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The Association of Plasma HDL-Cholesterol Levels with Dietary, Anthropometric, and Hematological Factors in Elderly Koreans*

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Cardiovascular disease (CVD) is one of the most common causes of death in elderly Koreans, and HDL-cholesterol is known to have a pivotal role in protecting against CVD. This study was undertaken to study the relationships between plasma HDL-cholesterol levels and dietary, anthropometric, and biochemical factors in elderly Koreans. The 102 subjects, who were over 60 years old, were classified into two groups based on their plasma HDL-cholesterol levels : a risk group with plasma HDL-cholesterol < 40mg/*dl* in men or HDL-cholesterol < 50mg/*dl* in women, and a control group with higher HDL-cholesterol levels. The subjects' mean intakes of energy, calcium, zinc, vitamin A, vitamin B_2, vitamin E, and folate did not meet the Korean RDA for elderly people. Vitamin B_2 and folate intakes were significantly lower ($p<0.1$) in the risk group compared to the control group. The consumption of seaweed was significantly lower ($p<0.05$), and fish intake was 33% lower, in the risk group compared to the control group. Subjects in the risk group showed a higher BMI, waist/hip ratio, triceps skinfold thickness, and % body fat, compared to control subjects. Plasma triglyceride levels and values of the atherogenic index were significantly higher ($p<0.001$) in risk group subjects. Significant negative correlations between HDL-cholesterol level and plasma triglyceride level ($r=-0.37$), and values of the atherogenic index ($r=-0.74$), were found. In summary, subjects with low levels of HDL-cholesterol were found to have relatively low intakes of vitamin B_2, folate, and seaweed, and higher levels of the CVD risk factors : body fat, plasma TG, and AI. These results suggest that plasma HDL-cholesterol levels can be modified by dietary, anthropometric, and hematological means.

Key words : low HDL-cholesterol, nutritional factor, cardiovascular disease, elderly

INTRODUCTION

Cardiovascular disease (CVD) has been a leading cause of death in elderly Koreans.[1)] The risk factors for cardiovascular disease include dyslipidemia, hypertension, obesity, lack of exercise, cigarette smoking, heredity, and aging. Of the risk factors, dyslipidemia, such as high plasma levels of triglycerides and LDL-cholesterol, and low HDL-cholesterol levels, is of major concern. High plasma LDL-cholesterol levels induce depositions of LDL particles in the intima of arteries; these particles subsequently undergo progressive oxidation. Oxidized LDL is internalized by macrophages, leading to foam cells and resulting in the formation of fatty streaks and fibrous plaque.[2)]

The concentration of HDL-cholesterol has been found to be inversely related to the incidence of cardiovascular disease in humans.[3-6)] Weverling-Rijnsburger reported that low HDL-cholesterol was associated with a two-fold higher risk of fatal cardiovascular disease.[7)] In the Framingham Heart Study, up to 40% of patients with documented cardiovascular disease under the age of 60 had low levels of HDL-cholesterol.[8)] In the Asian population, blood lipid levels of low HDL-cholesterol and high triglycerides are thought to play more important role in CVD pathogenesis than high LDL-cholesterol levels, probably due to the prevalence of high-carbohydrate diets.[9)]

Many studies have shown a strong inverse relation between HDL-cholesterol levels and CVD.[10-11)] Risk factors such as smoking, alcohol drinking and lack of exercise have been reported to be associated with low concentrations of HDL-cholesterol. In study by Craig et al, smokers had significantly lower dose-dependent serum concentrations of HDL-cholesterol and apoplipoprotein A-I than non-smokers.[10)] Leaf's results suggest that physical exercise affects HDL metabolism and increases plasma HDL-cholesterol levels by 4% to 43%.[11)]

Dietary factors also have effects on HDL-cholesterol levels. In a study of mildly hypercholesterolemic men,

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fish oil reduced the capacity for cholesterylester transfer between LDL-cholesterol and HDL-cholesterol by 23%.[12] Petersen et al[13] found that fish oil raised levels of the HDL2 subset which transports cholesterol to the liver. Another study showed that HDL-cholesterol concentrations can be inversely correlated with both total carbohydrate and refined carbohydrate in a healthy elderly population.[14]

Despite increasing evidence of a strong relationship between HDL-cholesterol and CVD pathogenesis, few studies have been conducted to examine factors affecting HDL-cholesterol in elderly Koreans. The purpose of this study is to evaluate how dietary, anthropometric, and biochemical factors are related to HDL-cholesterol levels in elderly Koreans.

METHODS

1. Subjects

The 102 study subjects, who were recruited through public announcements at a Health Center in Seoul, were over 60 years old and alert enough to complete the questionnaire. Individuals with specific diseases such a cancer, or with physical defects, were excluded. The data were obtained during the period from October 2000 to February 2001. Based on National Cholesterol Education Program (NCEP, Adult Treatment Panel[ATP] III),[15] subjects with plasma HDL-cholesterol < 40mg/dℓ in men or HDL-cholesterol < 50mg/dℓ in women were classified into the low HDL-cholesterol (risk) group, while those with higher HDL-cholesterol levels were assigned to the control group.

2. Dietary, anthropometric, and hematological assessment.

The elderly subjects were individually interviewed to obtain food consumption data, and their general and medical history. Food consumption was assessed using the 24-hour recall method. Food models were used to estimate portion sizes. Food intake data were analyzed using the can-pro 2.0 software for nutrient analysis to determine the equivalent nutrient intakes which were then compared to Korean Recommended Dietary Allowance (KRDA).[16] For anthropometric measurements, body weight, height, and body composition were assessed using INBODY 3.0 (Biospace Co). Waist and hip circumferences were measured by a tapeline (Anthropometric tape, Preston 5193). Body mass index (BMI, kg/m^2) and waist hip ratio (WHR) were calculated. Triceps skinfold (TSF) were measured by the Lange Skinfold Caliper (Cambrige Scientific Inc.).

Fasting blood samples were obtained in EDTA-containing tubes in the morning. The plasma was obtained and frozen at -80℃ in aliquots. Fasting blood glucose level was determined by the Accutrend alpha (Boehringer Mannhein Gmbh, Germany). Levels of total plasma cholesterol, triglyceride and HDL-cholesterol were measured by using an automatic blood analyzer (OLYMPUS Reply, Japan). LDL-cholesterol and atherogenic index (AI) values were calculated by the formulae of Friedwald[17] and Lauer,[18] respectively. Blood pressure was measured by using an automatic blood pressure calculator (Omron, HEM-705C).

Complement 3 (C_3), Immunoglobin G (IgG) were determined by radial immunodiffusion plate (Nor-partigen, Behring Co., Germany). Interleukin-2 (IL-2) and Interleukin-6 (IL-6) were measured using ELISA Kit (Immunotech; A Bechman coulter Co., France). Plasma thiobarbituric acid reactive substance (TBARS), and RBC superoxide dismutase (SOD) activity, were measured by the method of Yagi[19] and Flohe',[20] respectively. Total Antioxidant Status (TAS) was determined by a Kit (Randox Co., USA).

3. Statistical analysis

Anthropometric data were presented for male and female subjects, but all other data were pooled for both sexes. Statistical analysis was conducted using the statistical analysis system program (SAS, version 8.1). Data was expressed as the mean ± standard error. General personal characteristics and lifestyle behavior were compared by using the chi-square test. After the subject were classified into two HDL-cholesterol groups, the student t-test was used to analyze between-group differences of the mean for all measured parameters. To test the association between HDL-cholesterol and other CVD risk factors, Pearsons's correlation coefficient analysis was used.

RESULTS AND DISCUSSION

1. General characteristics

The subjects of this study were 102 elderly people over 60 years old (28 male, 74 female) with a mean age of 67.4±0.8 years. As shown in Table 1, there was no significant difference in age between risk and control groups. Approximately half of the subjects in both groups were college and/or high school graduates, and most of the subjects were housewives or were not employed. No significant differences were found in education and employment status between each group.

The proportion of cigarette smokers and alcohol drinkers were 16.2% and 48.5% of the subjects, respectively, and 72.3% of the subjects exercised regularly (Table 2). There were no significant differences in

Table 1. General characteristics of the subjects

Characteristics	Classification	All subjects (n=102)	HDL-cholesterol groups		
			Risk group (n=56)	Control (n=46)	p-value
Sex	Male	28(27.45)$^{1)}$	12(21.4)	16(34.7)	NS$^{3)}$
	Female	74(72.55)	44(78.6)	30(65.3)	
Education	≤ middle school	56(54.9)	32(57.1)	24(52.2)	NS$^{3)}$
	high school	29(28.43)	15(26.8)	14(30.4)	
	≥ college	17(16.67)	9(16.1)	8(17.4)	
Job	farmers, foreman	2(2.02)	0(0)	2(4.6)	NS$^{3)}$
	sales or service worker	2(2.02)	1(1.8)	1(2.3)	
	managers, officers	2(2.02)	2(3.6)	0(0)	
	professionals, technicians	4(4.04)	1(1.8)	3(6.8)	
	house wives, no job	89(89.9)	51(92.6)	38(86.3)	
Age(yr)		67.4±0.5$^{2)}$	67.4±0.6	67.4±0.8	ns$^{4)}$

$^{1)}$ n(%)
$^{2)}$ mean ± SE
$^{3)}$ NS : not significant at α=0.05 by chi-square test
$^{4)}$ ns : not significant at α=0.05 by t-test

drinking, smoking, and exercising habits between each group. In a previous study of elderly Koreans, it was reported that 48% of the male subjects was drinkers, and less than half of the male and female subjects exercised regularly.[21] In a further study by Hwang, 73% of the subjects were found to be drinkers.[22] The subjects in this study seemed to be more health-conscious, since they had a tendency to drink less and exercise more compared to subjects in other studies.

Table 2. Self-reported lifestyle behavior of the subjects

		All subjects (n=99)	HDL-cholesterol groups		
			Risk group (n=56)	Control (n=43)	p-value
Cigarett	Yes$^{2)}$	16(16.2)$^{1)}$	6(10.7)	10(23.2)	NS$^{4)}$
smoking	No	83(83.8)	50(90.3)	33(76.8)	
Alcohol	Yes$^{3)}$	48(48.5)	24(42.8)	24(55.8)	NS
drinking	No	51(51.5)	31(47.2)	20(44.2)	
Regular	Yes	73(72.3)	39(69.6)	34(79.1)	NS
exercise	No	28(37.7)	17(30.4)	11(20.9)	

$^{1)}$ n(%)
$^{2)}$ present smoker only
$^{3)}$ present drinker only
$^{4)}$ NS : not significant at α=0.05 by chi-square test

2. Dietary assessment

The subjects' mean daily intakes of nutrients are shown in Table 3. The intake of energy, calcium, zinc, vitamin A, vitamin B_2, vitamin E, and folate did not meet the Korean RDA for the elderly. Vitamin A, calcium, and vitamin B_2 are considered to be the most deficient nutrients in elderly Koreans.[16] Dietary fat and cholesterol intakes were not high in both groups. Energy from fat was 17.6% of total energy intake and cholesterol intake was 213.5mg. The 2001 National Nutrition Survey Report showed that energy from fat of elderly Koreans over 65 years old was 13.3%.[23] Our subjects were from Seoul, the most developed and affluent part of Korea, and this may explain why their fat intake status was higher than the national average.

Table 3. *Subjects' daily nutrient intake*

Nutrient	All subjects (n=102) Intake (%RDA)	HDL-cholesterol groups	
		Risk group (n=56) Intake (%RDA)	Control (n=46) Intake (%RDA)
Energy (kcal)	1597.4 ± 55.5$^{1)}$	1562.4 ± 77.8	1640.0 ± 79.0
	(87.2 ± 3.1)	(86.4 ± 4.3)	(88.3 ± 4.6)
Protein (g)	69.3 ± 3.1	67.7 ± 4.2	71.2 ± 4.6
	(120.0 ± 5.3)	(118.6 ± 7.3)	(121.6 ± 7.9)
Fat (g)	32.7 ± 2.6	31.9 ± 4.1	34.3 ± 3.02
Carbohydrate (g)	269.8 ± 9.4	265.3 ± 13.0	275.2 ± 13.6
Fiber (g)	6.1 ± 0.3	6.1 ± 0.4	6.2 ± 0.5
Calcium (mg)	528.4 ± 26.6	496.1 ± 35.3	567.6 ± 40.0
	(75.5 ± 3.8)	(70.9 ± 5.1)	(81.1 ± 5.7)
Phosphorus (mg)	857.2 ± 32.4	812.1 ± 41.0	912.1 ± 51.0
	(122.4 ± 4.6)	(116.0 ± 5.9)	(130.3 ± 7.3)
Iron (mg)	14.3 ± 0.7	14.1 ± 0.9	14.6 ± 1.0
	(119.1 ± 5.7)	(117.3 ± 7.8)	(121.3 ± 8.5)
Potassium (mg)	2338 ± 104	2254 ± 120	2440 ± 178
Na (mg)	3736 ± 157	3479 ± 178*	4050 ± 269
Zinc (mg)	7.8 ± 0.3	7.7 ± 0.4	7.8 ± 0.5
	(73.9 ± 2.9)	(74.3 ± 3.9)	(73.4 ± 4.5)
Vitamin A (μg RE)	473.2 ± 37.7	434.9 ± 50.4	519.9 ± 56.6
	(67.6 ± 5.4)	(62.1 ± 7.2)	(74.3 ± 8.1)
Vitamin B_1 (mg)	1.0 ± 0.1	0.9 ± 0.1	1.0 ± 0.1
	(94.1 ± 5.0)	(92.2 ± 7.9)	(96.4 ± 5.8)
Vitamin B_2 (mg)	0.9 ± 0.04	0.8 ± 0.1*	1.0 ± 0.1
	(75.2 ± 3.9)	(69.5 ± 4.9)	(82.1 ± 6.3)
Vitamin B_6 (mg)	1.7 ± 0.1	1.7 ± 0.1	1.7 ± 0.1
	(121.6 ± 6.3)	(121.8 ± 9.3)	(121.4 ± 8.3)
Vitamin C (mg)	109.1 ± 7.7	106.7 ± 9.6	112.0 ± 12.6
	(155.8 ± 11.0)	(152.4 ± 13.6)	(160.0 ± 18.0)
Niacin (mg)	13.1 ± 0.6	12.6 ± 0.7	13.7 ± 0.9
	(99.4 ± 4.3)	(96.2 ± 5.4)	(103.2 ± 6.9)
Vitamin E (mg α-TE)	8.1 ± 0.7	7.7 ± 0.9	8.6 ± 1.0
	(80.8 ± 6.8)	(76.8 ± 9.1)	(85.6 ± 10.2)
Folate (μg)	223.9 ± 13.1	203.2 ± 13.8*	249.0 ± 23.3
	(89.6 ± 5.3)	(81.3 ± 5.6*)	(99.6 ± 9.4)
Cholesterol (mg)	213.5 ± 18.4	194.5 ± 24.6	236.6 ± 27.5
% Carbohydrate	68.2 ± 0.8	68.5 ± 1.1	67.8 ± 1.2
% Protein	17.4 ± 0.5	17.5 ± 0.7	17.4 ± 0.7
% Fat	17.6 ± 0.8	17.2 ± 1.2	18.1 ± 1.1

$^{1)}$ Mean ± SE
* : significantly different at $p<0.1$ by Student t-test

Because vitamin and mineral intakes are more intimately associated with the quality rather than quantity of foods consumed, the marginal deficiency of vitamin and mineral intakes in this study suggests that the dietary quality of our elderly subjects was not satisfactory.

The levels of intake of most nutrients were comparable between the two groups. However, vitamin B_2 and folate intakes were significantly lower in the risk group than in the control group ($p<0.1$). Since low intakes of vitamin B_2 and folate induce hyperhomocysteinemia, which is regarded to be a CVD risk factor, low intakes of these nutrients in the elderly with low HDL-cholesterol is of great concern.

Table 4. Subjects' daily food intake according to food group

	All subjects (n=102)	HDL-cholesterol groups	
		Risk group (n=56)	Control (n=46)
Meats and poultry	44.6 ± 5.5[1]	49.3 ± 8.2	38.8 ± 6.9
Fishes	45.2 ± 5.9	36.9 ± 7.0	55.3 ± 9.9
Eggs	20.5 ± 3.3	16.1 ± 4.3	25.8 ± 4.9
Milk and product	73.6 ± 14.1	64.9 ± 15.6	84.0 ± 25.1
Oil	8.8 ± 2.9	10.7 ± 5.3	6.5 ± 1.0
Animal total	192.5 ± 16.8	177.9 ± 20.6	210.3 ± 27.6
Cereals and cereal products	285.8 ± 12.2	283.4 ± 19.1	288.7 ± 14.1
Potatoes and starch products	28.9 ± 8.1	37.9 ± 13.9	17.8 ± 5.5
Vegetables	214.8 ± 14.0	200.8 ± 15.5	231.9 ± 24.5
Fruits	190.3 ± 18.6	193.9 ± 25.8	186.0 ± 27.1
Beans and been products	36.4 ± 4.4	42.1 ± 6.7	29.4 ± 5.1
Legumes	2.9 ± 0.9	2.3 ± 1.2	3.7 ± 1.4
Mushrooms	0.3 ± 0.1	0.2 ± 0.1	0.5 ± 0.3
Seaweeds	3.9 ± 0.7	2.2 ± 0.4**	6.0 ± 1.4
Sugars and sugar products	5.7 ± 0.8	6.4 ± 1.2	4.9 ± 0.9
Plant total	769.2 ± 31.5	769.4 ± 42.1	769.1 ± 47.8
Total	1059.6 ± 42.6	1013.3 ± 49.1	1115.2 ± 72.8

[1] Mean ± SE

** : significantly different at $p<0.05$ by Student t-test

As shown in Table 4, the average total daily food intake of subjects were 1059.6g, and the percentage of animal food to total food consumed was 18.2%. In the risk group, seaweed intake was significantly lower than in the control group ($p<0.05$). Also, the fish intake in the risk group was 33% lower, even though this difference was not significant.

Mediterranean and Asian populations have very low rates of CVD mortality compared with western populations. These low rates were attributed to high intakes of vegetables, fruits, whole-grain products, and fish in their diets.[24] Studies in Japan,[25] and WHO-CARDIAC study[26] provided a strong inverse association between levels of taurine excretion, a biological marker of seafood protein intake, and CVD incidence.

From these results, the low intake of seafood in our risk group could partly explain their low plasma HDL-cholesterol levels.

3. Anthropometric assessment

Anthropometric values for the groups were compared by gender because of inherent sex differences. As shown in Table 5, mean heights/weights of male and female subjects were 163.9cm/63.1kg and 151.2cm/58kg, respectively. Compared with standard values for elderly Koreans,[16] the subjects of this study were shorter and heavier. For male and female subjects, BMI values were 23.4kg/m^2 and 25.4kg/m^2, triceps skinfolds thickness (TSF) were 12.1mm and 22.6mm, waist/hip circumferences ratio (WHR) were 0.89 and 0.85, and the percentages of body fat were 24.9% and 35.7%, respectively. The fatness indices such as BMI, TSF, and % body fat were higher in females than in males. In all the measured anthropometric parameters, the risk group showed higher values than the control groups. In male subjects, the differences between each group were significant in BMI, WHR, and % body fat ($p<0.05$), and weight, TSF ($p<0.1$).

Many studies have reported a positive association between anthropometric fatness indices and CVD prevalence, and/or HDL-cholesterol concentration.[27-28] A

Table 5. Anthropometric variables of the subjects

	Male			Female		
	Total subjects (n=28)	HDL-cholesterol groups		Total subjects (n=75)	HDL-cholesterol groups	
		Risk group (n=12)	Control (n=16)		Risk group (n=45)	Control (n=30)
Height (cm)	163.9 ± 0.8[1]	164.0 ± 1.1	163.9 ± 1.1	151.2 ± 0.5	151.3 ± 0.7	151 ± 0.8
Weight (kg)	63.1 ± 1.7	66.4 ± 2.5*	60.7 ± 2.1	58.0 ± 0.9	58.8 ± 1.2	56.8 ± 1.6
BMI (kg/m^2)[2]	23.4 ± 0.5	24.7 ± 0.8**	22.5 ± 0.7	25.4 ± 0.4	25.7 ± 0.5	24.9 ± 0.6
WHR[3]	0.89 ± 0.01	0.91 ± 0.01**	0.87 ± 0.01	0.85 ± 0.01	0.86 ± 0.01	0.84 ± 0.01
TSF[4] (mm)	12.1 ± 1.1	14.3 ± 1.8*	10.4 ± 1.3	22.6 ± 0.8	23.7 ± 0.9	21.3 ± 1.4
Body fat (%)	24.9 ± 1.1	27.6 ± 1.6**	23.1 ± 1.3	35.7 ± 0.6	36.2 ± 0.8	34.9 ± 0.9

[1] mean ± SE

[2] BMI : Body mass index

[3] WHR : waist/hip circumferences ratio

[4] TSF : Triceps skinfold thickness

* : Significantly different at $p<0.1$ by Student t-test

** : Significantly different at $p<0.05$ by Student t-test negative correlation was found between HDL-cholesterol and the anthropometric variables such as body weight, BMI, WHR, and the abdominal fat ratio in elderly males.[27] Leenen et al[28] reported that weight loss increased HDL-cholesterol levels and HDL/LDL cholesterol ratios in obese men.

The results of the present study strongly support the existence of a negative association between HDL-cholesterol and anthropometric factors in elderly Korean males.

4. Hematological assessment

Subjects' hematological values are shown in Table 6. Mean values of fasting blood glucose and of blood pressure were not significantly different between the risk and control groups. Mean concentrations total cholesterol and LDL-cholesterol were also not significantly different between the two groups; however, triglyceride levels and atherogenic index values were significantly higher in risk subjects than in the control group ($p<0.001$).

Table 6. Blood pressure levels and hematological values of the subjects

	All subjects (n=102)	HDL-cholesterol groups	
		Risk group (n=56)	Control (n=46)
Fasting blood glucose (mg/100ml)	101.5 ± 1.9[1]	101.4 ± 2.5	101.6 ± 3.1
Triglycerides (mg/100ml)	134.4 ± 7.1	156.6 ± 9.9***	107.4 ± 8.5
Cholesterol (mg/100ml)	219.9 ± 4.9	214.1 ± 6.5	227.0 ± 7.4
HDL-cholesterol (mg/100ml)	45.0 ± 1.5	34.9 ± 1.5***	57.3 ± 1.4
LDL-cholesterol (mg/100ml)	148.0 ± 4.2	47.9 ± 5.7	148.2 ± 6.2
Atherogenic index[2]	4.7 ± 0.3	6.2 ± 0.5***	3.0 ± 0.1
SBP[3](mmHg)	137.9 ± 2.2	136.7 ± 2.4	139.4 ± 3.9
DBP[4](mmHg)	82.8 ± 1.0	81.9 ± 1.3	83.8 ± 1.7

[1] mean ± SE
[2] Atherogenic index = (Total cholesterol-HDL-cholesterol)/HDL-cholesterol
[3] SBP : systolic blood pressure
[4] DBP : diastolic blood pressure
*** : significantly different at $p<0.001$ by student t-test

Figure 1 shows that HDL-cholesterol levels were negatively correlated with triglyceride levels (r=-0.37) and with atherogenic index values (r=-0.74). Kim found similar results where Korean subjects with high triglyceride levels showed low HDL-cholesterol levels.[29] Previous studies have repeatedly shown that elevated triglyceride levels are associated with low HDL-cholesterol levels and a substantial increase in the risk of CVD mortility.[30-31] The data from Table 6 and Figure 1 strongly suggest that subjects with low HDL-cholesterol levels have greater risks of CVD morbidity compared to those with high HDL-cholesterol levels, especially in the type of subject associated with hypertriglycemia rather than those associated with high LDL-cholesterol levels.

Table 7. Selected variables of immune and antioxidant status in subgroups

	HDL-cholesterol groups	
	Risk group	Control
Immune variables	(n=25)	(n=26)
IgG (mg/dl)	1353 ± 57[1]	1327.4 ± 47.2
C_3 (mg/dl)	118.6 ± 3.1	109.3 ± 4.7
Interleukin-2 (pg/ml)	307.3 ± 99.3	223.5 ± 67.6
Interleukin-6 (pg/ml)	41.1 ± 2.1	41.3 ± 1.9
Antioxidant variables	(n=31)	(n=19)
Plasma TBARS (nmol/ml plasma)[2]	2.3 ± 0.01	2.33 ± 0.01
TAS (nmol/L plasma)[3]	1.59 ± 0.03	1.55 ± 0.04
RBC SOD[4]	34.6 ± 3.4**	24.1 ± 3.9

[1] Mean ± SE
[2] plasma TBARS : plasma Thiobarbituric Acid Reactive Substance
[3] TAS : Total Antioxidant Status
[4] RBC SOD : RBC superoxide dismutase
** : *significantly different at $p<0.05$ by student t-test*

Immune and antioxidant variables were assessed in sub-samples of the subjects (Table 7). No differences were found in plasma concentrations of complement 3 (C_3), Interleukin-2 (IL-2), Interleukin-6 (IL-6), and Immunoglobin G (IgG) between risk and control groups. Total antioxidant status (TAS) and thiobarbituric acid reactive substance (TBARS) levels were not significantly

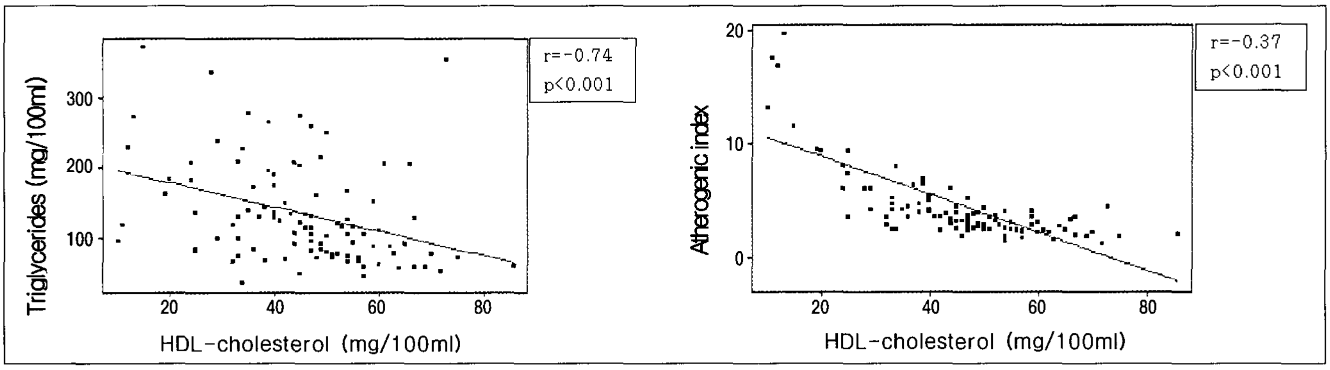

Fig 1. Correlation between HDL-cholesterol level and triglyceride(left panel) and atherogenic index (right panel)

different between the two groups, but RBC superoxide dismutase (SOD) activity was significantly higher in the risk group. However, when the subjects were classified on the basis of LDL-cholesterol levels, subjects with high LDL-cholesterol (LDL-cholesterol ≥ 160mg/dℓ) showed higher TBARS levels, lower TAS levels, and lower RBC SOD activity; this implies that hyperLDL-cholesterolemic individuals may incur higher oxidative stress (data not shown). In this study, since elderly people with low HDL-cholesterol did not shown a higher oxidative status, both high LDL-choelsterol and low HDL-cholesterol levles may exert different effects on CVD pathogenesis, as far as oxidative stress is concerned.

In summary, the subjects in the risk group showed lower intakes of vitamin B_2, folate, and seaweed compared to the control. Subjects in the risk group, with low HDL-cholesterol, had a higher BMI, waist/hip ratio, percent body fat, plasma concentrations of triglyceride, and atherogenic index. Moreover, significantly negative correlations between HDL-cholesterol and triglyceride levels and/or atherogenic index values were shown. Our results suggest that elderly Koreans with low HDL-cholesterol levels have several risk factors for CVD pathogenesis, and that these risk factors can be mitigated through dietary, anthropometric, and hematological changes. In this study, the number of subjects was too small to strongly link nutritional factors with HDL-cholesterol levels. Further research should be conducted using higher numbers of subjects, to help establish recommendations for raising HDL-cholesterol levels as well as for decreasing triglyceride levels for elderly Koreans.

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