, and are known to effect the incidence of chronic disease from the results of Alameda County Study(Wingard et al. 1982). In subsequent work, these factors have been found to be associated with low six- and nine-year mortality risk(Belloc 1973 ; Breslow & Enstrom 1980).

Based on the cross-sectional data, significant relationships between smoking and CVD mortality have been demonstrated(Criqui et al. 1987). Alcohol drinking is also known to alter the CVD risk score partially by increasing the plasma HDL-cholesterol level (Parker el al. 1996), but overall alcohol consumption appears to have a graphically U-shaped relation to the risk of CVD(Klatsky et al. 1981). Obesity and lack of physical activity are also associated with the risk of developing CVD(Hubert et al. 1983 ; Kannel et al. 1991 ; Ko et al. 1997 ; Perry et al. 1997). These life style risk factors are modifiable and known to be interactive(Downie et al. 1996).

Further, blood lipid levels are significantly correlated with the dietary intake of fats and calories and can be modified by dietary intake. This has been well demonstrated by many studies(Garry et al. 1992 ; McNamara 1987). With dietary changes, dietary habits such as meal frequency could also affect cholesterol concentrations. A clinical and large population-based study found meal frequency to be associated with blood lipids in humans(Edlstein et al. 1992 ; Jenkins et al. 1989).

Although there is a movement to practice health behaviors that improve health status, morbidity and mortality rates of CVD remain high. Therefore reducing the plasma CVD risk factors by improving dietary habits could be of interest to clinicians and nutritionists. Lowering the plasma cholesterol level is very important to reduce CVD risk, since results from the Coronary Primary Prevention Trial(Lipid Research Clinics Program 1984), and the Framingham Study(Anderson et al. 1991) both suggest that a 1% reduction in an individual's total cholesterol translates to an approximately 2% reduction in coronary heart disease risk.

In Korea, the studies in this area focus on the association of nutrient intake and blood lipid levels (Kang et al. 1996 ; Jin & Kim 1997). However, very little research has been done on the CVD risk associated with dietary behavioral factors. In respect to establish the strategies for improving CVD risks of the healthy subjects, modification of dietary habits is a more applicable and practical way, compared to manipulation of nutrient intake level.

Therefore to provide the basal data of the nutrition intervention program for healthy people, the research was planned to identify the impacts of health practice variables and dietary behavioral factors on the blood CVD risk factors in healthy male young adults.

Subjects and Methods

1. Subjects

This research was completed by cross-sectional surveys. A total of 159 male university students were initially recruited from a university located in Kyunggi-Do. Among them, 19 persons failed to become subjects, because they didn't come for blood collection. Finally 140 participants underwent a self-administered questionnaire, and an anthropometric and blood examination. Participation in this study was entirely voluntary and was limited to subjects who had not taken

any medication.

2. Clinical Measurements

All subjects attended this study after an overnight fast. Height and weight were measured with the subject in light clothing without shoes. Mid upper arm circumference was measured and triceps skinfold thickness was taken using a caliper(Lange). After sitting for at least 5 min, blood pressure was measured in the right arm by a registered nurse using a standard mercury sphygmomanometer.

Blood was taken for biochemical measurements in 0.1% Na EDTA. Plasma glucose level was measured by a commercial kit(Youngdong Pharmaceutical Co., Korea), immediately after separation of plasma by centrifugation at 3000rpm at 4℃ for 10 min.

Plasma total cholesterol and triacylglycerol were analyzed with a commercial kit(Youngdong Pharmaceutical Co., Korea). HDL-cholesterol was analyzed by the same commercial kit, following the precipitation of LDLs and very low density lipoproteins(VLDLs), using the modified heparin-manganese methods(Warnick & Albers 1977). The LDL-cholesterol concentrations were calculated by subtracting the HDL- and VLDL-cholesterol concentrations from the total plasma cholesterol levels. The VLDL-cholesterol was estimated by the formula of Friedewald et al(1972), which assumes that the concentration of VLDL-cholesterol approximates one-fifth of the plasma triacylglycerol concentration. The guidelines of National Cholesterol Education Program(NCEP 1993) and Korean Hypercholesterolemia Treatment Guidelines(1996) were used to identify the cut-off point between the moderate and high risk group of each CVD risk factors.

CVD risk scores were also calculated by the simple modified method of Framingham Heart Study(Anderson et al. 1987). The risk score counts the number of each risk factor which subjects had. The risk factors were current smoking, high total cholesterol level($\geq$200mg/dl) and hypertension(SBP$\geq$160mmHg and/or DBP$\geq$95mmHg).

3. Health practice and dietary behavior

A questionnaire administered to subjects included questions about demographic characteristics, health practice, and dietary behaviors. Health practice included smoking, alcohol drinking, and physical exercise. Smoking was assessed by the number of cigarettes smoked per day and the duration of smoking. From these data, pack-years of smokers was calculated. Alcohol intake was investigated by the frequency, types and mean amount of weekly alcohol intake. From these informations, grams of alcohol consumption per week were computed. The weekly frequency of exercise was also surveyed. Exercise more than three times per week was defined as regular exercise.

Dietary behaviors included 4 items to determine meal regularity, and the nutritional balance of the 6 food groups, 5 items to evaluate negative eating behaviors such as snacking and fast food intake, and 5 items food preferences. Meal regularity and meal balance were rated on a 5-point Likert scale from Strongly disagree(1) to Strongly agree(5). Weekly frequency of snacking, animal fat, high cholesterol food and fast food intake, and dining out were asked. Food preferences were rated on a 5-point likert scale from strongly dislike(1) to strongly like(5).

4. Statistical analysis

Statistical analysis was done by using the Statistical Analysis System(SAS). To compare differences for each health practice, Student's t-test, ANOVA and Duncan's multiple range test were used. The strength of relationships between the CVD risk factors and rated score of dietary behaviors were computed by Pearson correlations. A P-value of <0.05 was considered to be significant. The stepwise regression analysis was used to examine the variance in plasma triacylglycerol and cholesterol explained by the dietary behavioral variables. Variables which showed a significance level less than 0.150 were entered into the model.

Results and Discussion

1. Characteristics of CVD risk factors of the subjects

Generally it has been considered that analysis of blood lipid profiles is the first method to diagnose CVD. The mean value with standard deviation, range of the

cardiovascular disease risk factors and percent of the subjects beyond desirable value are shown in Table 1.

The age of subjects ranged from 20 to 27 years, with a mean of 22.1 years. The plasma triacylglycerol value was 152.2±53.9mg/dl, and percent of the subjects above the adequate level(<200mg/dl) was 20.0%. The mean total cholesterol level was 168.5mg/dl. According to the Korean Hypercholesterolemia Treatment Guidelines(1996), this level was slightly lower than the average level of young male adults, aged 20 to 34, in Korea. The total cholesterol risk group consisted of 19.3% of the subjects. This was also slightly lower than percentage of high cholesterol group in Korean male twenties(Korean Hypercholesterolemia Treatment Guidelines 1996). Fifteen percent of the subjects were represented in the HDL-cholesterol risk group and 5.7% of the subjects gualified for the LDL-cholesterol risk group. Gordon et al.(1989) has shown that the reduction of the ratio of LDL-cholesterol/HDL-cholesterol was a more effective way to prevent CVD rather than lowering the total cholesterol level. Among these subjects, the mean LDL-cholesterol/HDL-cholesterol was 1.95(risk group 10.0%) and average atherogenic index was 2.61(risk group 18.6%). 4.3% of the subjects showed a prevalence of hyperglucosemia. 12.1% had signs of hypertension according to systolic blood pressure over 140mmHg, and 16.4% according to the diastolic blood pressure over 90 mmHg. The cardiovascular risk scores were calculated considering the smoking status, plasma total cholesterol level, and the values of blood pressure. Seventy-eight percent of the subjects had more than one CVD risk factor, whereas only 21.4% of the subjects had none.

2. BMI and CVD risk factors

The anthropometric characteristics of the subjects are shown in Table 2. Mean body mass index(BMI) was 22.1, and percent of ideal body weight was 101.0%. These data were similar to the mean BMI of the Korean male in his twenties, from the data of the Korean National Nutrition Survey in 1995.

Most CVD risk factors showed strong positive association with BMI(Table 3). Plasma total cholesterol($p<.05$) and triacylglycerol levels($p<.01$) were significantly increased with BMI. In the overweight group(BMI over 24), fasting blood sugar levels were also significantly higher than those in normal or underweight groups($p<.01$). Many studies showed close

Table 1. Cardiovascular disease risk factors of the subjects

Variables	Mean±S.D.	Range	Adequate value	% of the subjects beyond the adequate value
				n (%)
Age(yr)	22.1 ± 2.2	19 - 27		
Total cholesterol (mg/dl)	168.5 ± 35.6	126.3 - 256.2	< 200	27 (19.3)
HDL-cholesterol (mg/dl)	51.4 ± 15.2	31.2 - 81.5	≥ 35	21 (15.0)
LDL-cholesterol (mg/dl)	86.6 ± 37.1	31.5 - 152.4	< 130	8 (5.7)
TG(mg/dl)	152.2 ± 53.9	81.2 - 257.3	< 200	28 (20.0)
LPH	1.95± 1.20	1.28 - 4.98	≤ 3.5	14 (10.0)
Atherogenic index	2.61± 1.45	1.56 - 5.58	≤ 4.0	26 (18.6)
FBS(mg/dl)	91.2 ± 21.7	60.2 - 153.6	< 140	6 (4.3)
SBP(mmHg)	122.0 ± 11.1	100 - 160	< 140	17 (12.1)
DBP(mmHg)	81.1 ± 8.5	60 - 100	< 90	23 (16.4)
CVD risk score, N(%)				
0	30 (21.4)			
1	92 (65.7)			
2	17 (12.1)			
3	1 (0.7)			

TG : triacyl glycerol LPH=LDL cholesterol/HDL cholesterol
Atherogenic index=(total cholesterol - HDL cholesterol)/HDL cholesterol
FBS : fasting blood sugar SBP : systolic blood pressure DBP : diastolic blood pressure

relation with BMI and total cholesterol level(Kang et al. 1996 ; Ko et al. 1997). The Framingham Heart Study concluded that increased relative body weight is an independent risk factor for CVD and it revealed an additive effect because it also contributed to hypertension, lower HDL-cholesterol, decreased glucose tolerance, and elevated total cholesterol and triacylglycerol levels(Hubert et al. 1983).

3. Health practices and CVD risk factors

Since the early report from Belloc(1973) and Breslow & Enstrom(1980), the close association between health related practices and good physical health status has been demonstrated. Among the subjects, 66.4% were current smokers(Table 4). The mean pack-years of the smoker was 3.1 years and their mean smoking duration was 3.4 years. Fifty-eight percent of the subjects drank alcohol more than once per week, and their mean alcohol intake was 51.5g per week. In exercise practice, 59.3% of the subjects exercised regularly, and 22.9% did it more than four times in a week.

The comparisons of CVD risk factors according to health practice are shown in Table 5. As expected, smoking increased the risk of CVD by increasing plasma total cholesterol($p < .01$), LDL-cholesterol($p <$

Table 2. Anthropometric characteristics of the subjects

Variables	Mean± S.D.	Range
Height(cm)	172.1± 5.2	159 – 184
Weight(kg)	65.5± 8.1	49.5 – 88.0
BMI(kg/m^2)	22.1± 2.4	17.6 – 28.7
PIBW(%)	101.0±10.8	75.6 – 128.5
Mid arm circumference(cm)	27.9± 2.8	23.0 – 37.5
Triceps skinfold thickness(mm)	16.9± 5.8	6.0 – 34.5

BMI(body mass index)
PIBW(percent ideal body weight)={Wt(kg) / Ht(cm) – 100} ×0.9}×100

Table 4. Health practices of the subjects

Variables	% (N)
Smoking status	
Smoker	66.4% (93)
Ex-smoker	3.6% (5)
Non smoker	30.0% (42)
Number of cigarettes(/day)	
≤ 10	8.6% (8)
11 – 20	61.3% (57)
21 <	30.1% (28)
Pack-years of the smoker	3.1 ± 2.0[1)]
Smoking duration(yr)	3.4 ± 2.3[1)]
Alcohol drinking	
None	42.1% (59)
More than once per week	57.9% (81)
Alcohol consumption(g/week)	51.5 ± 54.5[1)]
Regular exercise	
None	40.7% (57)
1 – 3(/week)	36.4% (51)
4 ≤ (/week)	22.9% (32)

1) Mean± S.D.

Table 3. Comparisons of cardiovascular disease risk factors according to BMI of the subjects

Variables	BMI			Significance
	< 20	20 ≤ < 24	24 ≤	
	(n=28)	(n=81)	(n=31)	
Total cholesterol(mg/dl)	157.8 ± 5.7[b]	169.0 ± 3.8[ab]	176.9 ± 7.5[a]	F=3.80, p<.05
HDL-cholesterol(mg/dl)	50.4 ± 3.1	51.2 ± 1.6	53.0 ± 3.0	NS
LDL-cholesterol(mg/dl)	79.5 ± 6.1	87.7 ± 4.1	90.3 ± 7.4	NS
TG(mg/dl)	139.5 ± 9.9[b]	150.5 ± 5.8[ab]	168.1 ±10.2[a]	F=5.85, p<.01
LPH	1.91± 0.26	1.95± 0.12	2.00± 0.22	NS
Atherogenic index	2.53± 0.32	2.60± 0.15	2.71± 0.28	NS
FBS(mg/dl)	90.0 ± 2.8[b]	87.6 ± 2.3[b]	101.7 ± 4.5[a]	F=5.05, p<.01
SBP(mmHg)	120.4 ± 1.9	122.5 ± 1.2	122.3 ± 2.2	NS
DBP(mmHg)	79.3 ± 1.5	81.2 ± 0.9	82.3 ± 1.7	NS
BMI(kg/m^2)	19.0 ± 0.1[c]	21.9 ± 0.1[b]	25.4 ± 0.2[a]	F=269.75, p<.0000

Mean± SEM
Means not sharing a common superscript in a row are significantly different at α=0.05 with Duncan's multiple range test.
TG : triacyl glycerol, LPH=LDL-C/HDL-C, Atherogenic index=(total cholesterol – HDL cholesterol) / HDL cholesterol
FBS : fasting blood sugar, SBP : systolic blood pressure, DBP : diastolic blood pressure, BMI : body mass index

Table 5. Comparisons of cardiovascular disease risk factors according to the health practices of the subjects

Variables	Smoking		Alcohol drinking		Exercise	
	Smoker	Non-smoker	Drinker	Non-drinker	≤ 2/week	≥ 3/week
	(n=93)	(n=42)	(n=81)	(n=59)	(n=57)	(n=83)
Total cholesterol(mg/dl)	178.3 ±5.0	161.8 ±3.6**	172.2 ±3.8	159.0 ±4.1*	166.9 ±3.5	167.6 ±5.7
HDL-cholesterol(mg/dl)	50.7 ±1.9	51.9 ±1.8	52.3 ±1.5	49.2 ±2.6	51.0 ±1.6	51.6 ±2.4
LDL-cholesterol(mg/dl)	94.2 ±4.9	81.4 ±4.0*	89.1 ±4.0	80.2 ±4.7	85.8 ±3.8	85.9 ±6.0
TG(mg/dl)	166.8 ±7.6	142.1 ±5.4**	153.9 ±5.4	147.8 ±8.7	150.5 ±5.4	150.5 ±8.8
LPH	2.11±0.23	1.82±0.12	1.98±0.12	1.89±0.17	1.96±0.12	1.94±0.19
Atherogenic index	2.91±0.22	2.44±0.23	2.63±0.15	2.57±0.20	2.62±0.15	2.59±0.23
FBS(mg/dl)	95.7 ±3.3	88.2 ±2.1	93.4 ±2.3	85.5 ±2.6*	90.9 ±2.1	89.4 ±3.3
SBP(mmHg)	121.6 ±1.6	122.3 ±1.2	122.1 ±1.1	121.8 ±1.9	121.1 ±1.0	124.8 ±2.1
DBP(mmHg)	80.9 ±1.1	81.2 ±1.0	81.2 ±0.8	80.8 ±1.5	80.7 ±0.9	81.9 ±1.5
BMI(kg/m^2)	22.2 ±0.3	22.0 ±0.3	22.2 ±0.2	21.7 ±0.3	21.9 ±0.2	22.1 ±0.3

Mean± SEM *p<.05, **p<.01, t-test
TG : triacyl glycerol, LPH=LDL-C / HDL-C, Atherogenic index=(total cholesterol – HDL cholesterol) / HDL cholesterol
FBS : fasting blood sugar, SBP : systolic blood pressure, DBP : diastolic blood pressure, BMI : body mass index

.05) and triacylglycerol levels(p<.01). However, smoking didn't affect HDL-cholesterol concentrations. These results are partially in agreement with studies which indicate that smokers increase the risk of CVD by increasing LDL-cholesterol concentrations and decreasing HDL-cholesterol levels(Criqui et al. 1987 ; Wingard et al. 1982). With respect to the effect of alcohol consumption, drinkers had a significantly high total cholesterol and fasting blood sugar levels, compared to nondrinkers. Contrary to expectations, HDL-cholesterol level of drinker was not significantly higher than that of nondrinkers. Moderate alcohol is known to have a protective effect to CVD by increasing HDL-cholesterol(Gordon et al. 1989 ; Parker et al. 1996). However, health outcomes depend on the amount of alcohol consumed. The impact of alcohol on CVD risk revealed a U-shaped relation(Klatsky et al. 1981). In my research, alcohol drinking increased the blood total cholesterol levels. This may be because Koreans usually drink alcohol with animal fat and cholesterol rich side dishes, and/or I didn't stratify the subjects by amount of alcohol drinking. The CVD risk factors such as blood lipid and blood pressure were not significantly different by the exercise status. Consistent with this, Parrel & Bobriak(1980) have reported that exercise-training didn't alter blood total cholesterol, and they concluded that it was due to low cholesterol levels present before exercise-training.

Table 6. Dietary behavioral factors of the subjects

Dietary behavioral factors	Mean±SD
Meal regularity[a]	
Eating breakfast	3.46±1.31
Eating regularly	2.93±1.03
Eating slowly	2.71±0.99
Overeating	3.01±0.98
Meal balance[a]	
Intake of grains with every meal	3.65±1.31
Intake of meat, fish and eggs with every meal	3.14±1.01
Intake of vegetables with every meal	3.91±1.06
Intake of fruits every day	2.72±1.11
Intake of milk every day	2.52±1.25
Intake of food cooked with oil with every meal	2.50±0.88
Negative food behavior	
Frequency of snacking(/week)	4.06±1.70
Frequency of animal fats intake(/week)	2.32±1.74
Frequency of high cholesterol food intake(/week)	2.68±1.72
Frequency of fast food intake(/week)	1.59±1.23
Frequency of dining out(/week)	2.88±1.92
Food preferences[b]	
Sweet taste	3.02±0.95
Salty taste	2.56±0.88
Oily taste	2.73±0.90
Preference for vegetables	3.61±0.93
Preference for fruits	4.22±0.89

a : Each item was rated on a 5-point likert scale, with 1(Strongly disagree) to 5(Strongly agree)
b : Each item was rated on a 5-point likert scale, with 1(Strongly dislike) to 5(Strongly like)

Table 7. Pearson Correlation Coefficients between cardiovascular disease risk factors and dietary habits of the subjects

	Total cholesterol	HDL – cholesterol	LDL – cholesterol	TG	LPH	Atherogenic index	FBS	SBP	DBP	BMI	CVD risk score
Eating breakfast	–.030	–.035	.039	–.184*	.034	.004	–.417***	.024	–.079	–.150	–.089
Eating regularly	–.063	–.005	–.008	–.172*	–.060	–.089	–.276**	.006	–.067	.014	–.027
Eating slowly	–.119	.060	–.130	–.032	–.087	–.079	–.248**	–.101	–.134	–.226**	–.099
Overeating	.244**	–.038	.199*	.171*	.120	.132	.275**	–.126	–.145	.411***	.211*
Intake of grains	–.175*	.057	–.129	–.214*	–.173*	–.183*	–.140	–.060	–.075	–.041	–.238**
Intake of meat, fish and eggs	–.114	.099	–.088	–.214*	–.125	–.154	–.256**	.037	–.041	.028	–.223**
Intake of vegetables	–.156	–.092	–.093	–.064	–.069	–.066	–.101	–.066	–.113	–.182*	–.260**
Intake of fruits	–.016	.019	–.018	–.018	.016	.008	–.068	.030	–.047	–.045	–.056
Intake of milk	.001	.096	–.055	.055	–.094	–.092	–.011	–.104	–.055	.122	–.060
Intake of food cooked with oil	.018	.013	–.013	.086	.021	.038	–.058	–.025	–.036	.174*	–.078
Frequency of snacking	–.004	.029	–.007	.059	–.007	–.001	.146	–.040	–.035	.031	.074
Frequency of animal fats intake	.119	–.102	.141	.052	.163*	.151	.123	–.052	–.038	–.201	.066
Frequency of high cholesterol	.101	.045	.036	.144	.010	.020	–.055	.059	.048	.087	.065
Frequency of fast food intake	.290***	–.096	.282***	.120	.242**	.236**	.306**	–.003	.069	.013	.220**
Frequency of dining out	.074	.132	.012	.016	–.162	–.071	.003	–.029	–.040	.118	.104
Preference for sweet taste	.048	–.046	.049	.054	.081	.087	.021	–.079	–.065	.056	.091
Preference for salty taste	.086	–.010	.096	–.029	.042	.025	.074	–.285***	–.196*	.174*	.139
Preference for oily taste	.136	.098	.034	.191*	–.012	.007	.102	–.103	–.065	.070	.107
Preference for vegetables	–.098	.099	–.115	–.069	–.161	–.159	–.184*	–.036	–.120	–.028	–.128
Preference for fruits	.018	.003	–.001	.062	.049	.057	–.137	–.040	–.053	–.025	–.126

* $p<.05$, ** $p<.01$, *** $p<.001$, by Pearson's correlation analysis
TG : triacyl glycerol, LPH=LDL – C/HDL C, Atherogenic index=(total cholesterol – HDL cholesterol)/HDL cholesterol
FBS : fasting blood sugar, SBP : systolic blood pressure, DBP : diastolic blood pressure, BMI : body mass index

Regular exercise-training in college students decreased serum LDL-cholesterol level, but didn't affect the total cholesterol and HDL-cholesterol levels(Cha et al. 1998).

4. Dietary behavior & CVD risk factors

Results of the dietary behavior are shown in Table 6. In the meal regularity factor, the mean score of eating breakfast was 3.46, whereas that of eating slowly was 2.71. From the meal balance, vegetables intake score was the highest(3.91), but milk intake score was lower(2.52). The score of food intake cooked with oil was lowest(2.50). The average weekly frequency of snacking was 4.06, and that of dining-out was 2.88.

Eating regularly and eating breakfast negatively correlated with plasma triacylglycerol($p<.05$) and FBS levels($p<.01$ and $p<.001$, respectively)(Table 7). Eating breakfast is associated with maintenance of a constant blood glucose level, prevention of hunger and subsequent overeating later in the day(Zabik 1987). Moreover a clinical trial found meal frequency to be associated with blood lipid(Jenkins et al. 1989), and a population-based study concluded the cholesterol reductions by increases in meal frequency(Edelstein et al. 1992). Overeating positively correlated with CVD risk score($p<.05$). Intake of grains, meats and vegetables negatively correlated with CVD risk score($p<.01$). Frequency of fast food intake positively correlated with total cholesterol($p<.001$), LDL-cholesterol($p<.001$) and CVD risk score($p<.01$). Preference of salty food negatively associated with SBP($p<.001$) and DBP($p<.01$), with a positive correlation with BMI($p<.05$).

Because there were many interrelationships among dietary variables, a stepwise multiple regression analysis was performed to examine the effects of specific dietary factors on plasma lipid levels(Table 8). For plasma total cholesterol levels, the frequency of fast food consumption was found to be a significant predictor, explaining 8.4%($p=0.005$), while overeating added 6.6%($p=0.010$) of the variance, followed by grain intake at 4.4%($p=0.031$), and high cholesterol food intake at 3.0%($p=0.073$). With respect to the prediction of plasma triacylglycerol level, preference for an oily taste explained 7.5% of the variance. Breakfast eating, preference of fruits and grain intake added 5.7%, 5.1%, 3.1% of the variance, respectively (Model $R^2=22.0\%$). The results suggest that habitual eating behavior had close correlations with blood CVD risk factors.

There are some limitations to generalize these data, based on the age and socioeconomic level of the sample. The subjects were college-age students, a group not likely to be seriously concerned with future health status. However, using an undergraduate sample gave us the opportunity to understand the relationships between health practice and dietary behavioral factors with the blood CVD risk factors in a controlled setting. Understanding those relations is important, because of the potential relationships between health practices and dietary behaviors of people in their twenties and health outcomes in older years.

Table 8. Dietary habits associated with the plasma total cholesterol and triacylglycerol level of the subjects according to stepwise multiple regressions

Dependent variable	Independent variables	Parameter estimate	SE	Partial R^2	Model R^2	P
Total cholesterol	Fast food intake	7.036	2.942	0.084	0.084	0.005
	Overeating	3.871	1.891	0.066	0.150	0.010
	Grain intake	-3.740	1.511	0.044	0.194	0.031
	High cholesterol food intake	4.836	2.150	0.030	0.224	0.073
Triacyl glycerol	Preference for oily taste	18.127	5.766	0.075	0.075	0.082
	Breakfast intake	-16.794	8.081	0.057	0.132	0.073
	Preference for fruits	11.397	5.576	0.051	0.183	0.022
	Grain intake	-4.298	2.313	0.037	0.220	0.045

Independent variables included all dietary behavioral factors. No other variables met the 0.150 significance level for entry into the model.

Conclusions

From the above results which evaluated relations between the health practice or dietary behaviors, and changes of plasma cardiovascular disease(CVD) risk factors, it is concluded that obesity, smoking and alcohol consumption increased plasma CVD risks, while exercise didn't reduce those risks in healthy male university students. Meal regularity and eating grains, meats and vegetables reduced plasma CVD risks, whereas negative eating behavior such as overeating and fast food intake increased those risks. The findings suggest that intervention programs to reduce the risk of CVD should focus on health practice through reducing BMI, smoking cessation and moderate or no alcohol drinking. Moreover, desirable dietary habits such as eating breakfast, not overeating and reduced intake of fast food may improve CVD risk. It also emphasizes the needs and availability of co-intervention about health and dietary behaviors to prevent the development of CVD risks.

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