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Cross-Sectional Study on Iron Status of Asan Residents and Regional Comparison

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ABSTRACT

Iron deficiency and anemia are severe nutrition problems in most of Korea. Iron intake, especially iron with better bioavailability is insufficient over a total age group. Recent changes in diet and life style of Koreans have been repeatedly suggested problems caused by excess nutrient intake rather than under intake. Despite the changes in diet patterns, iron deficient anemia is still prevalent in many parts of Korea. Eight hundred and fifty subjects(323 male and 527 female subjects) in Asan were recruited from farming, factory and urban area. Each subject was interviewed to assess nutrients intakes according to a 24hr-recall method. Twelve hour fasting blood samples were collected to vacutainer with EDTA for hemoglobin(Hb) and separate the tubes for serum iron(SI) and total iron binding capacity(TIBC). The mean serum iron value of female subjects in the factory area was significantly higher($p < 0.05$) than that of the female subjects in the urban area although subjects in urban area showed significantly higher the dietary iron intake for both the men and woman($p < 0.05$). Dietary iron intake for the younger women was lowest in the farming area and those in the urban area showed the highest dietary iron intake($p < 0.05$). When the dietary iron intake was compared by different the age groups, dietary iron intake of the older women from animal sources was less than that of younger women in the urban area($p < 0.05$). Dietary iron intake of Asan residents was not sufficient regardless of age, sex and regions and intake of heme iron was especially lower than nonheme iron. (*J Community Nutrition* 5(1) : 37~43, 2003)

KEY WORDS : iron status · dietary iron intake · regional comparisons · asan residents.

Introduction

During rapid growth of economic status and industrialization, risks of developing nutritional deficiency as a result of insufficient food intake has dramatically decreased. However, iron-deficiency anemia is still one of the most prevalent nutritional concerns in both developing and industrialized countries, regardless of the age of the target population (Park 1996). Iron deficiency normally develops via successive stages, and each sequential event can be determined by various parameters. A combination of such parameter is indicative of iron deficiency(Cook, Skikne 1989 ; Finch, Cook 1984).

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According to Gibson(1990) and Lee and Nieman(1995), three successive stages of iron deficiency are explained by the amount of iron in three compartments(stores, circulating, and erythrocytes). Usually, the first stage of iron depletion - in which iron stores are depleted but amount of circulating and erythron iron is still sufficient - is reflected by decreased serum ferritin levels. The second stage of iron deficiency, iron - deficiency erythropoiesis, can be detected with several biochemical indexes, such as serum iron(SI), total iron binding capacity(TIBC) and percent transferrin saturation(TS). The hematologic parameters can only detect the third stage of iron depletion - iron-deficiency anemia with insufficient erythron iron - which also can be indicated by other biochemical indexes, SI, TIBC or TS. Therefore, in order to correctly estimate iron nutrition status, it is necessary to analyze several combinations of biochemical indexes as well as hematologic parameters(Anne et al. 1995).

In large scale epidemiological studies, most commonly used iron status parameters are hematological parameters,

such as hemoglobin(Hb) and hematocrit(Hct), due to the simple and easy analytical procedures compared to other parameters. These parameters, however, are the least sensitive parameters to detect all three stages of iron deficiency sequences. Therefore, in many community based nutritional examinations, iron status usually reported with Hb or Hct values did not correctly reflect the iron status of decreased body iron storage without physiologic phenomenon or iron deficient erythropoesis with reduced formation of red cells caused by iron deficiency.

In this study, we examined the iron status of Asan residents. Asan is a medium-sized Korean city with a population of 185,847. It shows a unique feature with three distinctive regions since there are some areas with various kinds of industrial factories such as semi-conductor factories or automobile, air-conditioner and refrigerator manufacturing factories ; meanwhile, other areas are mostly composed of rice farms or other kinds of rural farms in the boundaries of Asan. Some areas with a largely populated urban area(On-yang si) are also within the district of Asan. Therefore, Asan can be easily differentiated into three distinctive regions of factory, farming and urban areas. The purpose of this study was to examine the iron status of Asan residents and to compare the iron status of the residents by different kinds of regions in order to effectively improve the iron nutritional status of Asan residents.

Materials and Methods

1. Study population

A convenient sample of eight hundred fifty adults, 323 men and 527 women who were willing to sign the consent form were invited for a community-based health and nutrition examination during January and February of 2001. The average age of the subjects was 58 years(19 - 91 years), and three hundred fifty four subjects were recruited from the farming area(Yoo-gok ri and Dong-wha ri), three hundred thirty three subjects were from the factory area(Gum-sung gun, Shin-wha ri) and one hundred sixty three subjects were from a populated urban area(On-yang si) of Asan regions.

2. Data collection and analysis

Information about medical history, demographic characteristics, cigarette-smoking and alcohol-drinking habits were obtained and reviewed by an occupational physician. Dietary iron intake assessment was conducted using one-day 24-hr recall method by one-to-one interview with trained interviewers. Detailed descriptions of all foods and beverages consumed and estimated food portion sizes were recorded by trained interviewers using food models, standard household measures, and natural-sized colored photographs as memory aids. Food records were converted to nutrient intake by using a computerized nutrient analysis program(CAN-pro, The Korean Society of Nutrition, Seoul, Korea). After height and weight were measured, percentage body fat was measured by a portable bioelectrical impedance analyzer(TBF-501, Tanita, Japan) whilst the subject stood upright on a four-platform-type terminal impedance plethysmograph, in accordance with the manufacturer's instructions.

Fasting blood samples were obtained from the subjects by venipuncture after abstinence from food. Approximately 10ml venous blood was collected and divided into two tubes: 4ml blood in a vacutainer with EDTA for Hb, 6ml blood in a vacutainer with SST gel and Clot Activator for serum iron (SI) and total iron binding capacity(TIBC). Hemoglobin was assayed by the Coulter counter(COULTEA AcT 8, UK) at whole blood in EDTA bottle. Serum iron and total iron binding capacity were measured by spectrophotometric procedure (TOSHIBA TBA-40FR, Japan) using serum after centrifuging blood in SST gel and clot activator tube. Percentage transferrin saturation(TS) was calculated by dividing SI by TIBC and multiplying by 100. Quetelet's index [weight (kg)/ height(m^2)] was used as a measure of body mass index (BMI).

3. Statistical analysis

Statistical analysis was conducted using SPSS 11.0. Data were expressed as the mean ± standard deviation. Statistical significance was determined at the 0.05 level by t-test, ANOVA and Tukey's test. For each iron deficiency stage, we used the chi-square test.

Results and Discussions

1. General characteristics

The general characteristics of subjects by regions are shown in Table 1. For the male subjects, the average age of the subjects in each area was not different. However, for the female subjects, the mean age of the subjects in the urban area was significantly younger than those of the other regions ($p < 0.05$). Accordingly, the mean height of the subjects in

Table 1. General characteristics of the subjects by regions[1)2)]

	Male				Female			
	Farming area	Factory area	Urban area	Total	Farming area	Factory area	Urban area	Total
N(%)	134(38)	137(41)	52(32)	323(100)	220(62)	196(59)	111(68)	527(100)
Age(yrs)	60.1±12.4	59.7±12.1	55.7±17.1	59.2±13.2	58.3±13.1[a)]	58.8±12.4[a)]	53.3±16.4[b)]	57.5±13.8
Height(cm)	165.1± 6.1	164.9± 5.7	166.0± 6.3	165.1± 6.0	151.1± 5.9[a)]	152.5± 6.0[ab)]	152.9± 7.5[b)]	152.0± 6.3
Weight(kg)	64.1± 9.7	65.0±10.0	67.8± 9.8	65.1± 9.9	57.2± 9.6	59.3±10.5	57.3± 8.9	58.0± 9.9
BMI	23.5± 2.8[a)]	23.8± 2.9[ab)]	24.6± 2.9[b)]	23.8± 2.9	25.0± 3.5	25.4± 3.9	24.5± 3.5	25.1± 3.7
Body fat(%)	24.2± 6.2[a)]	26.0± 7.4[ab)]	27.3± 5.1[b)]	25.5± 6.7	37.3± 8.3	37.8± 8.1	35.8± 7.7	37.2± 8.1
				χ^2				χ^2
Smoking(%)	62.7	63.5	44.2	6.494*	3.6	8.2	6.3	3.882
Alcohol(%)	70.1	70.8	71.2	0.023	27.7	18.4	33.3	9.425**

1) Values are Mean ± SD, 2) Values not sharing same alphabetical superscripts within a raw are significantly different($p < 0.05$) among regions by one-way ANOVA and Tukey's test.
* : $p < 0.05$, ** : $p < 0.01$

Table 2. Iron status of the subjects by regions[1)2)]

	Male				Female			
	Farming area	Factory area	Urban area	Total	Farming area	Factory area	Urban area	Total
N(%)	134(38)	137(41)	52(32)	323(100)	220(62)	196(59)	111(68)	527(100)
Hb(g/dl)	14.5± 1.3[a)]	14.8±1.2[b)]	14.6±1.3[ab)]	14.6± 1.3	12.8± 1.1	12.8± 1.1	12.7± 1.1	12.8±1.1
Serum Iron (μg/dL)	124.6±43.0	134.1±50.6	122.2±42.8	128.2±46.5	095.9±33.1[ab)]	100.5±34.8[a)]	89.9±38.4[b)]	96.3±35.0
TIBC(μg/dL)	352.0±61.6	352.4±63.1	353.7±54.5	352.5±61.0	367.0±58.6	371.3±54.1	363.8±48.3	367.9±54.9
TS(%)	37.0±16.0	38.7±16.0	35.5±14.1	37.5±15.1	26.7± 9.5	27.7±10.6	25.5±11.6	26.8±10.4
Iron intake (mg/day)	7.6± 4.1[a)]	9.9±6.6[b)]	10.8± 7.7[b)]	9.1± 6.1	7.2± 5.0[a)]	7.6± 3.7[ab)]	8.7± 4.7[b)]	7.6±4.5
Animal Fe (mg/day)	1.9± 3.2	2.4±4.2	2.1± 2.0	2.1± 3.5	1.5± 2.2	1.4±1.8	1.8± 1.9	1.5±2.0
Plant Fe (mg/day)	6.0± 3.0[a)]	7.7±4.3[b)]	8.9± 6.9[b)]	7.2± 4.5	5.8± 4.4[a)]	6.3±3.1[ab)]	7.2± 4.5[b)]	6.3±4.0
% RDA	63[a)]	82[b)]	90[b)]	76	56	58	63	58
Energy(kcal)	1666±608	1703±834	1712±599	1689±709	1328±484	1358±457	1441±539	1363±488
% RDA	76	77	77	77	72	74	77	74
Protein(g)	46± 19[a)]	57± 44[b)]	54± 24[ab)]	52± 33	40± 17[a)]	41± 15[a)]	50± 21[b)]	43± 18
% RDA	69[a)]	85[b)]	81[ab)]	78	74[a)]	76[a)]	92[b)]	79
Ascorbic acid (mg)	97±119	100±145	72± 45	94±123	87± 87	95±102	84± 78	89± 91
% RDA	139	144	103	135	125	136	121	128

1) Values are Mean ± SD, 2) Values not sharing same alphabetical superscripts within a raw are significantly different($p < 0.05$) among regions by one-way ANOVA and Tukey's test.
TIBC : Total iron binding capacity, TS : transferrin saturation

the urban area was taller than those of the other two regions ($p < 0.05$). Although the mean age and other values of the male subjects were not significantly different by regions, the mean BMI and body fat percentage values were significantly higher for the male subjects in the urban area compared to the subjects in the other regions($p < 0.05$). Body fat percent is considered to be high if men are more than 25% and women are more than 30%(Bray 1987). In this population, BMI values for the subjects were within the normal range. However, the mean values of body fat of female subjects in all three regions were higher than the normal range with no differences among the regions. On the other hand, male subjects showed the normal average values for both BMI and body fat except for the urban male subjects. Since male subjects in the urban area showed higher BMI and body fat values, it is important to offer a proper intervention for the urban male subjects such as regular exercises and increase every day activities. There were more male smokers in the factory area($p < 0.05$) while more alcohol drinkers were observed in the urban area for female subjects($p < 0.01$).

2. Iron status

Table 2 shows the average values of various biochemical indexes of iron status and dietary iron intake. The mean hemoglobin value of the male subjects in the factory area was significantly higher than that of the male subjects in the farming area($p < 0.05$). Female subjects in the factory area showed significantly the higher serum iron concentration than the female subjects in the urban area. Subjects in this study showed higher hemoglobin levels than other subjects from the study on the middle aged men and women by Lee and Woo(2000). Therefore, the general iron status of this population could be considered as normal compared to the other middles aged subjects and especially those from the factory area showed better iron status than the subjects from the other two regions of Asan.

For the dietary intakes, subjects in the urban area showed significantly higher dietary iron intake for both men and women($p < 0.05$). But significant differences in animal iron intake were not observed while iron from plant sources were higher in the urban area for both men and women. Despite iron from animal food is considered to be a better iron source than iron from plant food due to better bioavailability, most dietary iron intake for the subjects of this study was from plant sources regardless of the regions. Dietary intakes of other nutrients, which are known to influence the amount of iron intake or iron bioavailability, such as energy, protein and ascorbic acid were also evaluated. Energy and ascorbic acid intakes did not show any differences among the regions, but the protein intake of male subjects in the factory area and female subjects in the urban area showed significantly higher compared to the other regions($p < 0.05$). Even if we can not completely eliminate the possibility of measurement error caused by the day to day dietary variation due to the one-day 24hr recall method, dietary intake of the farming area was relatively insufficient in both quantity and quality aspects compared to the other regions.

Table 3 shows the iron status determined by different laboratory assessments of the relative body iron quantities of the subjects according to the different stages of iron deficiency. Iron deficiency anemia was determined using Hb concentration(male <13.5g/dl, female <12g/dl) as described by Gibson(1990). As expected, the most severe cases of iron deficiency, the third stage of iron deficiency were not very high in this population. For both men and women, about 14 - 18% of the total population was iron deficiency anemia. The regional differences were not statistically significant. When the second stage of iron deficiency, which is often referred to as iron-deficient erythropoiesis, was deter-

Table 3. Iron status of the subjects at different stages determined by hematologic and iron-status parameters

		Male				Female			
		Farming area	Factory area	Urban area	χ^2	Farming area	Factory area	Urban area	χ^2
Total N(%)	850(0)	134(100)	137(100)	52(100)		220(100)	196(100)	111(100)	
Iron deficient anemia determined by hemoglogic parameters									
Hemoglobin									
Male <13.5mg/dL	Yes	23(17.2)	16(11.7)	7(13.5)	1.700	33(15.0)	29(14.8)	20(18.0)	0.650
Female <12mg/dL	No	111(82.8)	121(88.3)	45(86.5)		187(85.0)	167(85.2)	91(82.0)	
Iron deficient erythropoiesis determined by iron-status parameters									
Serum iron	Yes	7(5.2)	2(1.5)	1(1.9)	3.483	30(13.6)	18(9.2)	24(21.6)	9.294*
<60 μg/dL	No	127(94.8)	135(98.5)	51(98.1)		190(86.4)	178(90.8)	87(78.4)	
TIBC	Yes	26(19.4)	23(16.8)	10(19.2)	0.349	70(31.8)	61(31.1)	32(28.8)	0.314
>390 μg/dL	No	108(80.6)	114(83.2)	42(80.8)		150(68.2)	135(68.9)	79(71.2)	
TS	Yes	4(3.0)	1(0.7)	0(0.0)	3.235	21(9.5)	15(7.7)	20(18.0)	8.481*
<15%	No	130(97.0)	136(99.3)	52(100)		199(90.5)	181(92.3)	91(82.0)	
Iron depletion determined by iron-status parameters									
Serum iron	Yes	58(43.3)	53(38.7)	25(48.1)	1.494	163(74.1)	140(71.4)	83(74.8)	0.543
<115 μg/dL	No	76(56.7)	84(61.3)	27(51.9)		57(25.9)	56(28.6)	28(25.2)	
TIBC	Yes	47(35.1)	56(61.3)	19(36.5)	1.010	110(54.1)	104(53.1)	49(44.1)	3.185
>360 μg/dL	No	87(64.9)	81(59.1)	33(63.5)		101(45.9)	92(46.9)	62(55.9)	
TS	Yes	49(36.6)	39(28.5)	23(44.2)	4.645	143(65.0)	124(63.3)	72(64.9)	0.154
<30%	No	85(63.4)	98(71.5)	29(55.8)		77(35.0)	72(36.7)	39(35.1)	

* : $p < 0.05$, TIBC : total iron binding capacity, TS : transferrin saturation

mined by TIBC higher than 390 μg/dl described as in Gibson(1990), there were no regional differences observed in both men and women. Even if TIBC showed a relatively low biological and intra-individual variation(Ahluwalia 1993), TIBC was not a good indicator of second stage iron deficiency for this population. When iron-deficiency erythropoiesis was determined either by serum iron less than 60 μg/dl or TS less than 15% as in Gibson(1990), women in the urban area showed significantly more prevalence of second stage iron deficiency than the other two regions ($p < 0.05$). The first stage of iron deficiency, a stage of depleted iron storage, was high for both men and women (35 - 40% for men and 44 - 54% for women) with no regional differences. Generally, subjects in the farming area showed higher incidences of iron deficient cases, especially for the female subjects, but the differences were not statistically significant.

The results of the present study showed that the overall diet intake of the Asan residents was not adequate. The amount of iron intake was inappropriate for both men and women, although the range variations were large. As expected, more women showed a tendency of insufficient iron intake. Iron status, however, was mostly in normal range for both men and women although more women showed the marginal iron deficiency. The discrepancy observed could be explained by underreporting tendency in dietary survey(Johansson et al. 2001). It could be also due to the age related physiological changes which could result in changes in iron metabolism(Hebert 1990 ; Vogel 1980 ; Yip, Dallman 1984). However, since the mean ages of the different regions of male subjects were not different and the age related physiological changes of women are more severe than men, we analyzed data of the female subjects in two different age groups of those over 50 years old and those under 50 years old.

Table 4 shows the average values of biochemical index of iron status of women with two different age groups and compared by the regions. Women who were younger than 50 years old and mostly of childbearing age, did not show iron status as good as those of older women who were older than 50 years old and mostly after the menopause, as we expected. The regional differences among younger women were not observed. Dietary iron intake for the younger women, however, was lowest in the farming area and those in the urban area showed the highest dietary iron intake. For older women, iron status of the subjects in the factory area was the highest while dietary iron intake was not significantly different. Protein intakes showed regional differences only among the younger women. Subjects in the urban

Table 4. Iron status of female subjects by regions in two age groups[1)2)]

	<50 year				≥ 50 year			
	Farming area	Factory area	Urban area	Total	Farming area	Factory area	Urban area	Total
N(%)	60(35)	57(33)	54(32)	171(100)	160(45)	139(39)	57(16)	356(100)
Hb(g/dL)	12.7 ± 1.2	12.5 ± 1.4	12.4 ± 1.3	12.5 ± 1.3	12.9 ± 1.0	13.0 ± 1.0	13.0 ± 0.9	13.0 ± 1.0
Serum Iron (μg/dL)	96.4 ± 35.0	91.1 ± 38.3	87.5 ± 44.7	91.8 ± 39.3	95.7 ± 32.5$^{ab)}$	104.3 ± 32.6$^{a)}$	92.2 ± 31.5$^{b)}$	98.5 ± 32.6
TIBC(μg/dL)	374.8 ± 59.3	393.1 ± 67.9	370.1 ± 53.5	379.4 ± 61.1	364.1 ± 58.2	362.4 ± 44.6	357.8 ± 42.3	362.4 ± 50.8
TS(%)	26.7 ± 11.2	24.0 ± 10.5	24.8 ± 13.6	25.2 ± 11.8	26.7 ± 8.8	29.3 ± 10.2	26.0 ± 9.3	27.6 ± 9.5
Iron Intake (mg/day)	7.2 ± 3.4$^{a)}$	8.5 ± 3.8$^{ab)}$	9.6 ± 5.0$^{b)}$	8.4 ± 4.2	7.2 ± 5.5	7.2 ± 3.7	7.7 ± 4.4	7.3 ± 4.7
Animal fe (mg/day)	1.5 ± 1.5	1.5 ± 1.5	2.2 ± 2.3	1.7 ± 1.8	1.5 ± 2.4	1.4 ± 2.0	1.4 ± 1.4	1.4 ± 2.1
Plant fe (mg/day)	5.8 ± 2.9$^{a)}$	7.1 ± 3.4$^{ab)}$	7.9 ± 5.1$^{b)}$	6.9 ± 3.9	5.8 ± 4.8	6.0 ± 2.9	6.4 ± 3.7	6.0 ± 4.0
% RDA	46$^{a)}$	55$^{ab)}$	61$^{b)}$	53	60	60	64	61
Energy(kcal)	1505 ± 612	1403 ± 78	1589 ± 648	1497 ± 560	1261 ± 410	1340 ± 486	1300 ± 362	1298 ± 435
% RDA	75	71	80	75	71	75	74	73
Protein(g)	45 ± 17$^{a)}$	44 ± 16$^{a)}$	56 ± 23$^{b)}$	48 ± 20	39 ± 16	40 ± 15	45 ± 17	40 ± 16
% RDA	82$^{a)}$	81$^{a)}$	103$^{b)}$	88	71	74	82	74
Ascorbic acid (mg)	107 ± 113	99 ± 95	104 ± 97	103 ± 101	79 ± 74	93 ± 105	65 ± 47	82 ± 85
% RDA	154	142	149	148	114	134	94	118

1) Values are Mean ± SD, 2) Values not sharing same alphabetical superscripts within a raw are significantly different($p < 0.05$) among regions by one-way ANOVA and Tukey's test.
TIBC : total iron binding capacity, TS : transferrin saturation

area showed higher protein intake. This result can be confirmed by the results of 2001 National Health and Nutrition Survey, which showed more severe differences in dietary intake by household income levels(Korean Health Industry Development Institute 2002). Household income of the rural area residents was lower than that of the urban area in this population(data not shown) and those with lower income level showed less dietary intake than those with higher income levels both in this study and the national study(Korean Health Industry Development Institute 2002). However, among the older age groups, dietary intake of energy and protein were lower than 75% of RDA except for the protein intake of the urban women. Due to the low dietary intake of all regions, regional differences were not observed among older women unlike among younger women. Therefore, dietary intake of older population and younger women with lower income levels were insufficient compared to the other population.

Table 5 compares the iron status of the female subjects in two different age groups. As we expected and confirmed in Table 4, older women showed higher serum iron status compared to the younger women, although dietary iron intake of the older women was less than that of younger women in the factory and urban areas. This result can be explained by the physiological changes of the female subjects(Hebert 1990 ; Vogel 1980 ; Yip & Dallman 1984). However, in the farming area, younger women did not show any differences in dietary iron intake when compared to that of the older women. Younger women are at higher risk of iron deficiency than older women, which was also confirmed in this population as shown in Table 4. Fortunately, most younger women showed higher dietary iron intake than older women, although the amount was not adequate. Younger women in the urban area showed significantly higher dietary iron intake from animal sources. Younger women in the farming area, however, were at the highest risk of iron deficiency due to inadequate dietary intake and physiological conditions(Min, Koo 1986). Overall results of iron status of women in the two different age groups, dietary iron intake was inadequate in all age groups regardless of regions, although younger women in the urban area showed better dietary iron intake tendency compared to the other groups. The results of iron status were different according to the iron status indicators used. It is not surprising since there was a previous report announcing that none of the in-

Table 5. Comparison of dietary iron intake of the female subjects by age groups[1)2)]

	Farming Area			Factory Area			Urban Area		
	< 50 year	≥ 50 year	Total	< 50 year	≥ 50 year	Total	< 50 year	≥ 50 year	Total
N(%)	60(27)	160(73)	220(100)	57(29)	139(71)	196(100)	54(49)	57(51)	111(100)
Hb(g/dL)	12.7 ± 1.2	12.8 ± 1.0*	12.8 ± 1.1	12.5 ± 1.4	13.0 ± 1.0*	12.9 ± 1.1	12.4 ± 1.3	13.0 ± 0.9*	12.7 ± 1.1
Serum Iron(μg/dL)	96.4 ± 35.0	95.7 ± 32.5	95.9 ± 33.1	91.1 ± 38.3	104.3 ± 32.6	100.5 ± 34.8	87.5 ± 44.7	92.2 ± 31.5**	89.9 ± 38.4
TIBC(μg/dL)	374.8 ± 59.3	364.1 ± 58.2	367.0 ± 58.6	393.1 ± 67.9	362.4 ± 44.6***	371.3 ± 54.1	370.1 ± 53.5	357.8 ± 42.3*	363.8 ± 48.3
TS(%)	26.7 ± 11.2	26.7 ± 8.8*	26.7 ± 9.5	24.0 ± 10.5	29.3 ± 10.2	27.7 ± 10.6	24.8 ± 13.6	26.0 ± 9.3**	25.4 ± 11.6
Iron Intake(mg/day)	7.2 ± 3.4	7.2 ± 5.5	7.2 ± 5.0	8.5 ± 3.8	7.2 ± 3.7	7.6 ± 3.7	9.6 ± 5.0	7.7 ± 4.4	8.7 ± 4.7
Animal fe(mg/day)	1.5 ± 1.5	1.5 ± 2.4	1.5 ± 2.2	1.5 ± 1.5	1.4 ± 2.0	1.4 ± 1.8	2.2 ± 2.3	1.4 ± 1.4*	1.8 ± 1.9
Plant fe(mg/day)	5.8 ± 2.9	5.8 ± 4.8	5.8 ± 4.4	7.1 ± 3.4	6.0 ± 2.9	6.3 ± 3.1	7.9 ± 5.1	6.4 ± 3.7	7.2 ± 4.5
% RDA	46	60*	56	55	60	58	61	64	63
Energy(kcal)	1505 ± 612	1262 ± 411*	1328 ± 485	1403 ± 378	1341 ± 487	1359 ± 458	1590 ± 649	1300.38 ± 362.63	1441 ± 539
% RDA	75	71	72	71	75	74	80	74	77
Protein(g)	45 ± 18	39 ± 17*	41 ± 17	44 ± 16	41 ± 16	42 ± 16	57 ± 24	45.08 ± 17.76**	51 ± 22
% RDA	82	71*	74	81	74	76	103	82**	92
Ascorbic acid(mg)	108 ± 113	80 ± 74	87 ± 87	99 ± 95	94 ± 106	95 ± 102	104 ± 97	65.65 ± 47.78*	84 ± 78
% RDA	64	56*	58	142	134	136	149	94*	121

1) Values are Mean±SD, 2) Significantly different between two age groups by t-test, * : p <0.05, **: p <0.01, *** : p <0.001
TIBC : total iron binding capacity, TS : transferrin saturation

dicators of iron status, elevated Hb, hematocrit, SI, TIBC, TS, transferrin or ferritin, accurately reflects body iron (Cook et al. 1976).

Summary and Conclusions

This study measured general characteristic, biochemical indexes of iron status and dietary iron intake of the subjects. Iron nutritional status was investigated among residents from farming, factory and urban areas by regional characteristic. A total of eight hundred ninety five subjects(male 323, female 527) participated in the study. The results are as follows :

1) The average ages of the male subjects in each area were not different. However the mean age of the female subjects in the urban area was significantly younger than those of the other regions. BMI and body fat percentage values of male subjects were significantly higher in the urban area compared to the subjects in the other regions.

2) The mean hemoglobin value of the subjects in the factory area was significantly higher than that of the subjects in the farming area among male subjects. Female subjects in the factory area also showed a higher iron status than the female subjects in the other regions, especially the mean serum iron value was significantly different. For the dietary intakes, subjects in the urban area showed significantly higher dietary iron intake for both men and woman.

3) For the female subjects, incidences of iron deficient erythropoiesis determined by TIBC was increased up to 30% while only 17 - 19% of the male subjects were categorized as iron deficient erythropoiesis. The first stage of iron deficiency, a stage of depleted iron storage, was high for both men and women.

4) Dietary iron intake for the younger women(under 50 years old) was lowest in the farming area and those in the urban area were the highest. For older women(50 years or older), iron status of the subjects in the factory area was the highest while dietary iron intake was not significantly different. When the dietary iron intake was compared by age of the female subjects, dietary iron intake of the older women was less than that of younger women in the factory and urban areas, although the iron status of older women determined by biochemical indexes was higher than younger women. Therefore, younger women, especially those in the farming area are at higher risk of iron deficiency than older women in both physiological and life-style aspects.

References

Anne C, Looker, PhD, Elaine W, Gunter, MT(ASCP) : And Clifford L. Johnson, MSPH(1995) : Methods to Assess Iron Status in Various NHANES Surveys. *Nutr Rev* 53(9) : 246-254

Ahluwalia N, Carol JL, Haley NR and Beard JL(1993) : Day-to-day variation in iron-status indexes un eldery women. *Am J Clin Nutr* 57 : 414-419

Bray GA(1987) : Overweight is risking fate : Definition. Classification. Prevalence and risk. *Ann Ny Aca Sci* 14 : 499

Cook JD, Finch CA, Smith NJ(1976) : Evaluation of the iron status of a population. *Blood* 48 : 449-455

Cook JD, Skikne BS(1989) : Iron deficiency : definition and diagnosis. *J Inter Med* 226 : 349-355

Finch CA, Cook JD(1984) : Iron deficiency. *Am J Clin Nutr* 39 : 471-477

Gibson RS(1990) : Assessment of iron status. In : Principles of Nutrition Assessment. pp.349-376, *Oxford University Press*, New York

Herbert V(1990) : Nutritional anemias in the elderly. In : Prinsley DM, Sandstead HH eds. Nutrition and aging. pp.203-227, Alan R Liss, New York

Johansson G, Wikman A, Ahren A, Hallmans G, Johansson I(2001) : Underreporting of energy intake in repeated 24-hour recalls related to gender, age, weight status, day of interview, educational level, reported food intake, smoking habits and area of living. *Public Health Nutr* 4(4) : 919-927

Korean Health Industry Development Institute(2002) : Ministry of Health and Welfare. Report on 2001 National Health and Nutrition Survey(Nutrition Survey)

Lee MS, Woo MK(2000) : A Study on Health-related Habits, Dietary Behaviors and Health Status of the Middle Aged and the Elderly Living in Chonju Area. *Korean J Nutr* 33(3) : 343-352

Lee RD, Nieman DC(1995) : Iron status. In : Nutritional Assessment. pp.402-410, McGrow-Hill, New York

Min BK, Koo BS(1986) : A Study of Menopause in Korean Women(II). *Korean Journal of Obstetrics and Gynecology* 29(9) : 1209-1218

Park HR(1996) : Current Nutritional Status by Different Age Group. *Korean J Comm Nutr* 1(2) : 301-322

Vogel JM (1980) : hematologic problems of the aged. *Mt Sinai J Med* 47 : 150-165

Yip R, Dallman PR(1984) : Age-related changes in Laboratory values used in the diagnosis of anemia and iron deficiency. *Am J Clin Nutr* 39 : 427-436