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Iron Status and Its Relations with Nutrient Intake, Coffee Drinking, and Smoking in Korean Urban Adults

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ABSTRACT

The iron status and its relations with nutrient intake, coffee drinking, and cigarette smoking were evaluated through the blood analysis and 3-day dietary recalls in 102 apparently healthy Korean adults (48 males, 54 menstruating females) aged 20−49 years and living in Daejeon City. Mean values of hemoglobin (Hb) in males and females were 15.5g/dL and 13.2g/dL, mean corpscular hemoglobin concentration (MCHC) 36.0% and 36.8 %, serum iron (SI) 135 μg/dL and 97 μg/dL, transferrin saturation (TS) 39.4% and 29.2%, and serum ferritin (Ft) 88.1 μg/L and 23.4 μg/L, respectively. For males the prevalences of abnormal values of iron status indicators were 4.2% in Hb, 2.1% in TS, and 4.2% in Ft, and for females 16.7% in Hb, 25.9% in TS, and 35.2% in Ft. Among females 9.3% had abnormal Ft, TS, and Hb, which was considered as iron-defeciency anemia, and 14.8% had abnormal Ft and TS. As a whole, the impaired iron status prevalences were estimated to be 2.1 − 4.2% for males and 9.3 − 35.2% for females. Mean daily intakes of iron and heme-iron were 13.7mg and 1.51mg in males, and 12.3mg and 1.45mg in females. Ft was positively correlated with dietary energy, protein, iron, and vitamin A, Hb with energy and iron, and MCHC with iron and heme iron. Vitamin A also tended to show positive correlations with Hb, SI, and TS. Coffee drinkers taking 3 cups per day or more had higher levels of Hb, MCHC, and Ft in males and MCHC in females, compared to non-coffee drinkers. Higher levels of Hb and MCHC were found in male smokers than in non-smokers. Coffee drinkers took more energy and vitamin A in males and MPF protein in females than non-coffee drinkers. From the above results, it was suggested that the iron status of men was much better than that of women, and the intakes of energy, iron, heme iron, and especially vitamin A were positively associated with the iron status. Cigarette smoking elevated Hb and MCHC, but the effect of coffee drinking on iron staus was not clear. (*J Community Nutrition* 5(1) : 44~50, 2003)

KEY WORDS : urban adults · three stage of iron deficiency · smoking · coffee drinking.

Introduction

The primary nutrition care for adults has been focused on the risk reduction of chronic degenerative diseases such as obesity, atherosclerosis, hypertension, and so on. However nutrient deficiency, particularly iron deficiency, is another problem which should be under careful surveillance to maintain and promote health of adult life. Iron deficiency in a severe state produces anemia and is associated with a reduction of work capacity, impaired behavior and intellectual performance, delayed adaptation of body temperature to a cold environment, and decreased resistance to infection. Moreover, several studies reported that iron status might be associated with the risk of coronary heart disease (Sempos et al 1994).

Despite the recent improvement of nutrient intake patterns in Korea, iron deficiency is still prevalent at all ages including adult age. According to the report of a 1998 Korean National Health and Nutrition Survey, the average intake amount of dietary iron was 13.0mg (male 14.5mg, female 11.8mg) in 20 − 29 years of age and 14.6mg (male 16.0mg female 13.1 mg) in 30 − 49 years of age. Of both age groups 48.9% and 40.5% took dietary iron below 75% of Korean RDA, respectively. These percentages in male adults were

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25.9% and 17.9%, and in female adults 68.7% and 63.2%, respectively (Korean Health Industry Development Institute, Ministry of Health, Welfare 1999).

The progress of iron deficiency is generally divided into three stages (Cook, Finch 1979). The first stage is a decrease of iron stores which induce a low serum ferritin concentration. The following phase is iron-deficient erythropoiesis which is reflected by a decreased transferrin saturation. At the final stage, anemia occurs with low levels of hemoglobin and hematocrit. To obtain the best diagnosis of iron status and to know the real prevalence of iron deficient anemia, several indices should be measured simultaneously. Iron deficiency is mainly caused by the insufficient intake of iron and its low bioavailability. Some other environmental factors such as individual lifestyle may have influence on the iron status (Houston et al. 1997).

Many studies about iron nutrition were concentrated on the periods of growth, puberty, and pregnancy (Hong et al 2003 ; Lee, Park 1997 ; Son, Yang 1998 ; Um et al. 2002 ; Yu, Yoon 1998), but research reports about iron status of male adults or non-pregnant female adults were limited. Therefore, this study was planned to investigate the iron status and the prevalence of iron-deficient anemia of Korean male and female adults through the determination of various indices reflecting three stages of iron deficiency development, and to examine if cigarette smoking and coffee drinking, which are common lifestyles among adults, affect iron status.

Subjects and Methods

1. Subjects

One hundred and two numbers of subjects were randomly selected from apparently healthy adults aged 20 − 49 years and living in Daejeon City, Korea. They consisted of 48 males and 54 menstruating females and all participated in dietary surveys and blood tests.

2. General characteristic and dietary survey

Coffee drinking and smoking habits of the subjects were surveyed by using questionnaire. The questions included whether you drink coffee or not, if yes, how many cups per day, whether you smoke at present time or not, and, if yes, how many packs per day. Age, education years, and height were also included in the questionnaire. Body weight was measured with an electronic weight scale.

Food consumptions of 3 consecutive days were surveyed through the first day of 24−hour recall interview and the next two days of self-recording. Self-recorded dietary intake data was confirmed by one to one interview if needed. Data was collected by researchers and senior university students who were carefully educated previously.

The average daily nutrient intakes were calculated by using a computerized data analysis program filed with Food Composition Table of Korea Rural Development Administration (1996). Of the iron intake, crude amount of heme iron was estimated as assumed to be equal to 40% of total iron taken from meat, poultry, and fish (Monsen, Balintfy 1982).

3. Blood test

Fasting venous blood was collected from each subject before breakfast by a nurse. An aliquot of blood was used for hemoglobin concentration (Hb) and hematocrit (Hct) determination immediately after the blood sampling. The rest of the blood was clotted and centrifuged (3000rpm, 20mins) into serum, which was frozen at −70℃ until analyzed. Hb and Hct were determined by cyanomethemoglobin and microcenrifuge (11,000rpm, 5mins) methods respectively. Mean corpscular hemoglobin concentration (MCHC) was computed from Hb and Hct. Serum iron (SI) and total iron binding capacity (TIBC) were determined on an autoanalyzer (747, Hitachi, Japan) and from both values transferrin saturation (TS) was computed. Serum ferritin was analyzed by a two-site immunoradiometric assay method using assay kits (INCSTAR, USA).

4. Statistical analysis

Statistical analysis was performed by SAS program package. All the data was analyzed into mean ± SD or frequency distribution. The significance of group differences was tested by ANOVA-Duncan's multiple range test, t-test, or Chi-square test and the correlation among variables was examined with Pearson's correlation.

Results and Discussion

1. General characteristics of the subject

Mean age of the male subjects was 31.4 ± 7.7 years and the female subjects was 35.5 ± 6.4 years, and average body mass indices of both men and women belonged to the nor-

mal range. Many subjects have graduated from college since their mean education years were about 15 years (Table 1).

2. Hematological indices

Table 2 shows the mean values of various hematological iron indices by gender. As a whole the mean values of men were better than those of women.

Mean values of the subject men and women were for hemoglobin (Hb) 15.5±1.5 and 13.2±1.5g/dL, hematocrit (Hct) 43.5±3.7 and 36.8±4.4%, mean corpscular hemoglobin concentration (MCHC) 36.0±4.7 and 36.8±4.7%. Mean Hb value in men was the same to 50th percentiles of 20 − 44 years of age Hb distribution of 1998 Korean National Health and Nutrition Survey (KNHNS), but a little bit higher in women. Mean Hct values of both sexes were lower than those 50th percentiles of 1998 KNHNS data. Thus, mean MCHC of men and women was higher than those 50th percentiles of 1998 KNHNS.

Mean serum iron (SI) of men and women were 135±50 and 97±46 μg/dL, total iron binding capacity (TIBC) 349±48 and 367±60 μg/dL, transferrin saturation (TS) 39.4±15.9 and 27.2±13.9%, respectively. Compared with the 50th percentiles of NHANES II since the report of 1998 KNHNS did not have the data, mean SI was higher and mean TIBC of men was lower, while those two values of women were similar. Mean TS of both sexes were higher than the 50th percentiles of NHANES II data (Gibson 1993).

Serum ferritin (Ft) levels of the subjects, a useful indicator of body iron stores, ranged 1.0 − 220.0 μg/L with the mean value of 88.1±53.7 μg/L of men and 23.4±18.7 μg/L of women. Serum Ft of men was close to the 50th percentiles of NHANES II of the USA, while the serum Ft of women was less than the 40th percentile.

Table 1. General characteristics of the subjects

Variables	Men (n = 48)	Women (n = 54)
Age (yrs)	31.4 ± 7.7[1]	35.5 ± 6.4
Height (cm)	172.0 ± 4.9	159.5 ± 4.7
Weight (kg)	65.8 ± 9.6	52.9 ± 5.6
BMI (kg/m^2)	22.2 ± 2.7	20.8 ± 1.8
Education (yrs)	15.3 ± 0.9	14.7 ± 2.1

1) Mean ± SD

Table 2. Mean values of hematological indices of the subjects

	Men (n = 48)	Women (n = 54)
Hb (g/dL)	15.5 ± 1.5[1] (11.3−18.5)[2]	13.2 ± 1.5 (9.6−16.4)
Hct (%)	43.5 ± 3.7 (34.3−50.0)	36.8 ± 4.4 (20.5−49.2)
MCHC (g/dL)	36.0 ± 4.7 (28.8−48.4)	36.3 ± 4.7 (26.0−51.3)
serum iron (μg/dL)	134.6 ± 50.4 (44.0−265.0)	96.5 ± 46.2 (11.0−194.0)
TIBC (μg/dL)	348.8 ± 48.4 (252−510)	366.8 ± 60.0 (243−516)
TS (%)	39.4 ± 15.9 (8.6−87.7)	27.2 ± 13.9 (2.9−59.0)
Serum ferritin (μg/L)	88.1 ± 53.7 (2.4−220.0)	23.4 ± 18.7 (1.0−75.1)

1) Mean ± SD, 2) Range of the values

3. Prevalence of iron deficiency

Iron deficiency prevalences of the present subjects, defined by using a different index cutoff point, are presented in Table 3. Percents of the subjects with impaired iron status varied as 2.1 − 43.8% in men and 5.6 − 50.0% in women, depending on the indices.

Impared iron status is generally divided into three sequential phases-a depletion of iron store, iron-deficient erythropoiesis, and anemia (Gibson 1990). Three stages were reflected by lowered serum ferritin and highered TIBC, decreased serum iron and increased TIBC resulting in lowered TS, and declined Hb and Hct resulting in decreased MCHC, respectively. Thus, according to serum Ft level of less than 12 μg/L, 4.2% of men and 35.2% of women were classified into the first stage of iron deficiency, that is, iron depletion. But when TIBC > 360 μg/dL was used, 43.8% of men and 50.0% of women belonged to the iron depletion stage. When serum iron < 60 μg/dL, TIBC > 360 μg/dL, and TS < 15% were used as criteria, the subject men and women with the second stage of iron deficiency (iron-deficient erythropoiesis) were 8.3% and 29.6%, 43.8% and 50.0%, and 2.1% and 25.9%, respectively. To detect the final stage of iron deficiency, that is, anemia Hb criteria, men < 13g/dL and women < 12g/dL were used. Of the subject men 4.2% and 16.7% of women belonged to iron-deficient

Table 3. Prevalence of iron deficiency defined by a different hematological index

Hematological indices[2]		Men	Women
Serum ferritin (μg/L)	< 12[3]	2 (4.2)[1]	20 (35.2)
TIBC (μg/dL)	> 360[4]	21 (43.8)	27 (50.0)
Serum iron (μg/dL)	< 60[4]	4 (8.3)	16 (29.6)
TS (%)	< 15[4]	1 (2.1)	14 (25.9)
Hb (g/dL)	M < 13, F < 12[5]	2 (4.2)	9 (16.7)
Hct (%)	M < 41, F < 36[5]	12 (25.0)	18 (33.3)
MCHC (g/dL)	< 30	1 (2.1)	3 (5.6)

1) N(%), 2) Cutoff points were based from the book of Gibson (1993), 3) Worwood (1979), 4) Gibson (1990), 5) WHO (1972)

anemia, by Hct, 25.0% and 25.9%, and by MCHC, 2.1% and 5.5%, respectively.

As seen in the above discussion, there is no single reliable blood index which can assess body iron status exactly. Thus multifactorial evaluation is recommended. Several models using multiple blood indicators such as ferritin model, hemoglobin-percentile shift model, and MCV model, have been suggested (Lee et al 2001 ; Lee, Nieman 1996). Therefore, in this study three indices of Ft, TS, and Hb were used, which reflect iron depletion, iron-deficient erythropoiesis, and anemia, respectively (Gibson 1993). Table 4 presented the prevalence of iron deficiency by stage identified by using the three criteria. Of the female adults 9.3% had all abnormal values of serum Ft, TS, and Hb, which was assessed as iron-deficiency anemia, while 14.8% had two abnormal values of ferritin and Hb, judged as iron-deficient erythropoiesis and 9.3% having only one abnormal serum Ft were in the iron depletion stage. While, of the male adults, only one (2.1%) was classified into iron-deficiency anemia and the other one (2.1%) belonged to the iron depletion stage.

Two women (3.7%) showed low Hb, low Ft, and normal TS ; the other two showed low Hb and normal TS and Ft. These results did not accord with the developing stages of iron deficiency, so it was difficult to diagnose the iron deficiency.

Table 4. Prevalence of iron deficient anemia and iron depletion estimated using multifactorial criteria

Criteria			Men	Women
Hb	TS	Ferritin		
Nomal[2]	Nomal	Nomal	45(93.8)[1]	32(59.3)
Nomal	Nomal	Low	1(2.1)	5(9.3)
Nomal	Low	Low	0	8(14.8)
Low	Low	Low	1(2.1)	5(9.3)
Low	Nomal	Noraml	1(2.1)	2(3.7)
Low	Normal	Low	0	2(3.7)

1) N(%), 2) Defined as a value higher than the cutoff-point indicated in Table 3

4. Iron and other nutrients intakes and its relations with hematological indices

As seen in Table 5, average intakes of dietary iron and crude heme-iron per day were 13.7±5.2mg (114% Korean recommended dietary allowances, KRDA) and 1.5±1.6mg in men, and 12.3±3.9mg (68% KRDA) and 1.5±0.8mg in women. Energy and other iron-bioavailability related nutrient intakes exceeded KRDA except for energy, vitamin A, and riboflavin in men, and vitamin A in women. Intakes of energy, protein, iron, and riboflavin as % of KRDA were significantly higher in men than those in women.

The Pearson's correlation coefficients between blood iron status indices and nutrient intakes are shown in Table 6. Serum Ft was positively correlated with dietary intakes of energy, protein, iron, and vitamin A, and Hb with energy and iron, MCHC with iron and heme iron. But MPF protein, crude fiber, and vitamin C did not show any significant correlations with blood iron indices. Overall, the intakes of energy, protein, iron and crude heme iron, and vitamin A were positively associated with iron body status. Particularly,

Table 5. Iron and other nutrient intakes per day of the subjects

Nutrients	Men	Women
Energy (kcal)	2109 ± 618[1] (84.4)[2]*	1875 ± 362(93.8)
Lipids (g)	49.4 ± 21.7	44.7 ± 14.0
Carbohydrate (g)	323.2 ± 77.6	293.2 ± 55.6
Protein (g)	76.6 ± 30.9(102.1)*	70.7 ± 19.3(117.8)
MPF protein[3] (g)	29.0 ± 27.4	25.5 ± 14.0
Iron (mg)	13.7 ± 5.2(114.2)***	12.3 ± 3.9(68.3)
Heme iron (mg)[4]	1.5 ± 1.6	1.5 ± 0.8
Crude fiber (g)	7.1 ± 3.2	6.4 ± 2.4
Vitamin A (RE)	360.1 ± 213.3(51.4)	310.9 ± 151.2(44.4)
Riboflavin (mg)	1.34 ± 0.49(89.3)**	1.31 ± 0.47(109.2)
Vitamin C (mg)	90.2 ± 40.4(164.0)	77.9 ± 35.5(141.6)

1) Mean ± SD, 2) %RDA, 3) Meat, poultry and fish protein
4) Heme iron was calculated as 40% of total iron taken from meat, poultry, and fish (Monsen and Balintfy 1982).
* : p < .05, ** : p < .01, *** : p < .001 compared with the %RDA of women

Table 6. Correlation coefficients between blood indices and daily nutrient intakes in the subjects (n = 102)

	Energy	Protein	MPF[1] protein	Crude fiber	Iron	Heme iron	Vitamin A	Vitamin C
Hb	0.284**	0.177	0.083	0.082	0.275**	0.175†	0.183†	−0.010
Hct	0.118	0.030	−0.055	0.046	0.025	−0.036	0.084	0.008
MCHC	0.170†	0.146	0.151	0.053	0.243*	0.214*	0.063	−0.011
Serum iron	0.098	0.085	−0.067	0.111	0.045	−0.099	0.175†	0.101
TIBC	−0.018	−0.043	−0.071	−0.147	−0.033	0.000	−0.060	−0.058
TS	0.094	0.098	−0.049	0.141	0.046	−0.101	0.187†	0.117
Serum ferritin	0.240*	0.211*	0.046	0.104	0.229*	−0.004	0.257*	0.090

1) Meat, poultry and fish protein, * : p<.05, ** : p<.01, † : .05<p<.1

vitamin A tended to show positive correlations with Hb, SI, and TS ($0.05 < p < 0.1$), in addition to Ft. It was reported that Hb levels were improved by vitamin A supplementation in anemic pregnant women whose vitamin A intakes were marginal or just adequate (Suharno et al. 1993). The vitamin A effect of the increased uptake of iron by the erythropoietic system was suggested (Ribaya-Mercado, Mayer 1997). However it was recently reported that adding vitamin A to iron supplementation did not increase Hb level in anemic pregnant women (Suprapto et al. 2002). A further study is needed to clarify the vitamin A effect on iron status.

5. Effects of smoking and coffee drinking on iron status

Cigarette and coffee may be associated with the iron status. Haematological indices and nutrient intakes by smokers and non-smokers, and those by two levels of coffee drinkers and non-drinkers are presented in Table 7, 8, respectively.

Higher levels of Hb and MCHC were found in male smokers than in non-smokers, although there were no significant differences between the two groups in nutrient intakes except vitamin C, which was a little lower in smokers. So cigarette smoking itself may affect hematologic status. This result agreed with other studies. According to Beser et al (1995) both male and female smokers had significantly higher Hct values than non-smokers, and Hb and Hct were decreased when smokers quit smoking. Smokers taking daily 10 cigarettes or more were also reported to have increased Hb levels (Whitehead et al. 1995). It was suggested that increased blood CO_2 concentration and decreased oxygen

Table 7. Serum indicators of iron status and daily nutrient intakes by smoking habits in men

	Non-smoker (n = 32)	Smoker (n = 14)
Hb (g/dL)	15.2 ± 1.5[1)]	16.4 ± 1.4*
Hct (%)	43.4 ± 3.7	43.3 ± 4.0
MCHC (g/dL)	35.2 ± 4.1	38.2 ± 5.6*
Serum ferritin (μg/L)	90.7 ± 55.9	86.7 ± 48.8
Serum iron (μg/dl)	135.5 ± 53.4	134.0 ± 46.0
TIBC (μg//dL)	340.7 ± 52.2	361.7 ± 30.0
TS (%)	40.7 ± 17.2	37.2 ± 2.8
Energy	2081 ± 452	2188 ± 923
Protein	76 ± 22	80 ± 46
MPF protein[2)]	28 ± 28	31 ± 27
Total iron	12.8 ± 4.1	15.1 ± 10.2
heme iron	1.4 ± 1.6	1.8 ± 1.6
Lipid	50 ± 18	50 ± 29
Crude fiber	7.1 ± 3.0	6.8 ± 4.0
Vitamin A	362 ± 173	367 ± 301
Vitamin C	97 ± 40	71 ± 36*
Riboflavin	1.3 ± 0.4	1.4 ± 0.7

1) Mean ± SD, 2) Meat, poultry and fish protein
* : $p < .05$

Table 8. Serum indicators of iron status and daily nutrient intakes by coffee drinking habits

	Men			Women		
	None (n = 8)	< 3cups/d (n = 28)	≥ 3cups/d (n = 10)	None (n = 5)	< 3cups/d (n = 37)	3 ≥ cups/d (n = 9)
Hb (g/dL)	14.2 ± 1.6[c1)]	15.7 ± 1.3[a]	15.9 ± 1.5[a]	12.9 ± 1.3	13.2 ± 1.5	13.4 ± 1.8
Hct (%)	41.8 ± 3.3	44.3 ± 3.8	42.5 ± 5.3	37.5 ± 2.4	37.3 ± 3.8	33.8 ± 6.8
MCHC (g/dL)	34.0 ± 2.4[b]	35.7 ± 4.4[ab]	38.0 ± 6.2[a]	34.5 ± 2.0[b]	35.4 ± 3.4[b]	40.7 ± 7.9[a]
Serum ferritin (μg/L)	65.8 ± 44.7[b]	77.7 ± 40.7[b]	144.7 ± 60.1[a]	41.0 ± 21.6[c]	20.3 ± 16.0[b]	29.9 ± 23.2[ab]
Serum iron (μg/dL)	133.8 ± 64.0	141.9 ± 53.4	116.8 ± 30.9	89.4 ± 32.7	99.6 ± 48.3	80.9 ± 45.3
TIBC (μg/dL)	333.8 ± 81.3	356.6 ± 36.9	327.9 ± 36.0	380.4 ± 80.0	369.3 ± 61.1	341.0 ± 52.0
TS (%)	43.7 ± 25.0	40.0 ± 15.2	35.7 ± 9.1	24.4 ± 9.8	24.5 ± 14.7	28.1 ± 14.7
Energy	1833 ± 373[b]	2074 ± 430[ab]	2426 ± 401[a]	1579 ± 388	1883 ± 343	1800 ± 387
Protein	73 ± 26	71 ± 17	95 ± 56	59 ± 20	67 ± 18	76 ± 19
MPF Protein[2)]	27 ± 24	31 ± 32	25 ± 14	17 ± 10[b]	23 ± 13[b]	35 ± 17[a]
Total iron	11.8 ± 4.1	12.9 ± 3.6	16.7 ± 8.1	10.4 ± 6.0	12.3 ± 3.6	12.8 ± 3.0
heme iron	1.4 ± 1.7	1.5 ± 1.6	1.2 ± 1.0	1.3 ± 1.0	1.4 ± 10.	1.8 ± 0.7
Lipid	46 ± 19	48 ± 19	57 ± 31	33 ± 17	45 ± 13	44 ± 13
Crude fiber	6.4 ± 2.1	6.5 ± 3.0	9.0 ± 4.4	5.1 ± 1.4	6.6 ± 2.7	6.6 ± 1.7
Vitamin A	286 ± 95[b]	324 ± 138[b]	560 ± 357[a]	294 ± 164	320 ± 163	288 ± 93
Vitamin C	87 ± 30	84 ± 41	108 ± 47	68 ± 26	80 ± 40	82 ± 20
Riboflavin	1.3 ± 0.3	1.28 ± 0.38	1.63 ± 0.82	0.98 ± 0.60	1.36 ± 0.48	1.23 ± 0.32

1) Mean ± SD, 2) Meat, poultry and fish protein
ab : Means within the row with different superscript differ significantly at $p < .05$ by Duncan's multiple range test

Table 9. Hemoglobin levels by coffee drinking and smoking in male adults

Coffee drinking	Smoking	N	Hb
No	No	8	14.2 ± 1.5[1)b]
Yes	No	24	15.4 ± 1.2[ab]
No	Yes	0	-
Yes	Yes	14	16.4 ± 1.4[a]

1) Mean ± SD, ab : Means within the row with different superscript differ significantly at $p < .05$ by Duncan'S multiple range test

partial pressure induced by smoking might promote erythropoiesis and hemoglobin synthesis (Tribble et al. 1993).

Coffee drinkers taking 3 cups per day or more were found to have higher levels of Hb, MCHC, and serum Ft in men, and MCHC in women, compared with non-coffee drinkers. More energy and vitamin A were taken by the male and MPF protein by the female coffee drinkers of 3 cups per day or more than those by non-coffee drinkers. Because energy and vitamin A intakes showed positive correlations with iron status (Table 6), better iron status of coffee drinkers than non-coffee drinkers might be due to the increased energy and vitamin A intakes, particularly in men.

In case of women, MCHC showed a significantly higher value in coffee drinkers taking 3 cups per day or more than those in non-coffee drinkers ; however non-coffee drinkers showed higher Ft level than coffee drinkers of less than 3 cups per day, and also higher, but not statistically significant, than coffee drinkers of 3 cups per day or more. Thus it was difficult to explain a certain tendency of the coffee effect on iron status. Moreover there were several reports which suggested coffee consumption has adverse effects on iron status in humans (Aldrian et al 1997 ; Garcia, Milena 1987). Garcia, Milena (1987) reported that lower Hb and Hct levels were observed in the offspring of coffee-exposed rats, and lower levels of maternal, cord, and infant Hb and Hct were found among human coffee drinkers, compared with non-coffee drinkers. Therefore to know the effect of coffee itself on iron status, more study will be needed. To examine the cross effect of smoking and coffee drinking, hematological indices were compared among the four groups as shown in Table 9. Coffee drinkers together with smoking showed higher Hb value than coffee drinkers without smoking, though not statistically significant (Table 9). But, because no male subject had smoking only without coffee drinking, it was not possible to know the added effect of coffee drinking to smoking.

Conclusion

The iron status and its relations with nutrient intake, coffee drinking, and cigarette smoking were evaluated through the hematological and dietary analysis in 102 Korean urban adults aged 20 − 49 years. Conclusively, daily dietary iron intake was adequate in men, but deficient in women. When defined by a single hematological criteria, impaired iron status prevalence ranged 2.1 − 43.8% for men and 5.6 − 50.0% for women. According to multifactorial analysis using hemoglobin concentration, transferrin saturation, and serum ferritin, the rate of iron-deficient anemia was 9.3% in women and 2.1% in men. The other 14.8% of women and none of men were in iron-deficient erythropoiesis, and 9.3% of women and 2.1% of men were in iron depletion state. As expected, the iron status of adult men showed much better than that of women. Among nutrient intakes energy, protein, iron, heme iron, and especially vitamin A were positively correlated with hematological indices. Cigarette smoking elevated Hb and MCHC, but the effect of coffee drinking on iron staus was not clear.

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