J Community Nutrition 6(2) : 103~109, 2004 □ Original Article □

Antioxidant Status and its Relationship to Plasma Cytokine Levels in Korean Elderly Women Living in Seoul*

Mi Joung Kim, Jung Hee Kim†

Department of Nutrition, College of Natural Sciences, Seoul Women's University, Seoul, Korea

ABSTRACT

Body antioxidant status is an important factor for the prevention of many chronic diseases in the elderly. This study was done to investigate antioxidant status and its relationship to immune response by measuring plasma cytokine (IL-2 and IL-6) levels in elderly women. Subjects were 76 elderly women aged over 60 years, visiting Jangwhi Social Welfare Center of Seongbook-Gu in Seoul. Subjects were divided into 3 groups according to age (< 65, 65 − 74, > 75). Dietary intakes were assessed by semi-quantitative food frequency questionnaires (SFFQ). Plasma vitamin C level was measured by 2,4-dinitrophenylhydrazine method and plasma levels of vitamin E, A and β-carotene were measured by HPLC. Plasma levels of IL-2 and IL-6 were determined with a solid phase sandwich enzyme linked-immuno-sorbent assay (ELISA) using commercial kits. The average intakes of antioxidant vitamins were 96.3mg (137.5% of RDA) for vitamin C and 523.3 μgRE (74.8% of RDA) for vitamin A in elderly women. All of the average plasma levels of antioxidant vitamins were within normal range. However the percentage of the elderly women with deficiency plus marginal values were 7.9% in vitamin C, 9.2% in vitamin A and 7.9% in vitamin E. Plasma levels of IL-2 and IL-6 were 27.1 ± 7.1pg/ml and 5.9 ± 5.3pg/ml in elderly women. Correlation data showed that plasma IL-2 level was negatively correlated with plasma vitamin C level. In addition, IL-6 level was also negatively correlated with plasma vitamin C, A and E levels, respectively. There was a significant positive correlation between erythrocyte thiobarbituric acid-reactive substance (TBARS) level and plasma IL-2 or IL-6 levels. In addition, erythrocyte TBARS level showed a significant positive correlation with plasma total antioxidant status (TAS) level and a significant negative correlation with plasma vitamin C level. Overall results might imply that the decreased levels of antioxidant vitamins result in an increase in oxidative stress and thereby increase cytokine production such as IL-2 and IL-6. However further research is required to elucidate these relationships. (*J Community Nutrition* 6(2) : 103~109, 2004)

KEY WORDS : antioxidant status · IL-2 · IL-6 · elderly women.

Introduction

Aging has been associated with various alterations of immune functions.

It is well known that T cell-mediated immunity is more decreased in the elderly than humoral immunity. The age-related impaired T cell-dependent immune function include defects in T cell-proliferative response to mitogens, antibody response after primary immunization with T cell-dependent antigens, and particularly, delayed-type hypersensitivity and interleukin (IL)-2 production (Hallgren et al. 1983 ; Meydani 1999).

As adequate cytokine production is crucial for optimal immune responses, in vitro mitogen-induced IL-2 production by peripheral blood mononuclear cells (PBMCs) was commonly assessed to evaluate T-cell reactivity. In addition, IL-6 is a B-cell stimulatory factor and its production was known to be elevated in inflammatory diseases or cancer (Taaffe et al. 2000). It has been also reported that IL-6 production was elevated in older persons (Beharka et al. 2001).

The decline in the cellular immune responsiveness such as T cell-proliferative response to mitogens, delayed-type hypersensitivity and interleukin (IL)-2 production in the elderly is generally associated with an increased incidence of infectious

*This study was supported by a grant of the Korea Health 21 R & D project, Ministry of Health and Welfare, Republic of Korea (00-PJ1-PG1-CH17-0006).

†**Corresponding author** : Jung Hee Kim, Department of Nutrition, Seoul Women's University, 126 Kongnung 2-dong, Nowon-gu, Seoul 139-144, Korea

Tel : (02) 970-5646, Fax : (02) 976-4046

E-mail : jheekim@swu.ac.kr

neoplastic, and autoimmune diseases (Cakman et al. 1996). Therefore, an effective method to prevent or delay this agerelated impairment of protective immune function would be of great public health significance, particularly in elderly persons.

Antioxidant vitamins play an important role to maintain optimal immune function since the depressed immune responsiveness observed in the elderly has been associated with an increase in free radical (Hatman, Kayden 1979 ; Meydani et al. 1995). Oxidative stress resulted in a suppression of IL-2 production. Many studies suggest that in a population under immunologic stress, supplementation of antioxidant vitamins may be beneficial (Bergsten et al. 1990 ; Meydani et al. 1995). The need for antioxidant vitamins in the elderly to maintain optimal immune function might be higher than RDA.

Despite the increase in elderly population, there are few reports about antioxidant status or antioxidant vitamins supplementation and its relationship to immune response in Korean elderly.

This study was done to investigate antioxidant status and its relationship to immune response by measuring plasma cytokines (IL-2 and IL-6) levels in elderly women.

Subjects and Methods

1. Subjects and study design

Subjects were 76 elderly women aged over 60 years, visiting Jangwhi Social Welfare Center of Seongbook-Gu in Seoul. The mean ages of elderly women were 74.2. Subjects were divided into 3 groups according to age. The numbers of elderly women aged 60 − 64, 65 − 74, over 75 years were 7, 34, and 35, respectively.

2. Dietary assessment

Dietary data were obtained through questionnaires by interviewers trained for nutritional survey. Dietary intakes were assessed by semi-quantitative food frequency questionnaires (SFFQ) that include 98 commonly consumed food items selected from Korean National Health and Nutrition Survey for elderly population and were verified for validity by Lee et al. (2002).

3. Blood sample preparation

Blood samples were drawn in the morning from the cubital vein after overnight fasting. Blood was collected in vacutainer tube with heparin and was immediately centrifuged (3,000 rpm, 20min, 4℃). Supernatant plasma aliquots were stored at −80℃, and thawed only once, just before analysis. Red blood cell (RBC) samples in a lower layer were made, washed 3 times with ice cold saline and phosphate buffered saline to detect antioxidant enzymes activities and were stored at 4℃.

4. Plasma antioxidant vitamins and lipid peroxidation

Vitamin C was assayed from plasma samples pretreated with 0.75M meta-phosphoric acid by 2, 4-dinitrophenylhydrazine method (Pesce, Kaplan 1987) using a UV spectrophotometer (Uvikon 930, Kontron, Switzerland).

Vitamin A and E were assessed by measuring retinol and α-tocopherol, respectively. Plasma vitamin A and E were extracted with ethyl alcohol and hexane. Retinol and α-tocopherol were separated by HPLC (712 HPLC System, Gilson Medical Electronics, France) on Nova-Pak C18 (3.9 × 150 mm, Waters, Ireland) column using methanol-water (95 : 5 v/v) as the mobile phase. Elution was detected spectrophotometrically at 292nm (Bieri et al. 1979).

Plasma β-carotene was extracted with absolute alcohol : distilled water : hexane (1 : 1 : 2) and separated by HPLC (712 HPLC System, Gilson Medical Electronics, France) on Nova-Pak C18 (3.9 × 150mm, Waters, Ireland) column using acetonitrile : dichloromethane : methanol (7 : 2 : 1) as mobile phase. Elution was detected spectrophotometrically at 452 nm (Bieri et al. 1985).

Plasma lipid peroxide level was assayed by thiobarbituric acid-reactive substance (TBARS) method (Ohkawa et al. 1979) and total antioxidant status (TAS) was determined by Randox kit based on trolox equivalent antioxidant capacity (TEAC) method using automatic blood analyzer.

5. Erythrocyte antioxidant enzymes activites

In erythrocyte, catalase activity was assayed by Abei (1984) method ; glutathione peroxidase activity was measured by Donald, William (1967) method. Erythrocyte superoxide dismutse (SOD) activity was assayed by modified Winterbourn et al. (1975) method and erythrocyte TBARS content was detected by Bidlack, Tapple (1973) method.

6. PLasma IL-2 and IL-6

The concentration of IL-2 and IL-6 in plasma was determined with a solid phase sandwich enzyme linked-immunosorbent assay (ELISA) using commercial kits (DIACLONE Research, France).

7. Statistical analysis

All data was expressed as mean ± SD. Statistical analy-

Table 1. Comparison of antioxidant vitamin intakes in elderly women by age

Variables	60 – 64	65 – 74	≥ 75	Total	%RDA[2]	<75%RDA
Vitamin C (mg)	141.9 ± 143.6[1,NS]	103.5 ± 99.6	78.6 ± 69.3	96.3 ± 93.3	137.5 ± 133.3	46.8[3]
Vitamin A (μgRE)	630.1 ± 578.3[NS]	511.8 ± 372	512.1 ± 544.2	523.3 ± 469.1	74.8 ± 67.0	60.8
Retinol (μg)	28.6 ± 27.7[NS]	43.0 ± 31.3	43.3 ± 44.4	41.8 ± 37.1	–	–
β-carotene (μg)	3494.9 ± 3,300.2[NS]	2554.4 ± 1851.1	2519.5 ± 2724.9	2629.3 ± 2399.1	–	–

1) Mean ± SD, NS : Not significant
2) RDA : recommended dietary allowance for Koreans, 7th revision, 2000
3) Percentage of subjects whose intake was less than 75% of Korean RDA

Table 2. Plasma antioxidant vitamin and TAS, and lipid peroxidation levels in elderly women

Variables	60 – 64	65 – 74	≥ 75	Total	Normal range
Vitamin C (mg/L)	10.6 ± 4.2[1,NS]	14.5 ± 5.8	11.1 ± 6.7	12.6 ± 6.3	6 – 20[2]
Vitamin A (mg/L)	0.51 ± 0.13[NS]	0.48 ± 0.18	0.43 ± 0.12	0.46 ± 0.15	0.34 – 0.75[2]
Vitamin E (mg/L)	9.6 ± 2.9[NS]	8.8 ± 3.1	7.9 ± 2.4	8.5 ± 2.8	5 – 12[3]
β-carotene (mg/L)	0.15 ± 0.12[NS]	0.17 ± 0.09	0.16 ± 0.09	0.16 ± 0.09	–
TAS (mmol/L)	1.58 ± 0.12[NS]	1.52 ± 0.13	1.53 ± 0.10	1.53 ± 0.12	1.30 – 1.77[4]
TBARS (nmole/mg protein)	0.10 ± 0.02[NS]	0.11 ± 0.03	0.11 ± 0.03	0.11 ± 0.03	–

1) Mean ± SD, NS : Not significantly different
2) Refer to Pesce & Kaplan (1987)
3) Refer to NRC (National Research Council) (1980)
4) Refer to Randox Laboratories LTD

sis was performed by SAS-PC program. Statistical significant difference was determined by using ANOVA, Duncan's multiple range test. The relationship between cytokines and plasma antioxidant vitamins and other related parameters were analyzed by Pearson's correlation test.

Results and Discussion

1. Dietary intakes of antioxidant vitamins

The average intakes of vitamin C were 96.3mg (137.5% of RDA) (The Korean Nutrition Society 2000) in the elderly women (Table 1). But the percentage of subjects consuming less than 75% of Korean RDA were 46.8%. Vitamin C intake of the elderly tended to be decreased by age. The average intakes of vitamin A were 523.3 μgRE (74.8% of RDA) and the percentage of subjects consuming less than 75% of Korean RDA were 60.8% in the elderly women.

2. Plasma antioxidant vitamin levels

Plasma levels of antioxidant vitamins are presented in Table 2. The average levels of plasma vitamin C were 12.6 mg/L in elderly women. Those levels are within normal range (6 – 20mg/L) (Pesce, Kaplan 1987). But the percentage of the elderly women with deficiency (< 2mg/L) and marginal level (2 – 4mg/L) of vitamin C were 5.3% and 2.6%, respectively (Pesce, Kaplan 1987) (Table 3). Average of plasma retinol levels in elderly women was within normal range

Table 3. Distribution of subjects according to nutritional status of antioxidant vitamins

Variables	Deficiency	Marginal	Normal
Vitamin C (mg/L)	Range < 2[2]	2 – 4	> 4
	5.3[1]	2.6	92.1
Vitamin A (mg/L)	Range < 0.1	0.1 – 0.3	> 0.3
	2.6	6.6	90.8
Vitamin E (mg/L)	Range < 5[3]		> 5
	7.9		92.1

1) Percentage of subjects
2) Refer to Pesce & Kaplan (1987)
3) Refer to NRC (National Research Council) (1980)

(0.34 – 0.75mg/L) (Pesce, Kaplan 1987). The percentage of subjects with deficiency (< 0.1mg/L) and marginal (0.1 – 0.3 mg/L) level of vitamin A were 2.6% and 6.6%, respectively in elderly women (Pesce, Kaplan 1987). Plasma α-tocopherol level of the elderly women was 8.5mg/L within normal range (5 – 12mg/L) (NRC 1980). The percentage of subjects below deficiency level (< 5mg/L) of α-tocopherol were 7.9% in elderly women (NRC 1980). Plasma vitamin E level tended to be decreased by age although the difference was not significant. Plasma TAS and TBARS levels were 1.53mmol/L and 0.11nmole/mg protein, respectively in elderly women. There was no significant difference by age.

3. Erythrocyte antioxidant enzyme activities and TBARS level

Activities of erythrocyte SOD and catalase were not significantly different by age. However eythrocyte glutathione pe-

roxidase activity was highest in elderly women aged 65 − 74 years. Erythrocyte TBARS level was also not significantly different in elderly women by age (Table 4).

4. Plasma cytokines levels

Plasma levels of IL-2 and IL-6 were 27.1 ± 7.1pg/ml and 5.9 ± 5.3pg/ml in elderly women. There was no significant difference in cytokine levels by age (Table 5). When we measured plasma cytokine levels of the college women in our preliminary study, IL-2 and IL-6 levels were 26.1 ± 7.5pg/ml and 4.7 ± 2.5pg/ml, respectively.

5. Correlation data between cytokines and biochemical parameters or antioxidant intakes

Correlation data showed that a significant positive correlation ($r = 0.31$, $p < 0.001$) between plasma IL-2 and IL-6 levels (Table 6). There was a significant negative correlation ($r = -0.34$, $p < 0.001$) between plasma IL-2 and vitamin C levels. Plasma IL-6 level was negatively correlated with plasma vitamin C, A and E levels, respectively. In addition, plasma IL-6 level was also negatively correlated with intakes of vitamin C, A, and β-carotene, respectively.

When we compared plasma cytokines and erythrocyte TB-

Table 4. Antioxidant enzymes activites and TBARS content of erythrocyte in elderly women

Variables	60 − 64	65 − 74	≥ 75	Total
SOD (unit/mgHb)	2.8 ± 1.9^{NS}	2.7 ± 1.8	2.8 ± 1.4	2.8 ± 1.6
GSH-Px (IU/gHb)	25.1 ± 3.7^{b}	31.0 ± 7.2^{a}	29.9 ± 7.1^{ab}	29.9 ± 7.0
Catalase (μmole/min/gHb)	1.42 ± 0.22^{NS}	1.43 ± 0.23	1.36 ± 0.28	1.40 ± 0.25
TBARS (nmole/gHb)	150.5 ± 35.0^{NS}	136.1 ± 45.8	147.4 ± 43.9	142.7 ± 43.9

Mean ± SD. NS : Not significantly different
Means with different superscript letter are significantly different among groups at $p < 0.05$ by Duncan's multiple range test

Table 5. Plasma cytokine levels in elderly women

	60 − 64	65 − 74	≥ 75	Total	Range
IL-2 (pg/ml)	27.1 ± 8.4$^{1)NS}$	27.5 ± 6.8	26.9 ± 7.3	27.1 ± 7.1	1.8 − 38.8
IL-6 (pg/ml)	6.0 ± 2.3^{NS}	6.5 ± 7.5	5.2 ± 2.5	5.9 ± 5.3	0 − 8.4

1) Mean ± SD. NS : Not significantly different

Table 6. Correlation coefficients between plasma cytokines levels and antioxidant vitamins

	Plasma							Erythrocyte	Intake			
Plasma	IL-6	TBARS	TAS	Vit. C	Vit. A	Vit. E	β-carotene	TBARS	Vit. C	Vit. A	β-carotene	Retinol
IL-2	0.31**	−0.20	0.09	−0.34**	−0.09	−0.19	−0.15	0.36**	−0.17	0.01	−0.03	−0.11
IL-6		−0.18	0.15	−0.28*	−0.30**	−0.27*	−0.22	0.27*	−0.25*	−0.26*	−0.26*	−0.20

Vit. C : Vitamin C, Vit. A : Vitamin A, Vit. E : Vitamin E
*, ** : significantly correlated at $p < 0.05$, $p < 0.01$ by Pearson's correlation

Table 7. Plasma cytokine levels in elderly women by antioxidant vitamin intakes

Variables		Q1 (N = 18)	Q2 (N = 19)	Q3 (N = 19)	Q4 (N = 19)
Vitamin C (mg)	Range	5.0~ 33.4	33.6~ 55.2	61.5~ 124.3	127.0~ 452.7
	IL-2 (pg/ml)	25.8 ± 6.3^{NS}	27.9 ± 6.5	29.7 ± 8.2	26.0 ± 7.2
	IL-6 (pg/ml)	8.9 ± 9.1^{a}	6.3 ± 3.9^{ab}	4.3 ± 2.3^{b}	4.3 ± 1.8^{b}
Vitamin A (μgRE)	Range	58.5~192.3	197.0~ 326.1	339.4~ 652.1	667.9~ 2321.7
	IL-2 (pg/ml)	28.5 ± 6.8^{NS}	25.7 ± 6.5	27.0 ± 7.2	28.3 ± 8.4
	IL-6 (pg/ml)	9.1 ± 9.0^{a}	4.8 ± 1.9^{b}	5.7 ± 3.9^{ab}	4.2 ± 2.2^{b}
Retinol (μg)	Range	0.1~ 13.4	13.6~ 33.1	33.8~ 56.3	63.1~ 208.2
	IL-2 (pg/ml)	25.3 ± 5.0^{b}	30.7 ± 8.2^{a}	26.6 ± 7.8^{ab}	27.0 ± 6.6^{ab}
	IL-6 (pg/ml)	6.0 ± 3.1^{ab}	9.1 ± 9.5^{a}	3.8 ± 1.3^{b}	5.1 ± 2.0^{b}
β-carotene (μg)	Range	294.3~947.6	956.0~1603.2	1756.7~3328.7	3391.6~11929.3
	IL-2 (pg/ml)	28.2 ± 6.4^{NS}	27.0 ± 7.5	26.7 ± 6.5	27.6 ± 8.6
	IL-6 (pg/ml)	8.8 ± 9.2^{a}	5.0 ± 1.8^{b}	5.7 ± 4.1^{ab}	4.1 ± 1.9^{b}

Mean ± SD, NS : Not significantly different
Means with different superscript letter are significantly different among groups at $p < 0.05$ by Duncan's multiple range test

Table 8. Plasma cytokine levels in elderly women by plasma antioxidant status

Variables		Q1(N = 18)	Q2(N = 19)	Q3(N = 19)	Q4(N = 19)
Vitamin C(mg/L)	Range	0.4~ 7.1	7.6~ 13.0	13.1~ 16.8	17.1~ 31.6
	IL-2(pg/ml)	32.3 ± 7.5^{a}	27.1 ± 7.4^{b}	24.8 ± 6.6^{b}	24.6 ± 4.4^{b}
	IL-6(pg/ml)	8.1 ± 5.7^{a}	6.4 ± 8.1^{ab}	4.2 ± 2.2^{b}	4.9 ± 2.3^{ab}
Vitamin A(mg/L)	Range	0.08~ 0.33	0.34~ 0.44	0.44~ 0.53	0.54~ 0.95
	IL-2(pg/ml)	27.7 ± 7.5^{NS}	28.1 ± 8.3	27.5 ± 6.8	25.3 ± 5.9
	IL-6(pg/ml)	7.5 ± 5.3^{NS}	6.5 ± 8.2	5.1 ± 3.7	4.3 ± 1.4
Vitamin E(mg/L)	Range	3.2~ 6.2	6.3~ 8.1	8.2~ 9.9	9.9~ 16.8
	IL-2(pg/ml)	30.7 ± 9.0^{a}	25.0 ± 4.8^{b}	26.4 ± 6.1^{ab}	26.7 ± 7.3^{ab}
	IL-6(pg/ml)	9.1 ± 9.5^{a}	5.5 ± 2.8^{b}	4.4 ± 2.1^{b}	4.6 ± 1.9^{b}
β-carotene(mg/L)	Range	0.02~ 0.09	0.09~ 0.14	0.14~ 0.21	0.22~ 0.51
	IL-2(pg/ml)	28.4 ± 8.8^{NS}	29.9 ± 7.2	25.1 ± 5.7	25.3 ± 5.9
	IL-6(pg/ml)	6.9 ± 5.1^{ab}	7.9 ± 8.5^{a}	4.0 ± 1.4^{b}	4.7 ± 2.4^{ab}
TAS(mmol/L)	Range	1.07~ 1.45	1.48~ 1.55	1.56~ 1.62	1.63~ 1.67
	IL-2(pg/ml)	26.3 ± 6.5^{NS}	26.6 ± 6.1	26.0 ± 6.0	29.6 ± 9.3
	IL-6(pg/ml)	4.2 ± 2.2^{b}	5.3 ± 2.4^{ab}	8.0 ± 8.7^{a}	6.1 ± 5.0^{ab}
TBARS(nmole/gHb)[1]	Range	49.7~102.2	104.9~147.8	149.1~173.7	173.9~238.9
	IL-2(pg/ml)	23.5 ± 4.0^{b}	26.5 ± 7.1^{ab}	28.9 ± 7.4^{a}	29.5 ± 8.1^{a}
	IL-6(pg/ml)	4.0 ± 1.9^{b}	4.6 ± 2.2^{ab}	7.3 ± 5.5^{ab}	7.4 ± 8.2^{a}

Mean ± SD, NS : Not significantly different
Means with different superscript letter are significantly different among groups at $p < 0.05$ by Duncan's multiple range test
1) TBARS was determined in erythrocyte

ARS level, there was a significant positive correlation between erythrocyte TBARS level and plasma IL-2 or IL-6 levels (Table 6). In addition, erythrocyte TBARS level showed a significant positive correlation with plasma TAS level and a significant negative correlation with plasma vitamin C level.

According to all parameters of antioxidant status, all subjects were divided into 4 groups by quartile and then plasma IL-2 and IL-6 levels were compared among the 4 groups, concerning the significant difference between the lowest quartile and the highest quartile groups (Table 7, 8). When subjects were divided into 4 groups by quartile according to antioxidant vitamin intakes, plasma IL-6 level was significantly highest in the lowest quartile group of vitamin C intakes. Similar to vitamin C, the lowest quartile group of vitamin A and β-carotene intakes showed the highest plasma IL-6 levels. However plasma IL-2 level was not significantly different by antioxidant vitamin intakes except retinol.

In accordance with previous correlation data, both plasma IL-2 and IL-6 levels were highest in the lowest quartile of plasma vitamin C level. Similar to plasma vitamin C level, the lowest quartile group of plasma vitamin E level showed the highest plasma IL-2 and IL-6 levels. In addition, plasma IL-2 or IL-6 level was significantly increased by increasing erythrocyte TBARS level.

It is known that the ascorbic acid level in the lymphocyte is 20 − 100 times as high as that in plasma (Bergsten et al. 1990). It was also reported that the oxidative stress of immune cell in the condition of inflammatory diseases was elevated for the protection against bacteria or virus. Thus the levels of antioxidant vitamin in plasma and lymphocyte might be decreased since the requirement of antioxidant vitamins in immune cells was increased during inflammatory responses (Henson et al. 1991). IL-6 level might be increased under these conditions since IL-6 is one of the inflammatory cytokines. The elderly have an increased oxidative stress and inflammatory status by aging and chronic diseases such as arthritis. Therefore it is hard to say that the elevated IL-6 level was due to the enhanced immune function. A lot of antioxidant vitamin intervention studies have been reported that the supplementation of antioxidant vitamins might improve the immune response including mitogen-induced cytokine production by PBMC (Calder, Newholme 1993 ; Meydani et al. 1997 ; Wang et al. 1994). This study has some limits because we measured plasma cytokine level instead of mitogen-induced cytokine production by blood immune cells as an indicator of immune function. Therefore it is difficult to interpret that the elderly women with higher plasma IL-2 levels have better immune function. Furthermore, the normal levels of

plasma IL-2 in a healthy human are as low as undetectable. Conclusively, overall results of this study might imply that the decreased levels of plasma antioxidant vitamins result in an increase in oxidative stress and thereby increase cytokine production such as IL-2 or IL-6. However, further research is required to elucidate those relationship.

Summary and Conclusions

This study was done to investigate antioxidant status and its relationship to immune response by measuring plasma cytokines (IL-2 and IL-6) levels in elderly women. Subjects were 76 elderly women aged over 60 years, visiting Jangwhi Social Welfare Center of Seongbook-Gu in Seoul. The mean ages of elderly women were 74.2. Results of this study are summarized as follows.

1) The average intakes of antioxidant vitamins were 96.3 mg (137.5% of RDA) for vitamin C and 523.3 μgRE (74.8% of RDA) for vitamin A in elderly women. All of the average plasma antioxidant vitamins levels were within normal range. But there was no significant difference in plasma levels of antioxidant vitamins, TAS and TBARS by age.

2) Plasma levels of IL-2 and IL-6 were 27.1 $\pm$ 7.1 pg/ml and 5.9 $\pm$ 5.3 pg/ml in elderly women. There was no significant difference in cytokine levels by age.

3) Correlation data showed that plasma IL-2 level was negatively correlated with plasma vitamin C level, and IL-6 level was also negatively correlated with plasma vitamin C, A and E levels, respectively.

4) There was a significant positive correlation between erythrocyte TBARS level and plasma IL-2 or IL-6 levels. In addition, erythrocyte TBARS level showed a significant positive correlation with plasma TAS level and a significant negative correlation with plasma vitamin C level.

Overall results might imply that the decreased levels of antioxidant vitamins result in an increase in oxidative stress and thereby increase cytokine production such as IL-2 or IL-6. However, further research is required to elucidate those relationships.

References

Abei H (1984) : Catalase in vitro. Methods in enzymology. *Academic press* 105 : 121 -126

Beharka AA, Meydani M, Wu D, Leka LS, Meydani A, Meydani SN (2001) : Interleukin-6 production dose not increase with age. *J Gerontol* 56 : B81-B88

Bergsten P, Amitai G, Kehri J, Dhariwal KR, Klein HG, Levine M (1990) : Millimolar concentration of ascorbic acid in purified human mononuclear leukocytes. *J Biol Chem* 265 : 2584-2587

Bidlack WT, Tapple AL (1973) : Damage to microsomal membrane by lipid peroxidation. *Lipid* 8 : 177-182

Bieri JG, Brown ED, Smith JC (1985) : Determination of individual carotenoid in human plasma by high performance liquid chromatography. *J Liq Chrom* 8 (3) : 474-484

Bieri JG, Tolliver TJ, Catignani GL (1979) : Simultaneous determination of alpha-tocopherol and retinol in plasma or red blood cells by high pressure liquid chromatography. *Am J Clin Nutr* 32 : 2143-2149

Cakman I, Rohwer J, Schutz RM, Kirchner H, Rink L (1996) : Dysregulation between TH1 and TH2 T cell subpopulations in the elderly. *Mech Aging Dev* 87 : 197-209

Calder PC, Newholme EA (1993) : Influence of antioxidant vitamins on fatty acid inhibition of lymphocyte proliferation. *Biochem Mol Biol* 29 : 175-183

Donald EPM, William NV (1967) : Studies on the quantative and qulitative characterization of erythocyte glutathione peroxidase. *J Lab Clin Med* 70 (5) : 158-169

Hallgren HM, Jacola DR, O'leary JJ (1983) : Unusual pattern of surface marker expression on peripheral lymphocytes from aged humans suggestive of a population of less differentiated cells. *J Immunol* 131 : 191-194

Hatman LJ, Kayden HJ (1979) : A high-performance lipid chromatographic method for the determination of tocopherol in plasma and cellular elements of the blood. *J Lipid Res* 20 : 639-645

Henson DE, Block G, Lecine M (1991) : Ascorbic acid-biological functions and relation to cancer. *J Natl Cancer Inst* 83 : 547-550

Lee HJ, Park SJ, Kim JH, Kim CI, Chang KJ, Yim KS, Kim KW, Choi HM (2002) : Development and validation of a computerized semi-quantitative food frequency questionnaire program for evaluating the nutritional status of the Korean elderly. *Korean J Comm Nutr* 7 (2) : 277-285

Meydani M (1999) : Dietary antioxidants modulation of aging and immune-endothelial cell interaction. *Mech Aging Dev* 111 (30) : 123-132

Meydani M, Wu D, Santos MS, Hayek MG (1995) : Antioxidants and immune response in aged person : overview of present evidence. *Am J Clin Nutr* 62 : 1462S-1476S

Meydani SN, Meydani M, Blumberg JB, Leka LS, Siber G, Loszewski R, Thompson C, Pedrosa MC, Diamond RD, Stollar BD (1997) : Vitamin E supplementation and in vivo immune response in healthy elderly subjects : randomized controlled trial. *JAMA* 277 : 1380-1386

NRC (National Research Council) (1980) : Recommended dietary allowances, 9th ed

Ohkawa H, Ohishi N, Aogi K (1979) : Assay for lipid peroxides in animal tissues by thiobarbituric acid reaction. *Anal Biochem* 95 : 351-358

Pesce AJ, Kaplan LA (1987) : Methods in clinical chemistry. The CV Mosby-Company, St. Louis Washington. DC Toronto. Part 10. *Chapter* 75 : 574-581

Taaffe DR, Harris TG, Ferrucci L, Rowe J, Seeman TE(2000) : Cross-sectional and prospective relationships of interleukin-6 C-reactive protein with physical performance in elderly persons : MacArthur Studies of Successful Aging. *J Gerontol* 55A : M709-M715

The Korean Nutrition Society(2000) : The recommended dietary allowance for Koreans, 7th revision

Wang Y, Huang DS, Linag B, Watson RR(1994) : Nutritional status and immune responses in mice with murine AIDS are normalized by vitamin E supplementation. *J Nutr* 124 : 2024-2032

Winterbourn CC, Rosemary EH, Maureen BRW(1975) : Carrell chirstchurch. *New Zeland J Lab Clin Med* 85(2) : 337-341